© 2017 IJSRST | Volume 3 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Using of Olive Oil By-Products In Farm Animals Feeding

A. A. M. Habeeb*, A. E. Gad, A. A. EL-Tarabany, M. M. Mustafa, M. A. A. Atta
Biological Applications Department, Radioisotopes Applications Division, Nuclear Research Center, Atomic Energy Authority, Cairo, Egypt

ABSTRACT

Olive by-products represent an important group of feed resources for ruminants in the Mediterranean areas. Noteworthy studies have been conducted in recent years showing the potential use of the different olive by-products in both animal performance and product quality. From these studies some practical recommendations can be highlighted as olive leaves provide half of the energy and amino acid requirements of sheep and goats at maintenance level and, if adequately supplemented, can be used as part of the forage in diets for production. It is recommended to feed olive leaves fresh rather than dried or ensiled. Olive cakes can be preserved in different ways, ensiling or incorporation into multi-nutrient blocks being the most successful developed so far the use of olive by-products rich in oil appears to increase the content of mono-unsaturated fatty acids and lower the content of saturated fatty acid in milk. However, high level of Cu in olive leaves could restrict the use of this by-product in practical feeding.
Keywords: Olive By-Products, Olive Cakes, Feed Intake, Digestibility, Blood Components.

I. INTRODUCTION

Due to the shortage of feed ingredients and the lack of sufficient feeds to meet the nutritional requirements of existing animal population there is a critical problems of animal production in Egypt, especially, in these days where they are using some of the ingredient for production of bio-energy [1]. These will lead to a big problem in animal production, especially, in the developing countries including Egypt. There are some byproducts that can be used for feeding animals as an alternative of feed ingredient. Olive pulp (OP) represents one of those byproducts which may be used as a nutritive source [2]. Many authors have described the use of olive cake (OC), the main by-product from olive oil industry, in animal feeding as air dried [3], ensiled [4] and soda or ammonia-treated feedstuff [5]. Olive cake is featured by high neutral detergent fiber (NDF) (51.3% dry matter, DM) and acid detergent lignin (ADL) (24% DM) but low crude protein (CP) (5.5% DM). Olive pulp is the remainder of olive cake (the raw material resulting from extraction of olive oil) after the removal of the seed fractions [6].

It can be achieved by sieving the dry OC to separate most of the seeds. About 0.3 of cell wall fraction will be removed by sieving [7]. Olive pulp may be a suitable raw material in livestock diets and help to save cereals which can be used for human consumption. Feasibility studies have shown that there is good intake for many livestock species without any harmful effect on health, blood parameters or carcass merits. With high fiber content in OP, it is mainly suitable for ruminants [8]. Agro-industrial by-product as OP could be successfully used in formulating concentrate mixtures for Frisian calves to 30%, especially, when the traditional feed ingredients are not available and expensive [9]. In addition, this feed ingredient reduces the feed cost without any adverse effect or harmful to calves healthy. The agro-industrial by-products have a considerable importance for animal feeding, especially, in the Mediterranean area, considering the nutritional characteristics of the forage resources available. For this reason, the aim of the review paper was to study the utilization of olive oil byproduct in farm animals feeding

Olive production:

The land area occupied by olive orchards has increased in recent years, largely in response to the worldwide rise in olive oil consumption [10]. Mediterranean countries represent 65% of the world's surface area cultivated in olives, 76% of the trees in production and, 74% of total olives harvested. Globally olive orchards occupied 8046 thousand ha in 1981 and 10,149 ha in 2001. The world production of olive oil has risen from 2,459.4 thousand tons in 1996/97–1999/2000 to 2,765.1 in 2000/01–2003/04. The estimation for olive oil production in 2005/06 is 2,584.5 thousand tones. Production across the 25 countries of the European Union, where Spain (45%), Italy (31%) and Greece (22%) are the largest producers, is expected to account for almost 75% of the world's olive oil. The chemical composition of olive fruits (olive pulp, stone and seed) as a percentage are in **Table (1) and Figure (1).**

TABLE 1 Chemical composition of olive fruit (%) [30]

Components	Olive pulp	Stone	Seed
Water	50.00-60.00	9.30	30.00
Oil	15.00-30.00	0.70	27.30
N-content g-components	2.00-3.00	3.40	10.20
Sugar	3.00-7.50	41.00	26.60
Cellulose	3.00-6.00	38.00	1.90
Minerals	1.00-2.00	4.10	1.50
Polyphenols	2.25-3.00	0.10	0.50-1.00
Other components		3.40	2.40

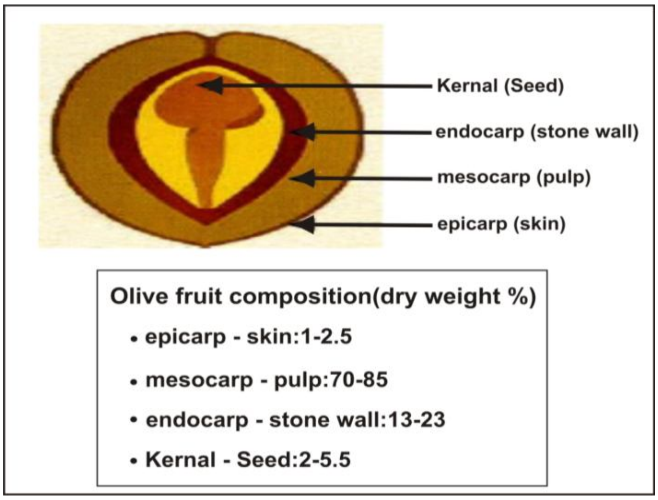

Figure 1 Olive fruit components

Olive by-products:

By-products derived from the olive trees and olive oil extractions are generally known as olive by-products. The different by-products considered in this review are defined as follows.

Olive leaves:

This product refers to a mixture of leaves and branches from both, the pruning of olive trees as well as the harvesting and cleaning of olives prior to oil extraction. The production of olive leaves from pruning has been estimated to be 25 kg per olive tree, to which can be added 5% of the weight of harvested olives that is collected at the oil mill [11].

Olive cakes:

Olive cakes consist of olive pulp, skin, stone and water. Different terms may be given depending on factors such as composition and oil content (crude or extracted olive cakes), stones or moisture (fresh or dry olive cakes). The different oil extraction procedures and resulting by-products have recently been documented by Alburquerque et al. [12].

It is worth distinguishing between olive cakes from three (3P olive cakes) and two-phase (2P olive cakes) centrifugation extraction procedures **(Figure 2).**

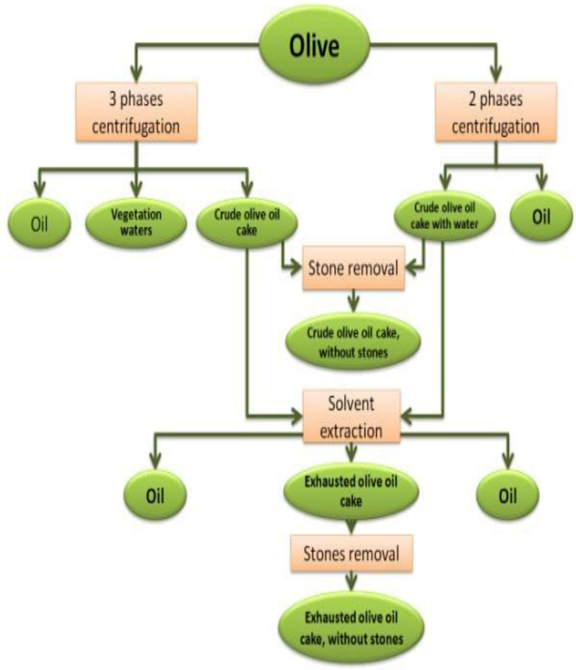

Figure 2 Phases of olive oil extraction and by-product production.

The main difference is the higher moisture and the lower oil content from the 2P olive cakes procedure, as a result of a more efficient and environmentally friendly centrifugation process, compared to the traditional system (3P olive cakes). For 1000 kg of olives the three-phase procedure generates 550 kg of olive cakes while the two-phase procedure produces 800 kg. Olive stones may be a single by-product when they are well separated from pulp either before or after oil extraction. This separation results in another by-product, olive pulp.

Oil extraction also produces watery waste which is sometimes dried and transformed into a concentrate known as olive molasses. Finally, olive cake is increasingly used as fuel in olive oil mills and in power generation, which results in a new by-product called olive cake ash. An estimated 140–160 g of olive cake ash is produced per kg of ^{O}C. Machine for olive oil extraction by centrifugation is shown in **Figure (3).**

Olive oil extraction by centrifugation

Figure 3 Machine for olive oil extraction by centrifugation

Olive cake characterized:

Olive cake is characterized by high variability of residual water (25–30%), in relation to the extraction method, and by high percentage of crude fiber (27–41%). For these reasons, it is unlikely to administer OC into the diet of high yielding dairy cows, considering the particular metabolic and nutritional requirements of these animals. In addition, though OC has a high lignin content, it is also characterized by good oil percentage, approximately 18–25% in the crude OC which represents a valid energetic supplement and by a high level of oleic acid which is interesting in human feeding for its beneficial effects on blood cholesterol and other health related outcomes [13, 14]. Moreover, considering the characteristics of the vegetable fatty acids, a rational administration to the ruminants of this by-product is important to limit the negative effects on the ruminal fermentation considering the high content of the unsaturated fatty acid in the OC [13].

Sheep play a great commercial role as a dairy animal, especially in Muslim countries for meat, wool and milk production. There is limited information regarding the response of sheep to olive pulp. Supplementation of some additives or by-products may affect on function of organs in the as its side effect including liver and kidney which may affect indirectly on the performance and production on animals.

One of the main aims of the present review was to evaluate the physiological and biochemical effects of OP feeding on different organs through detection level of biochemical parameters.

Olive cake Preservation:

The production of olive by-products is seasonal their use in animal feeding over the whole year requires adequate preservation and storage. Drying may preserve olive leaves but excess drying could decrease intake and nutritive value [15]. Ensiling has also been considered but it is impractical due to the physical structure of olive leaves, having high DM content, low density and a lack of fermentable sugars. Conversely, the main constraints to preserve crude olive cakes are its high water and oil contents. However, silage has been reported to be a simple, cheap, and efficient procedure to preserve olive cakes, either alone [4] or with the addition of poultry manure**,** conventional feedstuffs [16], urea [17] or an alkali [16]**.** Ensiled olive cakes have been included as a part (100–780 g/kg) of multi-nutrient blocks [18] and/or as partial replacement of barley hay, straw or concentrates in diets for growing [19] and lactating [4] livestock. The inclusion of OC, even those with high moisture, into multi-nutrient blocks has proved to be a promising way for their utilization [20, 21]. The olive molasses has been successfully used in diets for pregnant and lactating ewes [22].

Chemical analysis of the olive oil by-products:

One of the main limiting factors for the use of olive byproducts olive cake in the feed of domestic animals is its variable chemical composition [21] **(Table 2).**

Table 2 Chemical compositions of Olive oil by-products (%)

Chemical compositions	Olive oil by-products	
	Olive cake Martin-Garcia et al. **[6]**	Olive leaves Al-Jassim et al. **[17]**
DM	80.50	77.70
CP	7.26	10.00
EE	5.45	5.64
ADF	54.40	30.20
NDF	67.60	40.60

OM content of OP was 93.83% while that of YM maize (YM) was 98.36%. The CP content of OP was 7.86% and YM was 8.6%. The EE was 11.92% and 2.8 for OP and YM, respectively. The EE percentage increased with increasing OP concentration in the ration and was high with 30% OP and low with the 20%. [9]. The CP content is low (70–129 g/kg DM) and contains high levels of arginine, leucine and valine but is low in tyrosine and cysteine [24]. The proportion of ADIN is high and variable (from 3.31 to 13.5 g/kg DM) [25]**.** Fibrous components vary depending largely on the proportion of stones in olive cakes. The proportion of branches and storage time largely determine variability in neutral NDF and acid ADF detergent fiber, and acid detergent lignin (ADL) (from 368 to 626, 255 to 540 and 150 to 328 g/kg DM, respectively). NDF, ADF and ADL values decreased after treating with and these levels may be lowered by treating with alkali ($NH4OH$ or $NaOH$) [26, 27, 28]. Variable amounts of total condensed tannins at levels of 5.75–11.1 mg/g DM and the growth energy (GE) content of oil varies depending mainly on residual oil that comes from the crushing of olives during the cleaning process prior to oil extraction.

However, differences in the chemical composition can be due to oil extraction process, degree of extraction, residual oil extraction, year, geographical origin of olives, proportion of different physical components (stone, skin, pulp, water) and contamination with soil cause great variability in chemical composition [23, 25]. As in olive leaves, the CP content is low and variable (from 48 to 106 g/kg DM) and the fatty acids composition of OC reveals a high proportion of oleic acid and polyunsaturated fatty acids [13]. The OC energy content is high presumably due to its high structural carbohydrate content as gross energy is similar in crude and extracted olive cakes. Olive molasses is rich in soluble carbohydrates**.**

The mineral composition (g/kg) of OC A is: P, 18; K, 20.1; Ca, 150; Mg, 45; Na, 3.2; Fe, 19 and (mg/kg) Mn, 438; Cu, 207; Zn, 83 [22]. Oil composition varies depending on its origin, proportion of branches, storage conditions, climatic conditions, moisture content and degree of contamination with soil.

Effect of olive oil by-products on feed intake and apparent digestibility:

As described for olive leaves, the in vitro apparent digestibility of olive cakes is also low and variable, especially for CP. Values found in vitro showed high correlations with those obtained in vivo [29]**.** The direct comparison between rumen liquor from sheep and goats to digest OC revealed contradictory results. Martın-Garcıa et al. [24] found higher values using rumen liquor from goats as inoculum compared with sheep. In vitro apparent digestibility from gas production, the values were within the range. As observed with olive leaves, supplementation of olive cakes with both urea and sunflower meal increased OM in vitro digestibility by 18% [30]. Olive leaves as well as olive cakes show low values of ruminal degradation profiles both in sheep and in goats. There is a considerable lack of information on rumen CP degradability of OL and values published are low and variable. Escalona et al. [31] provided the only available data on the NDF degradability (0.42). Comparing the rumen degradability of OL between goats and wethers were carried by Yanez Ruiz et al. [25] and observed higher values for goats and degradability was low in both species probably affected by the high oil content of this by-product, which reduces bacterial attachment to fiber particles. However when animals were supplemented with beans and barley grain, the rumen degradability of OL increased by 50% [27, 28]. With regards to rumen degradability of OC, Martın-Garcıa et al. [24] reported values ranging from 0.38 to 0.44 of effective rumen degradability of CP measured in sacco which shows the low nitrogen supply provided by feeding this by-product. Degradability of OM (0.51) and ADF (0.37) in sheep rose by 20 and 23%, and by 35 and 40%, respectively as a result of treating OC with ammonia or NaOH, respectively [16].

The only information concerning in vitro gas production promoted by OC degradation has been reported by Al-Masri [30] who found values ranging from 18.8 to 36.4 ml gas/g OC. In both OL and OC, the rumen degradability of amino acids was higher (0.75 and 0.90, respectively) than that of CP (0.45 and 0.56, respectively). The highest degradability (>0.80) were observed for lysine, histidine, phenylalanine, and guanine in OL, and histidine, lysine, phenylalanine, threonine, tyrosine, isoleucine, and leucine in OC. The lowest (<0.60) values were for tyrosine in OL, and cystine in OC. Information on parameters related to the protein value of feedstuffs for ruminants, such as composition and intestinal digestibility of rumen un-degraded protein and their amino acids is scarce for olive by- products. In OL and OC, total and amino acid nitrogen content of the rumen un-degraded fraction were 10.8 and 7.30 g/kg DM, and 612 and 431 g/kg total N, respectively [24].

The amino acid content in the rumen un-degraded protein fraction of OL was close to the accepted roughage value (0.65) in the Nordic System for protein evaluation of ruminant feedstuffs while in OC it was lower (0.41). The amino acid composition of the rumen un-degraded protein of OL revealed high contents of arginine, alanine, valine and proline and low values for histidine, tyrosine, and cysteine [32].

Although ruminants consume OL without problems of adaptation, their intake is variable. Goats kept in metabolic cages consumed more fresh (80 g DM/kg $BW^{0.75}$) than dried (71 g DM/kg $BW^{0.75}$). OL and in sheep, values ranging from 23 to 42 g/kg $BW^{0.75}$ have been reported by Boza and Guerrero [33]**.** Higher intakes of dried OL, offered *ad libitum*, in wethers than in goats (40.6 and 32.5 g/kg $BW^{0.75}$, respectively) and similar fractional passage rates of the digesta through the gastrointestinal tract [25]. This contrasts with the findings of Garcia et al. [34] who observed higher intakes of shrubs in goats than in sheep associated with a faster passage rate along the digestive tract. However, in vivo apparent digestibility of OL depends on the method of preservation and the wood content which results in a wide range of DM and OM digestibility (0.16–0.6) and when OL are dried the apparent digestibility of DM and OM and, particularly, CP decline [15].

In vivo apparent digestibility of CP, EE and NDF after treating fresh OL with ammonia leading to intakes in pregnant ewes of 53.7 g fresh matter/kg $BW^{0.75}$ and the 25% aqueous solution of ammonia was applied at a rate of 5 L/100 kg OL [26]. Rations containing alfalfa hay, barley, sunflower meal and variable proportions (0.2–0.83) of OC, with the addition of beet molasses to encourage intake, were satisfactorily consumed (85–130 g DM/day/$BW^{0.75}$ or 1.4–2.2 kg of DM/day) by sheep [5]. Higher intakes of extracted OC was observed in sheep when fed as pellets (116 g DM/$BW^{0.75}$/day) than as silage (99 g DM/$BW^{0.75}$/day) and the pelleting OC reduced OM digestibility, probably due to a reduction in particle size resulting in a decrease in rumen retention time [16]. Aguilera et al. [22] reported intakes of 750 g DM/day of concentrates including 100–300 g/kg of OC by pregnant and lactating ewes. Higher intakes in lactating ewes compared to lactating goats and cows when conventional roughages (barley straw and barley hay) were replaced with ensiled crude OC (6, 5 and 4.9 g DM/kg$BW^{0.75}$, respectively) [4]. Lower intakes (150 g DM/day was found in growing lambs and 100 g DM/day in rams) of feed blocks including 400 g/kg DM as OC when a basal diet of Acacia cyanophylla was offered [35]. With lactating ewes, Chiofalo et al. [23] observed, intakes of 700 g/day of a pellet including crude OC (200 g/kg DM). However, estimation of the apparent digestibility of OC is generally calculated by difference and ignoring any associative effect of the other dietary ingredients. The digestibility is variable depending on the type of OC, however, apparent digestibility of OM and CP is low (0.20–0.50), while EE is highly digested (0.60–0.90), regardless of type of OC and processing method [36]**.** Apparent digestibility of cell wall components was low (NDF, 0.15; ADF, 0.09; ADL 0.14), but was improved by the addition of 5 g of NaOH/100 g of OC (up to 0.34, 0.28 and 0.28, respectively) [5].

Several approaches have been explored to increase N content and nutrient utilization of OC. Molina and Aguilera [5] found that sodium hydroxide (5 g NaOH/100 g OC) has been shown to improve both metabolizable energy content (from 4.22 to 6.46 MJ/kg DM) and apparent digestibility of cell wall components. With oil-rich OC, treatment with alkalis may lead to soap formation and, therefore, ensiling may be the best option for improving its nutritive value [4]. Sadeghli et al. [37] reported that low degradable fraction of DM, CP and NDF of olive by products are the most important limitation factors in ruminant nutrition, however, destining of olive cake significantly increased the its digestible content and nutritive values. Saleh et al. [38] found that olive cake may have higher nutritive value than the others olive cake by products and it has improved body weight gain, growth rate and feed conversations **(Table 3).**

TABLE 3 Analysis of different ingredients used in the rations of farm animals [23].

Ingredients	Chemical analysis on DM basis%				
	CP	CF	EE	NFE	Ash
Olive pulp	7.9	40.6	11.9	33.5	6.2
Yellow maize	8.6	1.8	2.8	85.1	1.6
Wheat bran	15.8	8.2	3.5	67.9	4.6
Undecortcatted cotton seed meal	31.1	22.9	1.7	38.4	5.4
Soya bean meal	45.5	6.2	2.2	39.1	7.0
Corn silage	10.6	24.0	2.6	54.8	8.0

Effect of olive oil by-products on blood components:

Protein fractions are estimated to evaluate the effect of OP components on immunity function in animals. Transaminases liver enzymes activities are estimated to evaluate the effect of OP components on liver function because these enzymes are elevated when liver cells are destructed due to exposure to toxic compounds. Urea and creatinine are estimated to evaluate the effect of OP on kidney function because urea and creatinine concentrations are elevated when kidney function are disturbed when animals exposure to toxic compounds. The values of lipogram profile including cholesterol triglycerides, total lipids, HDL and LDL levels are used to evaluate the effect of OP components on fat metabolism. The hormones of thyroid gland are playing an important role for controlling different metabolism in the body of animal. The levels of these hormones are used to evaluate the effect of OP on metabolism **(Table 4).**

Animals fed olive pulp had higher value in albumin level as compared to control [39]. No significant changes were detected in transaminases liver enzymes except in case of ALT where it was slightly elevated but still within normal range and concluded that feeding of olive pulp by 30% to growing calves has no harmful effect on liver cells [9, 40].

Table 4 Blood components and physiological body functions of growing buffalo calves received olive pulp [9]

Physiological performance	0.0 % Olive pulp	20 % Olive pulp	40 % Olive pulp
Total proteins (g/dl)	7.69^{b}±0.11	8.37^{a}±0.14	7.99^{ab}±0.09
Albumin, A (g/dl)	4.29±0.13	4.36±0.14	4.16±0.13
Globulin, G (g/dl)	3.40^{b}±0.03	4.01^{a}±0.03	3.83^{ab}±0.02
Urea-N mg/dl)	34.30^{b}±2.3	34.80^{b}±3.1	41.00^{a}±3.1
Creatinine (mg/dl)	1.08^{b}±0.1	1.06^{b}±0.1	1.40^{a}±0.1
GOT(U/ml)	57.90±2.3	57.60+-2.5	61.00+-2.2
GPT(U/ml)	44.1^{b}±2.1	42.9^{b}±2.1	52.2^{a}±2.1
Cholesterol (mg/dl)	105.8^{a}±3.1	102.6^{a}±4.1	90.5^{b}±3.2
T4 (nmol/I)	91.94^{b}±5.2	99.75^{a}±3.92	82.9^{b} ±4.33
T3 (nmol/l)	3.48^{a}±0.17	3.30^{ab}±0.13	2.79^{b}±0.19
T4/T3 ratio	26.4^{b}± 1.4	30.23^{a}±1.1	29.71^{a}±1.2
P (mg/dl)	P (mg/dl)	P (mg/dl)	P (mg/dl)

No significant changes were detected in transaminases liver enzymes except in case of ALT where it was slightly elevated but still within normal range and concluded that feeding of olive pulp by 30% to growing calves has no harmful effect on liver cells [9]. Adding olive pulps by different concentrations have affected on kidney functions including urea and creatinine but this increase in their levels are still within normal range and concluded that feeding of olive pulp by 30% to growing calves has no harmful effect on liver function [9]. No significant changes were observed in any of the parameters examined in the animals fed olive byproduct and concluded that there no effect of feeding any levels of olive pulp on lipid profile in the body in Friesian calves [9]. No significant changes in T_4 level which also refer that no side effect of feeding olive pulp on thyroid gland in lambs and Friesian calves [9].

Calcium and phosphorus are the two main elements for bon formation. Detection of their level in blood reflects the importance olive pulp as a source of Ca and Pi [41]. Animals fed olive pulp had higher values in Ca and inorganic phosphorus levels as compared to control and concluded that olive pulp is considered as a good source of calcium and phosphorus [9].

Effect of feeding olive by-products on animal performance:

The olive and olive oil industries play important economical and social roles in the Mediterranean region. In 2003 more than 2.5 million tons of olive oil was produced [10]. From each ton of olives, 200 kg of oil and 800 kg of olive cake are obtained [42]. The cake includes remainder of pulp, stones, skins and water. Harvest of olives and subsequent oil production is seasonal with high accumulation of product over a short time span. Therefore, large amounts of OC, which accumulated during the season of olive oil production, might result in environmental pollution, both from the solid part and the effluent which might pollute freshwater sources. Therefore, utilization of the cake might alleviate the environmental pollution caused by this by-product [43].

Many studied were looked into the utilization of OC for composting purposes [44]. However, OC contains energy, crude protein and fiber, and therefore, could be utilized by ruminants [23, 24, 45]. However, utilization of olive cake for ruminant feeding is limited due to low digestibility and the high polyphenol content which decrease protein availability and microbial protein synthesis [24, 46]. Utilization of OC for animal feeding would be beneficial both for the ruminant farms and for the environment. Efficient utilization of the OC for ruminant feeding requires appropriate preservation and upgrading its nutritional value [43]. For a feed to be of value in practice it has to have both the desired nutritional qualities and be available at a cost which allows a profit in the market place. Olive by-products must be able to compete in feeding value, quality of product and cost with conventional alternative feeds, the cost of which may be subsidized. Several papers have examined the effect of including olive by-products on animal performance; however, very few studies have addressed the effects on meat and milk quality. The effects on growth, milk production and milk quality of feeding a range of olive by-products to cattle, goats and sheep are studied by different authors [47, 48] **(Table 5).**

TABLE 5 Growth performance of growing buffalo calves received olive pulp (OP) [9]

Growth performance	0.0 % OP	20 % OP	40 % OP
Live body weight (LBW)			
Initial LBW	313.0±5.8	306.1±6.9	308.5±5.8
Final LBW	360.6±6.6	353.7±7.6	346.2±8.6
Total gain, kg (60 d)	47.6^{a}±2.8	47.6^{a}±3.4	37.7^{b}±3.1
DBWG (g)	793.0^{a}±16	793.0^{a}±18	662.0^{b}±19

Mioč et al. [49] investigated the effect of olive cake (fed a concentrate with the addition of 15% and 30%) olive cake in the feed of weaned Pramenka lambs on their daily gain, carcass traits and on the chemical composition of different groups of muscles. The results showed that the high level of olive cake inclusion (30%) decreased daily gain, final weight, empty carcass weight and dressing percentage of lambs. The olive cake resulted in a significantly higher significantly proportion of stomach and intestines in the carcass compared to the control. The content of fat, proteins and dry matter in all the analyzed groups of muscles was lowest in the carcasses of lambs fed olive cake. The results of this research suggest that the addition of 15% of olive cake to the concentrate had no significant negative effect on daily gain, carcass weight and dressing. Chiofalo et al. [23] reported that administration of OC influenced the milk yield of lactating ewes that was significantly higher in the olive (fed on a concentrate with 20% of partly-destoned OC and olive + E) fed on a concentrate with 20% of partly-destoned OC plus 280 mg per head per day of tocopheryl acetate and found that the possibility of administration of olive cake for feeding ewes, considering the positive effects on the milk yield and no effects on the chemical composition. Chiofalo et al. [23] support the possibility of the administration of partly destoned olive cake for ewe feeding for the following three reasons; (1) no reduction of the productive performances of the animals; (2) a positive influence on the milk yield and no effects on the chemical composition and the clotting properties, which is very important, considering that the ewe's milk is entirely employed in cheese making and (3) an improvement of the dietetic-nutritional characteristics of the milk, testified by the increase of the unsaturated/saturated ratio.

The olive cake ensiling process has been confirmed to be a simple and low cost technique for OC conservation [50]. Despite the satisfactory result of the ensiling process, the palatability of olive cake was low and its inclusion in the diet reduced intake and digestibility of nutrients. Nevertheless, due to sheep capability to buffer medium-term under-nutrition around lambing, ewes' performances were not significantly affected by the substitution of moderate quality grass hay with olive cake, at least up to a level of 250 g DM/head/day. The inclusion of olive cake in complete diets based on feedstuffs other than hay, and the implementation of low cost treatments for improving OC nutritive value deserve further attention. The effect of OC-based diets should also be evaluated in the light of their impact on the quality of dairy and meat products and hence consumers' acceptability [50].

Weinberg et al. [43] study the ensiling properties of olive cake with and without added molasses at 2–6%. The results indicate that molasses enhanced the ensiling fermentation of olive cake, as evidenced from higher lactic acid content and higher lactic acid bacteria numbers at 4% and 6% added molasses. However, when applied at 4% and 6% molasses increased fermentation losses up to 9.4%, probably due to larger yeast population. Poly phenols which could interfere with protein utilization by ruminants, decreased during ensiling by about 40%. It is concluded that molasses added at 3% could improve the ensiling fermentation of olive cake without substantial losses.

The effect of feeding olive trees pruning by-products (leaves and twigs) treated biologically and chemically on ewe lambs performance, nutrients digestibility and some rumen and blood parameters was studied by Fayed et al. [51] and found that the final body weight was differed among treatments, urea treatment and biological treatment showed higher final body weight than the control group being 38.70, 37.77 and 37.25 kg, respectively, but, average daily gain had the same trend of live bodyweight. Concerning the chemical composition of olive by-products, the data showed that urea and biological treatments increased CP content and decreased CF content and its fraction. In addition, digestibility trials indicated that treatments tended to increase the digestibility of DM, OM and CP, CF more than control group. CFM +olive leaves had the highest values of TDN and DCP (% of intake). Fayed et al. [51] concluded that feeding sheep on olive trees pruning by-products treated biologically or chemically improved rumen fermentation, nutrients digestibility and blood parameters. Mustafa [52] studded the effects of dried olive oil by-products (0, 15 & 30% replacement) on the performance of lactating local sheep and their lambs. The results showed that the performance of both ewes and their lambs was improved and concluded that Olive oil by-products can partially replace in diets of growing and lactating ruminants and it is economically feasible to replace energy resources with olive oil by-products, especially, corn. Fegeros et al. [26] compared ammonia treated OL with alfalfa hay as forages, together with concentrate, fed to lactating ewes and observed no differences in milk yield. Notably, the fatty acid composition in the milk fat produced by the animals fed OL had more oleic and linolenic acids and less myristic and palmitic acids than that from the animals fed alfalfa hay. The amount and composition of the fat in OL may explain these differences, which opens an interesting possibility for further research on the use of OL with high oil content in diets for lactating ruminants to manipulate milk fat composition.

Different ways to include OC in animal diets have been described, varying from feeding it fresh, ensiled, dried or as a component of concentrate pellets and multi-nutrient feed blocks. The latter may be a practical and economical possibility as it has been found that multi-nutrient blocks allow farmers to decrease the cost of feeding lambs by 38% [53] and 18% [20]. Al-Jassim et al. [17] evaluated urea treated OC (50 g urea/kg DM) as an alternative energy source to replace barley (200 g/kg) in diets of fattening lambs and found no difference in live-weight gain. Hadjipanayiotou [4] showed the practical advantage of using crude OC silage by comparing its use in diets for lactating Chios ewes, Damascus goats, and Friesian goats. In the three species, the partial replacement of conventional roughage (barley hay and barley straw) with OC silage had no affect on milk yield. Milk fat content was increased by 3.1–5.8 g/kg milk. Although OC silage constituted only 0.15 of the total diet, it raised the fat content of the total diet by 65%. These results agree with previous studies [19] in which young ewe lambs utilized OC silage more effectively than goat kids, however, the latter were more effective than heifers. The use of high-fat OC might be constrained by its effect on the rumen microbial population, especially on cellulolytic activity. However, if included in the right proportion in the diet, there is a great potential due to its effect on milk composition [13]. Chiofalo et al. [23] included crude OC (200 g/kg of the concentrate DM) in the diet of lactating ewes and observed an increase in total milk yield (649 g vs. 772 g per animal per day) and the OC also increased milk fat and protein.

In diets containing OC, oleic acid and the total monounsaturated fatty acid content of ewes' milk were increased while saturated fatty acids dropped. Molina Alcaide et al. [21] studied the effect of replacing 50% of a concentrate with multi-nutrient blocks in diets for lactating goats and observed no differences in milk yield. Molina Alcaide et al. [21] and Chiofalo et al. [23] found that oleic and linoleic acid and unsaturated fatty acids increased in animals fed the diet including crude POC compared to a commercial concentrate. Both studies show the potential of using crude OC, not only to provide cheap fiber and energy in ruminant feeding but also for healthier animal products in terms of their fatty acid profile.

Olive cake, in which the oil has been extracted, has also been used in practical diets, either included in concentrates or as a component of multi-nutrient blocks. Aguilera et al. [22] used a mixture of extracted OC and olive molasses to replace part of the conventional feedstuffs, such as sunflower meal and barley grain, in the diets of ewes in late pregnancy and lactation. The basal diet was comprised of alfalfa hay and barley straw. The performance of the ewes offered the concentrates with OC molasses was similar or better than ME content of the concentrate ranged from 0.16 to 0.25 and 0.05 to 0.12 in pregnancy those fed the standard concentrate. Lamb growth rate during suckling was similar for those with mothers receiving an OC-molasses mixture, as for those fed a conventional concentrate. In addition, lambs from ewes fed concentrate including the OC-molasses mixture had higher carcass yields.

With regards to the quality of the animal product, Priolo et al. [54] reported that supplementing diets based on oat hay and acacia with feed blocks, based on olive cake, slightly reduced the overall acceptability of the meat as assessed by a taste panel compared with meat from lambs receiving conventional concentrate foods; however, the meat from all treatments was very acceptable for Mediterranean consumers. Gad et al. [9] found that the average body weight was 11.29% higher significantly in calves received with 30% olive pulp plus 20% yellow maize than those in non-received olive pulp calves and concluded that feeding of olive pulp by rate of 30% could be used in the diet of Friesian calves which has positive effect on body weight and daily gain. Gad et al. [9] and Fayed et al. [51] found that the animals fed olive pulp by rate of 30% had higher values of feed efficiency that recorded 14.69% higher than those fed olive oil of 0.0%. In addition, Pulp had lower values in daily feed costs compared to control ration. Consequently, the economic feed efficiency (%) was highest in the animals fed olive pulp and the lowest was control group. Youssef and Fayed [8] and Fayed et al. [51] with Rahmani lambs found that replacing up to 30% with olive cake was beneficially and economically feasible. In addition, the price of one ton from olive pulp recorded the lowest price than the price of yellow maize.

From these review some practical recommendations can be highlighted olive leaves provide half of the energy and amino acid requirements of sheep and goats at maintenance level and, if adequately supplemented, can be used as part of the forage in diets for production and it is recommended to feed olive leaves fresh rather than dried or ensiled. In addition, olive cakes can be preserved in different ways, ensiling or incorporation into multi-nutrient blocks being the most successful developed so far. Moreover, the use of olive by-products rich in oil appears to increase the content of mono-unsaturated fatty acids and lower the content of saturated fatty acid in milk and high levels of Cu in olive leaves could restrict the use of this by-product in practical feeding. More research is needed to maximize the quality of animal products through inclusion of olive by-products in their diets.

II. CONCLUSION

Olive by-products represent an important group of feed resources for ruminants in the Mediterranean areas. Olive leaves provide half of the energy and amino acid requirements of farm animals at maintenance level and if adequately supplemented, can be used as part of the forage in diets for production. Olive cakes can be preserved ensiling or incorporation into multi-nutrient blocks being the most successful developed. In addition, the use of olive by-products rich in oil appears to increase the content of mono-unsaturated fatty acids and lower the content of saturated fatty acid in milk. However, more research is needed to maximize the quality of animal products through inclusion of olive by-products in diets of farm animals, especially, under hot summer season of Egypt.

III. REFERENCES

[1]. Ali, M.F. (1996). The use of treated and untreated sugar beet by-products in feeding form animals. Ph.D. Thesis, Fac. of Agric. Kafr El-Sheikh, Tanta Univ., Egypt.

[2]. Mohsen, M.K.; M.F. Ali and M.L. Bassiouni (1999). The effect of partial replacing concentrate mixture by dried sugar beet pulp on performance of growing Angora goats. Proc. 7th scientific conference of Animal Nutrition. 309-318.

[3]. Liotta, L., Chiofalo, B., Bella, M. and Chiofalo, L. (2001). Use of vitamin E in lambs fed olive cake: Effects on intramuscular fat fatty acids. In: Proc. of the XIV Congress of ASPA, Firenze (Italy), : 559-561.

[4]. Hadjipanayiotou, M (1999). Feeding ensiled crude olive cake to lactating Chios ewes, Damascus goats and Friesian cows. Livest. Prod. Sci. 59, 61–66.

[5]. Molina, E. and Aguilera, JE (1988). Nutritive value of a soda-treated olive cake. Digestibility of cell wall components.Ann. Zootech. 37, 63–72.

[6]. Martın Garcıa, A.I., Yanez Ruiz, D.R., Moumen, A., Molina Alcaide, E (2006). Effect of polyethylene glycol, urea and sunflower meal on olive (Olea europaea var. europaea) leaf fermentation in continuous fermentors.Small Rumin. Res. 61, 53–61.

[7]. Fayed, Afaf, M.; K. M. Yossef and H. M Abou El-Nasr (2001). Nutritional performance of goat fed non-conventional diets based on olive pulp in Sinai. Egypt. J. Nut. & feeds, 4:81.

[8]. Youssef, K.M. and Afaf M. Fayed (2001). Utilization of some organic wastes as feed supplement for growing goats under desert conditions. Egyptian J. Nutrition and Feeds. 4 (2): 91-99.

[9]. Gad, A. E.; Fatma E. I. Teama and M. M. Mostafa (2008). Effect of different concentrations of olive pulp on body weight and some Biochemical parameters in Friesian calves. Isotope & Radiation Res., 40,4,(suppl. 1),1195-1204.

[10]. International Olive Oil Council (IOOC), (2005&2006). www.interantioanloliveoil.org.

[11]. Delgado Pertinez, M., Chesson, A., Provan, G.J., Garrido, A., Gomez-Cabrera, A (1998). Effect of different drying systems for the conservation of olive leaves on their nutritive value for ruminants. Ann. Zootech. 47, 141–150.

[12]. Alburquerque, J.A., Gonzalez, J., Garcıa, D., Cegarra, J (2004). Agrochemical characterization of alperujo a solid by-product of the two-phase centrifugation method for olive oil extraction. Bioresour. Technol. 91,195–200.

[13]. Chiofalo, B., Liotta, L., Zumbo, A., Chiofalo, V (2002). Olive cake for ewe feeding: effect on the milk acidic composition. In: Proceedings of the 15th National Congress of SIPAOC, Cagliari, Italy, pp. 136–137.

[14]. Williams, C. M. (2000). Dietary fatty acids and human health. Ann. Zootech. 49, 165 –180.

[15]. Delgado Pertinez, M., G´omez-Cabrera, A., Garrido, A (2000). Predicting the nutritive value of the olive leaf (Olea europaea): digestibility and chemical composition and in vitro studies. Anim. Feed Sci. Technol. 87, 187–201.

[16]. Nefzaoui, A.and Vanbelle, M (1986). Effects of feeding alkali-treated olive cake on intake, digestibility and rumenliquor parameters. Anim. Feed Sci. Technol. 14, 139–149.

[17]. Al-Jassim, R.A.M., Awadeh, F.T. and Abodabos, A (1997). Supplementary feeding value of urea-treated olive cakewhen fed to growing Awasi lambs. Anim. Feed Sci. Technol. 64, 287–292.

[18]. Hadjipanayiotou, M (1996). Urea blocks without molasses made of variety of by-products and binders. Livest. Res. Rural Dev. 8, 30–36.
[19]. Hadjipanayiotou, M. and Koumas, A. (1996). Performance of sheep and goats on olive cake silage. Technical Bulletin No. 176. Agricultural Research Institute, Nicosia, Cyprus, 10 pp.
[20]. Ben-Salem, H., Ben Salem, I., Nefzaoui, A., Ben Saıd, M.S (2003). Effect of PEG and olive cake feed blocks supply on feed intake, digestion, and health of goats given kermes oak (Quercus coccifera L.) foliage. Anim. Feed Sci. Technol. 110, 45–59.
[21]. Molina Alcaide, E., Morales Garcıa, E.Y., Mart´ın Garcıa, A.I (2005). Effect of feeding multinutrient blocks on rumen fermentation, intake, digestibility and milk yield and composition in dairy goats. In: Proc. of the 11th Seminar of the Sub-Network FAO-Ciheam on Sheep and Goat Nutrition, Catania, Italy, p. 77.
[22]. Aguilera, J.F., Garcıa, M.A. and Molina, E., (1992). The performance of ewes offered concentrates containing olive by-products in late pregnancy and lactation. Anim. Prod. 55, 219–226.
[23]. Chiofalo B., Liotta L., Zumbo A., Chiofalo V. (2004). Administration of olive cake for ewe feeding: effect on milk yield and composition. Small Rumin. Res., 55, 169-176.
[24]. Martin-Garcia, A.I., Moumen, A., Yanez-Ruiz, D.R., Molina-Alcaide, E., (2003). Chemical composition and nutrients availability for goats and sheep of two-stage olive cake and olive leaves. Anim. Feed Sci.Technol. 107, 61–74.
[25]. Yanez Ruiz, D.R., Martın Garcıa, A.I., Moumen, A., Molina Alcaide, E (2004). Ruminal fermentation and degradation patterns, protozoa population and urinary purine derivatives excretion in goats and wethers fed diets based on olive leaves. J. Anim. Sci. 82, 3006–3014.
[26]. Fegeros, K., Zervas, G., Apsokardos, F., Vastardis, J., Apostolaki, E., (1995). Nutritive evaluation of ammonia treated olive tree leaves for lactating sheep. Small Rumin. Res. 17, 9–15.
[27]. Martın Garcıa, A.I., Yaez Ruiz, D.R., Moumen, A., Molina Alcaide, E., (2004a). Effect of polyethylene-glycol on the chemical composition and nutrient availability of olive (Olea europaea var. europaea) by-products. Anim.feed Sci. Technol. 114, 159–177.
[28]. Martın Garcıa, A.I., Yanez Ruiz, D., Moumen, A., Molina Alcaide, E (2004b). Effect of polyethylene glycol, urea and sunflower meal supply on two-stage olive cake fermentation. Anim. Res. 53, 245–257.
[29]. Aguilera, J.F.and Molina, E (1986). Effect of soda treatment on the feeding value of olive cakes. Ann. Zootech. 35,205–218.
[30]. Al-Masri, M.R (2003). An in vitro evaluation of some unconventional ruminant feeds in terms of the organic matter digestibility, energy and microbial biomass. Trop. Anim. Health Prod. 35, 155–167.
[31]. Escalona, B., Rocha, R., Garcıa, J., Carabano, R., de Blas, C (1999). Characterization of in situ fibre digesti´on of several fibrous foods. Anim. Sci. 68, 217–221.
[32]. Madsen, J., Hvelplund, T., Weisbjerg, M.R., Bertilsson, J., Olsson, I., Sp¨orndly, R., Harstad, O.M., Volden, H., Tuori, M., Varvikko, T., Huhtanen, P., Olafsson, B.L (1995). The AAT/PBV protein evaluation system for ruminants: a revision.
[33]. Boza, J. and Guerrero, J.E (1981): Nutritive value of some agricultural by-products in goats. In: Morand-Fehr, P.
[34]. Garcıa, M.A., Aguilera, J.F., Molina Alcaide, E., (1995). Voluntary intake and kinetics of degradation and passage of unsupplemented and supplemented pastures from semiarid lands in grazing goats and sheep. Livest. Prod. Sci. 44, 245–255.
[35]. Ben-Salem, H., Nefzaoui, A., Ben Salem, L., Tisserand, J.L (2000). Deactivation of condensed tannins in Acacia cyanophylla Lindl. Foliage by polyethylene glycol in feed blocks. Effect on feed intake, diet digestibility, nitrogen balance, microbial synthesis and growth by sheep. Livest. Prod. Sci. 64, 51–60.
[36]. El-Fouly, H.A., S.M. Abdel-Baki, M.E. Nowar, and M.M. Mostafa (2004): Formulating of rations contained dried sugar beet pulp for milking ewes and their lambs. Zagazig J. Agric. 31(4B): 1769-1784.
[37]. Sadeghil H, Yansari AT and Ansari-Pirsarai, Z (2009). Effects of Different Olive Cake by

Products on Dry Matter Intake, Nutrient Digestibility and Performance of Sheep. International Journal of Agriculture and Biology, 11(1):39–43.
[38]. Saleh, M.S., N.M. Eweedah, M.F. Ali and M.K. Mohsen (2001). Comparison between dried sugar beet pulp and yellow corn as a source of energy with berseem in rations of growing lambs. Egypt. J. Nutrition and Feeds, 4 (special issue): 231.
[39]. Abd-El-Rahman, G. A.; H. M. Abou El-Nasr; M. S. Ayyat; Afaf M. Fayed and M. S. Nassar. (2003). Utilization of some agro-industrial by-products in fattening lambs on the natural ranges in the south of valley. Egyptian. J. Nutrition and feeds (Special Issue): 851-865.
[40]. Mostafa M. R. M.; R. Salama; M. E. Lashin and A. A. Abodo (2003). Utilization of olive cake in fattening rations of Rhmani lambs. Egyptian J. Nutr. And Feeds 6(special Issue):811-820.
[41]. Mustafa, M. M. M.; H. M. Saleh and H. A. EL-Fouly (2009). Effect of olive by-product inclusion in lambs diet on productive performance and some blood parameters. Egyptian J. Nutr. And Feeds, 12(3) special Issue: 253-262.
[42]. Alburquerque, J.A., Gonzalez, J., Garcıa, D., Cegarra, J (2004). Agrochemical characterisation of "alperujo",a solid by-product of the two-phase centrifugation method for olive oil extraction. Bioresour. Technol. 91,195–200.
[43]. Weinberg Z.G. , Y. Chen and P. Weinberg (2008). Ensiling olive cake with and without molasses for ruminant feeding. Bioresource Technology 99 :1526–1529.
[44]. Benitez, E., Sainz, H. and Nogales, R., (2005). Hydrolytic enzyme activities of extracted humic substances during the vermicomposting of a lignocellulosic olive waste. Bioresource Technol. 96, 785–790.
[45]. Hadjipanayiotou, M. (2000). The use of crude olive cake silage as small ruminant feed in Cyprus: A review. Options Méditerranéennes, Series Cahiers, 52: 51-54.
[46]. Al-Masri, M.R. (2005). Nutritive value of some agricultural wastes as affected by low gamma irradiation levels and chemical treatments. Bioresource Technol. 96, 1737–1741.
[47]. Molina Alcaide, E., Yanez Ruiz, D.R., Moumen, A., Martın Garcıa, A.I (2003a). Ruminal degradability and invitro intestinal digestibility of sunflower meal and in vitro digestibility of olive by-products supplemented with urea or sunflower meal Comparison between goats and sheep. Anim. Feed Sci. Technol. 110, 3–15.
[48]. Molina Alcaide E., Yanez Ruiz D., Moumen A., and Martin Garcia I (2003b). Chemical composition and nitrogen availability for goats and sheep of some olive by products. Small Rumin. Res., 49, 329-336.
[49]. Mioč, B. , V. Pavić, I. Vnučec, Z. Prpić, A. Kostelić, V. Sušić (2007). Effect of olive cake on daily gain, carcass characteristics and chemical composition of lamb meat. Czech J. Anim. Sci., 52, (2): 31–36.
[50]. Cabiddu, A.; M. Canu, M. Decandia, R. Pompei and G. Molle (2004).The intake and performance of dairy ewes fed with different levels of olive cake silage in late pregnancy and suckling periods :197-201.
[51]. Fayed , Afaf M., M.A. El-Ashry and Hend A. Aziz (2009). Effect of Feeding Olive Tree Pruning By-Products on sheep performance in Sinai. World Journal of Agricultural Sciences 5 (4): 436-445.
[52]. Mustafa, M.M.M. (2011). Effect of dried olive oil By-Product supplementation to Ration on the Performance of Local Ewes and Their Lambs. Isotope & RAD.RES., 40,4,(suppl. 1),507-518.
[53]. El-Hag, M.G., Al-Merza, M.A., Al-Salti, B (2002). Growth in the Sultanate of Oman of small ruminants given date by-products–urea multinutrient blocks. Asian-Aust. J. Anim. Sci. 15, 671–674.
[54]. Priolo, A., Ben Salem, H., Atti, N., Nefzaoui, A (2002). Polyethylene glycol in concentrate or feed blocks to deactive condensed tannins in Acacia cyanophylla Lindl. foliage 2. Effects on meat quality of Barbarine lambs. Anim.Sci. 75, 137–140.