

EFFECT OF ADDITION PROTECTED FATTY ACIDS IN RUMINANT RATIONS ON PRODUCTIVE PERFORMANCE OF SUFFOLK X OSSIMI CROSSBRED EWES DURING DIFFERENT PRODUCTION STAGES

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SUMMARY

This study was conducted to evaluate the effect of dietary supplementation of protected fatty acids (FA) on nutrient digestibility, rumen parameters, some blood components, milk yield and its composition and lambs growth performance during the pre-weaning period (2 months old) of Suffolk x Ossimi ewes. A total of 36 pregnant ewes, weighing on the average 64.89 ± 1.57 kg in their 2nd – 4th parities and aged 2.5 – 4.5 years were divided into three similar groups according to their body weight (12 ewes each) using a complete randomized block design. The feeding trial started 60 days before lambing (late pregnancy period) and continued 60 days after lambing (suckling period). The experimental rations were offered into animals with the rate of 0, 4 and 6% calcium-soap as protected fatty acids (based on DM intake). Body weight, total gain and daily gain of the new born lambs were recorded during the preweaning period (suckling period). The basal rations composed of 60% concentrate feed mixture (CFM) and 40% roughage (berseem 30% + rice straw 10%, RS). Three digestibility trials were carried out using nine Suffolk x Ossimi crossbred rams with average 62 kg BW and aged 2-2.5 years to determine the digestibility and feeding values of the experimental rations. Data showed that significant higher digestibility at ($P < 0.05$) of OM, CP, CF, EE and NFE for fat supplemented groups than those of control one. Rumen parameters (pH, total VFAs and ammonia-N concentration) were higher in supplemented groups than those of the control one. Values of concentrations of blood plasma total protein and its fractions, glucose, total cholesterol, triglycerides and total lipids of experimental ewes were higher in for supplemented groups than that of control one in the two stages of the whole production cycle. Supplemented fat treatments (group) led to significant increases in birth, weaning weights and total gain of lambs, and the highest values were occurred with FA₆. Milk yield was higher significantly in supplemented groups than that of control one as well as its composition (fat, total solids and protein, %) were followed the same trend of milk yield among treatments. Generally, it could be concluded that the supplementation of calcium salt of fatty acids at different levels (FA₄ or FA₆) for rations of Suffolk x Ossimi crossbred ewes improved digestibility, feeding values, increased lambs birth weight and milk yield and its composition beside better feed efficiency, with superiority of 6% level (FA₆).

Keywords: *Fatty acids, ewes, blood, milk yield, digestibility, rumen fermentation and productive performance.*

INTRODUCTION

As a rule, negative energy balance (NEB) is a physiological stage experienced by dairy cows after giving birth and is caused by the voluntary intake of feed which is insufficient for the nutritional requirements of the animal during the early period lactation. To fulfill high energy requirement post calving, the use of different fat products in the ration may be considered as an appropriate strategy. Supplementation of unsaturated fatty acids from vegetable oils in feeding ruminant could improve its productivity. Fewer studies with less information are available on use fat supplementation for ewes and goats than for dairy cows ration (Chilliard *et al.*, 2003). Energy that released from fat ingredient of a ration is considering a main nutritional factor which potentially affect favorably on milk production for high yielding dairy animals. Use of fat supplementation may continue to increase as the genetic potential

for milk production increases. Zeedan (2003) revealed that buffalo calves could be fattened on diets supplemented with fats especially in the form of Ca-soap as an energy source to replace part of dietary corn without any adverse effects on productive performance, digestibility, rumen fermentation and blood parameters. It is well known that the energy density of fat is greater than the other feed ingredients (White *et al.*, 1992). Simas *et al.* (1998) found that adding fat to the diets of ruminants can help in covering the requirements of high energy for high milk yield and/or faster growth rate without causing metabolic disorders that often associated with large intake of grain. Protected fat supplementation had significantly increases CP and EE digestibilities with no effect on OM and NFE digestibilities (Bendary *et al.*, 1994). Chan *et al.* (1997) showed that supplementation of ruminal inert fat to ruminant rations increases the energy density in diets and avoids the adverse effects on ruminal fermentation. Sanz Sampelayo *et al.* (2002) concluded that the replacement of concentrate fraction of the diets for lactating goats by the protected fat gives a good digestive utilization of the diet together with improved N and metabolisable energy utilization for milk production. Zeedan *et al.* (2010) revealed that supplementation of dry fat to diets of lactating Damascus goats at different levels 3 or 5% had positive effects on improvement nutritive values, digestion, rumen fermentation and milk production consequently. Also, they reported that using fat can avoid some problems such as ruminal acidosis and liver abscess. Moreover, Zeedan *et al.* (2014) recommended that using oil or dry fat supplementation at levels (3% DM intake /h/d) in ration of Egyptian buffalo cows tended to improve the digestibility, feeding values, actual milk yield and 7% FCM yield and its composition and economic efficiency. Atia (2015) explained that supplementing buffaloes ration with different levels of dry fat (2 and 4% based on DM) improved the digestibility coefficients of all nutrients, TDN and DCP as well as improved rumen liquor parameters without hazard effects on beneficial microflora. Dry fat treatment led to an increase in both birth and weaning weights of newborn calves, milk yield and composition, adjusted blood parameters and dependently increasing the economic efficiency of the production. Zeedan *et al.* (2016) revealed that supplementation of dry fat to ration of lactating buffalo- cows at levels (3 or 5%) tended to improve the rumen fermentation, digestibility, nutritive values, milk yield and its composition with better feed efficiency as well as improved economic efficiency. Sharma *et al.* (2016) indicated that the transition period is a critical determinant of both productivity and profitability of dairy animals. During this period, hormones and metabolites significantly alter to mobilize the body reserves to meet energy requirement of fetus and lacto genesis. They were reported that the supplementation of fat at this crucial stage may improve the milk production and fat content through increase in energy balance of buffaloes without affecting milk protein, lactose, SNF and DMI in Murrah buffaloes. Kumar (2017) reported that Supplementing bypass fat aides in enhancing milk and fat yield in lactating animals. Supplementation of by-pass fat had no adverse effect on the rumen fermentation, feed intake and digestibility of nutrients and blood parameters of dairy animals. Suharti *et al.* (2017) showed that the addition of calcium soap-soybean oil increased the post ruminal content of unsaturated fatty acids leading to the increase of its absorption. Also the addition of calcium soap-soybean oil did not influence concentration of serum glucose, cholesterol and protein, but increases the serum triglyceride content. Atkare *et al.* (2018) found that supplementation of bypass fat improves the energy balance of lactating buffaloes and significantly increase milk yield as well as modify the composition of fat and TS. More recently, Ranaweeral *et al.* (2020) observed that the cows supplemented with bypass fat (200 g/cow/day) had recorded significantly higher ($P < 0.05$) milk production compared with cows that did not receive bypass fat supplements until eleventh week of the lactation.

The main objective of this study was to investigate the influence of including bypass fatty acids (FA) on productive performance, rumen parameters and milk yield and its composition of Suffolk x Ossimi crossbred ewes during late pregnancy and suckling period as well as their lamb's performance from birth until weaning.

MATERIALS AND METHODS

This study was carried out at El-Gemiza Experimental Station, Animal Production Research Institute (APRI), Agricultural Research Center (ARC), Ministry of Agriculture, Egypt. Thirty six Suffolk x Ossimi crossbred ewes weighted on the average 64.89 ± 1.57 kg in their 2nd – 4th parities and aged 2.5 – 4.5 years (during the last 60 days of pregnancy stage), the animals were divided into three similar groups according to their body weight (12 ewes each) as follows: Control group fed on a basal ration without fatty acids supplementation (FA₀), while the 1st treated group was fed on the control ration supplemented with 4% fatty acids (FA₄) and the 2nd treated group was fed on the control ration supplemented with 6% fatty acids (FA₆) on the base of DM. Fatty acids (FA's) were added to a part of the ground concentrate

feed mixture of the two experimental diets. The FA's were composed of calcium salt for fatty acids–plant origin 95%, moisture 4.98% and antioxidant BHT 0.02%. This supplement was contained 80% crude FA's, 7600 kcal/kg gross energy and 180%TDN with having digestion coefficient 95%, constancy degree 96% and stearic acid<5% .

All experimental animals were free of diseases and parasites and housed in semi-shaded well ventilated pens. The experiment began 60 days before lambing and extended for 60 days post lambing (suckling period). Ewes were fed on the basis of their body weight, pregnancy requirements according to NRC (1981). The experimental control ration was formulated from 60% concentrate feed mixture (CFM):40% roughage (berseem 30% and rice straw, RS 10 %). The portion of CFM was offered to animals at 8.30 a.m. and the quantities of berseem and rice straw at 11.30 a.m. Fresh drinking water was offered twice daily at 12.00 and 04.00 p.m. hr. The ingredients of experimental ration were chemically analyzed for determination of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE) and ash contents according to A.O.A.C. (1990).In addition the calculated chemical composition of the experimental rations are presented in Table (1).

Digestibility trials were carried out to determine the digestibility and feeding values of the experimental rations, using nine Suffolk x Ossimi crossbred rams with average 62 kg BW and aged 2-2.5 years .The rams were kept and fed individually in metabolic cages allowing separate collection of urine and feces as described by Maynard *et al.* (1979).Animals were adapted to the cages for 14 days as a preliminary period followed by a 6-days collection period. Animals received the same ration of the feeding trial according their nutrient requirements that stated by NRC (1981). Every morning, feed residues if any, were collected, weighed and subtracted from the amount offered to calculate the actual daily feed intake. Feces were quantitatively collected for each animal along the days of collection period, sampled by 10 % and then composited for lab analysis. Feedstuffs and feces samples were dried at 70 C⁰ for 24 hrs and then ground pass through 1 mm. screen sieve and kept for analysis. Proximate chemical analysis of feed and feces samples was done according to the AOAC (1990). By the end of the digestibility trial, rumen samples were collected by a stomach tube at zero and 3 hours post-feeding. The rumen samples were strained through four layers of cheesecloth into a plastic containers and pH was immediately measured using a pH meter with glass electrode. Ammonia-N concentration was estimated as soon as possible using the distillation method as described by Horn *et al.* (1981). Total volatile fatty acids were determined according to the technique described by Warner (1964).

Blood samples were collected from experimental animals at 60, 30, 15 days of pre lambing period and also at 15, 30 and 60 days post lambing period (suckling period) .Blood samples were collected in dried clean tubes by jugular vein puncture from 7 ewes from each group in the morning just before feeding and drinking and immediately centrifuged at 4000 rpm for 15 minutes. The plasma was carefully taken after treated by ethylene diamine tetra acetic acid EDTA and then stored at -20° C until analysis. Total protein and albumin concentrations were estimated, while globulin was calculated by the difference between total protein and albumin concentrations. Glucose, urea and creatinine were assayed and also the liver functions were measured throughout the activities of alanine amino transferase (AST), aspartate amino transferase (ALT). Total cholesterol, triglycerides and total lipids were determined using commercial kits (Produced by Bio-Diagnostics Company, Egypt).

Daily milk yield was recorded over the suckling period of lambs. Representative milk samples (about 0.5% of total milk produced) were taken at 7, 15, 30 and 60 days post lambing from each ewe at each daily milking (twice daily) at 7 a.m. and 5 p.m. Lambs were separated from their dams at 5 p.m. prior to the day of milk assessment and the body weight of lambs was recorded at 7 a.m. and left them suckling their dams for 30 minutes and then body weight was recorded again. The residual milk was hand milked and recorded. Similar procedure was repeated at the evening suckling at 5 p.m. Milk intake plus milk removed by hand milking represented daily milk yield for each ewe. The same procedure was reported for milk yield for ewes by Moawd (2003) and Saleh (2004). Milk samples were collected at the same time of milk yield recording and kept at -20° C and analysis for fat, protein, lactose, solids non-fat and total solids using milk scan apparatus (model/30 series type 10900 FOSS).

Data were statistically analyzed according to SPSS (2012) computer program using the following fixed model:-

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: Y_{ij} = The observation. μ = Overall mean. T_i = Effect of the treatments. e_{ij} = Random error component assumed to be normally distributed.

Duncan's multiple range tests was performed (Duncan, 1955) to detect significant differences among means.

RESULTS AND DISCUSSION

Chemical composition of feedstuffs and experimental rations:

Results of chemical composition of CFM, berseem and RS (Table,1) are within the normal ranges that reported in Egypt by several workers (Zeedan *et al.*, 2010, 2014 and 2016 and Atia, 2015). Regarding the calculated chemical composition of experimental rations, no marked differences among these rations respecting CP, CF and ash contents were observed, while EE content was increased and NFE content was decreased clearly with increasing the fat percentages in the tested rations (FA₄ and FA₆). Presumably these nutrient concentrations in all rations appeared to be closely suitable for feeding the pregnancy and lactating ewes and are agreeable what outcome with (NRC). This suitability of experimental rations for feeding ewes excessively due to the two valuable ingredients (CFM and berseem) that being in the formula of these rations.

Table (1): Chemical composition of ingredients used by experimental animals (on DM basis).

Item	Chemical composition on DM basis (%)						
	DM	OM	CP	EE	CF	NFE	Ash
CFM*	90.25	92.08	16.14	2.98	12.60	60.36	7.92
Berseem	18.94	90.07	14.69	3.68	24.59	47.11	9.93
Rice straw	92.13	85.71	3.89	1.10	38.89	41.83	14.29
Calculated chemical composition of experimental rations:							
FA ₀	76.51	90.11	13.21	2.70	20.43	53.77	9.89
FA ₄	76.21	90.32	13.41	6.73	19.84	50.34	9.68
FA ₆	75.54	89.98	13.71	8.79	19.29	48.19	10.02

*CFM; concentrate feed mix contained; 37% yellow corn, 30% undecorticated cotton seed and 20% wheat bran, 6.5% rice bran, 3% molasses, 2.5% limestone, 1% common salt.

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

Nutrient digestibility and feeding values:

Data in Table (2) indicated that the two level of FA supplementation (tested rations) increased significantly ($P < 0.05$) digestibility of OM, CP, CF, EE and NFE than those of unsupplemented one (control). Similar results were obtained by Zeedan (2003) who found that adding protected fat especially in the form of Ca-soap in the diet of buffalo calves increased the digestibility of DM, OM, CP, EE, NFE and CF than those of control during fattening stages. These results are in accordance with those obtained by El-Bedawy *et al.* (1994 b), Gabr *et al.* (2008), Zeedan, *et al.* (2010, 2014 and 2016), and Atia (2015). In the present study the increased EE digestibility in fat supplemented rations might be due to the higher digestibility of fatty acids in supplementary fat (El-Bedawy *et al.*, 1994 a, b and Khattab *et al.*, 2001). In supporting to the present results, Kumar (2017) reported that supplementation of bypass fat had no adverse effect on digestibility of nutrients. On the other hand, El-Ashry *et al.* (1997) reported that no significant effect of the different oil types at 6% level on digestibility of DM, OM and starch. In respect of the effect of fat levels in the diets, it could be observed that most nutrient digestibility values were better with FA₆ ration than those of FA₄ one. Respecting to this point, Mostafa *et al.* (1995) revealed that fat inclusion in the rations of ruminant animals up to 7.5% did not significantly affect DM, OM and CF digestibilities as well as the TDN value. Definitely, Garnsworthy (1997) concluded that enrichment of diets for dairy animals with different types of fat provided an opportunity to increase milk production and to improve the proportion of fatty acids in milk fat, but at the same time, if fed in larger amounts can provoke a negative effect on nutrient digestion and development of micro-organisms in the rumen. Nonetheless, the influence of vegetable oil fed to ruminants on metabolic processes in the rumen, nutrient digestibility, performance of cattle and proportion of fatty acids in the lipids of the carcass may be modified by diet composition, type and physical form of fat that can be included into the rations as oils, whole seeds, meals, cakes or fatty acids calcium salts as a protection state (Murphy *et al.*, 1990; Strzetelski *et al.*, 1992 and Kowalski, 1997).

It is obvious (Table 2) that FA supplementation improved significantly ($P<0.05$) the feeding value as TDN and DCP in both supplemented groups than control group. Values of TDN and DCP were 64.04, 70.00 and 73.80% and 8.13, 9.17 and 10.14% for FA₀, FA₄ and FA₆, respectively; being the differences between the low and high levels of fat addition was significant. Improvement of TDN and DCP might be due to the higher values of digestibility of most nutrients by supplementation with different levels of fatty acids, particularly EE digestibility. These findings are in agreement with those obtained by El-Bedawy (1995), El-Bedawy *et al.* (1996), Omer (1999) , Bendary *et al.*(1994), Zeedan (2003), Atia (2015) and Zeedan *et al.* (2010, 2014 and 2016).

Table (2): Effect of FA supplementation on nutrients digestibility and feeding values of the experimental diets fed to Suffolk ×Ossimi rams.

Item	Treatment			SE
	FA ₀	FA ₄	FA ₆	
Digestibility, %				
DM	63.45	65.49	67.28	1.02
OM	65.19 ^b	68.41 ^a	70.88 ^a	0.60
CP	69.80 ^b	73.01 ^a	73.97 ^a	0.70
CF	61.36 ^b	62.48 ^b	65.08 ^a	0.36
EE	69.88 ^c	73.46 ^b	75.96 ^a	0.55
NFE	70.59 ^c	72.88 ^b	74.87 ^a	0.26
Feeding values, %				
TDN	64.04 ^c	70.00 ^b	73.80 ^a	0.16
DCP	8.13 ^c	9.17 ^b	10.14 ^a	0.01

^{a, b, c} values in the same row not sharing the same superscripts are significantly different ($P<0.05$).

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

Rumen parameters:

Ruminal pH value is one of the most important factors, which affect microbial fermentation in the rumen and in turn influenced its functions. Data presented in Table (3) illustrated that the differences among the experimental rations respecting pH values did not significant over the two sampling times ,being very slight increases due to fat addition especially with the high level fat-ration(FA₆). These results are in agreement with those reported by Omer (1999) who reported that no significant differences in the values of ruminal pH due to fat addition. Similar results were found by Zeedan *et al.* (2010 and 2016) and Atia (2015).

Ammonia-N concentration was higher at zero and 3hr post feeding for supplemented groups as compared to the control one and the differences among groups were significant at ($P<0.05$) for the two sampling times. There were no significant differences between the low and high fat addition levels respecting zero sampling time, but the vice versa was found on 3 hrs post feeding time, where the high level increasing ammonia-N concentration than that of low level, significantly. These results are in accordance with those obtained by Zeedan *et al.* (2010). On the other hand, Titi *et al.* (1998) showed that the addition of 4% fat to lactating beef cow diets did not affect ruminal ammonia-N compared with no fat supplementation. Regarding to total VFAs, data presented in Table (3) showed that there were significant differences ($P<0.05$) among the tested groups and control one at 3hr post feeding being 10.12, 11.61 and 13.21meq/100ml for control, 4 and 6 % fatty acids groups, respectively. While, insignificant effect at zero time among the dietary treatments. The concentration of total VFA appeared to be better with the high level fat ration (FA₆) than that of the low –one (FA₄). Total VFA was increased with the advancement of sampling time. In the present study, greater VFA's concentration with fatty acids groups may be due to the increases in all nutrients digestibility than those of control one. These results are in accordance with those obtained by Basiony (1998), Shafie and Ashour (1997) and Khattab *et al.* (2001).Other with results here are contract with what obtained by Zeedan *et al.* (2016) who found that NH₃-N and Total VFA concentrations were significantly ($P< 0.05$) decreased for dairy buffalos fed supplemented diet involved dry fat (3 and 5 % based on DM intake) compared to those on unsupplemented one (control). In relation with the tendency of fermentation in the rumen, Jenkins (1993) summarized the results of others on lipid metabolism in the rumen, concludes that fermentation inhibition caused by increased levels of fat in the diet can be considerably reduced if the content of meadow hay or lucerne meal in the diet is high ; e.g. a 10 % supplement of rape seed oil to the diet did not depress DM digestion in the rumen when the basic

ration contained 50% meadow fescue hay. Moreover, Stasiniewicz *et al.* (2000) demonstrated that complete feeds that covered energy and protein disulfide isomerase (PDI) requirements for rumen micro-organisms and the requirements of animals, and that the increased vegetable oil intake did not cause digestive disorders in the gastro-intestinal tract of fattened bulls. Earlier Palmquist and Jenkins (1980) reported that 3 to 5 % of fat addition to common feeds seemed to be tolerated by ruminal micro-organism, thus research being continued to develop high – fat feeds with no thing be impair fermentative digestion i.e. encapsulated fat, prilled fat, calcium salt of fatty acids and other cutting edge technology outputs. The use of these forms of fats could be potentially employ up to 8 to 9% as the diet of highly productive ruminant animals (El-Bedawy *et al.*, 2004 and Kumar, 2017).

Table (3): Effect of FA supplementation on some rumen liquor parameters of Suffolk x Ossimi rams.

Item	Treatments				SE
	Time (hr)	FA ₀	FA ₄	FA ₆	
pH	0	6.54	6.61	6.72	0.04
	3	6.17	6.17	6.38	0.05
Ammonia-Nmg/100ml	0	24.12 ^b	25.19 ^a	26.10 ^a	0.30
	3	28.19 ^c	31.12 ^b	32.59 ^a	0.24
Total VFA meq/100ml	0	8.43	9.05	10.61	0.15
	3	10.12 ^c	11.61 ^b	13.21 ^a	0.06

^{a, b, c} values in the same row not sharing the same superscripts are significantly different ($P < 0.05$).

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

Blood components:

Late pregnancy period:

Data in Table (4) illustrated that the concentration of plasma total protein and its fractions in supplemented rations with 4% and 6% fatty acids was insignificant higher than those of control one over the late gestation period, being the best values were occurred with the high level of fat supplementation (FA₆). These results are in accordance with the findings that reported by Abo-Donia (2003) and Zeedan (2003). Zeedan *et al.* (2010) who found that the total serum protein was increase due to the inclusion of either oil or fat in the diets small ruminant and buffalos. Data also showed that glucose concentration was significantly higher ($P < 0.05$) for 4% and 6% fatty acids supplementing groups as compared to control. Kidney functions as urea and creatinine concentrations were in the normal range, being increased significantly with urea and insignificantly with creatinine with tested rations compared those of control one. Supplemented groups had higher significantly concentrations of total cholesterol, triglycerides and total lipids than those of control one during late pregnancy period. These results are in agreement with those obtained by El-Bedawy *et al.* (2005) who found that increasing protected fat levels to 4% or 8% of dietary ration dry matter increased ($P < 0.05$) total lipids and triglycerides ($P < 0.05$) in blood plasma. Total cholesterol was higher ($P < 0.05$) for 8% fat group than the control and 4% fat group. Similar results were obtained by Palmquist and Conrad (1978), Avila *et al.* (2000), Zeedan (2003) and Zeedan *et al.* (2010). Liver functions as the activities of AST and ALT did not significantly affect by diet supplementations with protected fat, based on supplemented one (control). Values AST and ALT were within the normal range and indicated that the animals were generally in a good nutritional status and their livers were in a normal health condition. The elevation in plasma total lipids of fat supplemented groups may be attributed to greated quantity of fatty acids absorbed from fat supplemented diets through the gut and /or the fact that feeding fat is associated with depression in lipogenic enzyme activities by liver and adipose tissues (Storry, 1981). Generally, Hill and West (1991) decided that many factors may influence plasma fatty acids concentrations including metabolic processes of other nutrients, level or composition of dietary fat and production stage and type of production (beef or milk).

Table (4): Effect of fatty acids supplementation on blood constituents of Suffolk x Ossimi ewes during late pregnancy period.

Item	Treatment			SE
	FA ₀	FA ₄	FA ₆	
Total protein (g/dl)	6.68	7.09	7.58	0.16
Albumin (g/dl)	3.47	3.86	4.18	0.17
Globulin (g/dl)	3.21	3.23	3.40	0.11
Glucose (mg/dl)	46.35 ^c	50.39 ^b	55.10 ^a	0.65
Urea (mg/dl)	34.41 ^b	36.61 ^a	36.79 ^a	0.12
Creatinine (mg/dl)	1.29	1.35	1.37	0.01
Total Cholesterol (mg/dl)	90.12 ^b	92.18 ^b	97.61 ^a	1.02
Triglycerides (mg/dl)	73.01 ^c	81.12 ^b	92.11 ^a	0.88
Total lipids (mg/dl)	459.11 ^c	489.11 ^b	517.31 ^a	0.89
AST (IU/dl)	32.40	32.82	33.01	0.33
ALT (IU/dl)	30.12	30.61	31.06	0.33

^{a, b, c} values in the same row not sharing the same superscripts are significantly different ($P < 0.05$).

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

Suckling period:

Data in Table (5) showed that total protein concentration was insignificant increased with FA₄ and significant increased with FA₆ in comparison with that of FA₀ (control), while albumin concentration was significant higher with the two levels of fat supplementations vs. that of unsupplemented one (FA₀). Otherwise, globulin concentration did not affected by dietary treatments. Data also showed that glucose concentration was significantly higher ($P < 0.05$) for 4% and 6% fatty acids supplementing groups as compared to control. Urea concentration was insignificantly increased by fatty acid supplementations where the higher value was associated with the higher level of fat ration (FA₆). These results probably attributed to the higher of blood plasma glucose and albumin concentrations of animals fed the high level supplemented ration as shown in Table (5). Regarding creatinine concentration in blood plasma, only its value was significant higher with (FA₆)-ration compared with control one (FA₀), but the value of (FA₄) was insignificant higher than that of control. Also, data illustrated that most concentrations of total cholesterol, triglycerides and total lipids were higher for supplemented groups than those of control group. These results are in harmony with the findings obtained by Nestel *et al.* (1978), Deborah *et al.* (1984), El-Bedawy *et al.* (1994a) and Gabr *et al.* (2008). Also, Zeedan (2003 and 2010) confirmed the same conclusion with fattening buffalo calves and Damascus goats. No significant effect on AST and ALT concentrations due to the dietary treatments over the suckling period were found, and its concentration values were in place of normal range which in turn indicated that the animals were in a good nutritional status and their livers were in a normal biological and physiological condition.

Table (5): Effect of fatty acids supplementation on blood constituents of Suffolk x Ossimi ewes during suckling period.

Item	Treatment			SE
	FA ₀	FA ₄	FA ₆	
Total protein (g/dl)	6.80 ^b	7.20 ^{a, b}	7.61 ^a	0.02
Albumin (g/dl)	3.72 ^c	3.98 ^b	4.38 ^a	0.01
Globulin (g/dl)	3.08	3.22	3.23	0.10
Glucose (mg/dl)	50.19 ^c	53.91 ^b	61.31 ^a	0.12
Urea (mg/dl)	35.66	37.44	38.21	0.40
Creatinine (mg/dl)	1.18 ^b	1.27 ^{ab}	1.32 ^a	0.01
Total Cholesterol (mg/dl)	96.11 ^b	98.91 ^b	102.41 ^a	0.45
Triglycerides (mg/dl)	75.66 ^c	84.12 ^b	96.41 ^a	0.25
Total lipids (mg/dl)	460.41 ^c	495.18 ^b	528.12 ^a	1.25
AST (IU/dl)	33.12	33.51	34.22	0.19
ALT (IU/dl)	29.33	29.45	30.71	0.22

^{a, b, c} values in the same row not sharing the same superscripts are significantly different ($P < 0.05$).

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

It is of interesting to note from data in Tables (4 and 5) that most of the concentrations of blood plasma constituents were lower during late pregnancy than those measured at suckling period. Respecting glucose concentration, the present results are in match with those reported by Abdel-Hafez (2002) for Suffolk x Ossimi ewes as he proved that blood glucose was high at 90 days after mating and decreased at the last week of pregnancy. These results may be due to high demand for energy especially glucose as a main source of energy during late pregnancy. Manston and Allen (1981) reported that reduction in blood sugar level in the late pregnancy and 1-2 days after parturition indicates a heavy demand for glucose in late gestation and early lactation. The results here are in match with those obtained by El-Shafie and Ashmawy (2010) who revealed that serum glucose concentration was slightly higher in suckling period than lactation period in all groups that given different levels of whole sunflower seeds in their diets. Generally, the increase in blood constituents may be due to the role of fat in improving all nutrients digestibility especially CP and TDN (Table 3). Also, it may be probably led to an increase in the absorption rate from the digestive tract, thus blood constituents of the supplemented animals reflected a corresponding increase of these values.

Milk yield and its composition:

Milk yield expressed as actual daily milk yield, 4% fat corrected milk (FCM) yield and milk composition are presented in Table (6). Daily milk yield was significantly higher ($P < 0.05$) for fat supplementation rations (FA₄ and FA₆) than that of control one (FA₀). Protected fatty acids supplementation improved actual daily milk yield by 6.89 and 13.34% for 4% and 6% supplemented group, respectively as compared to control group. These results could be attributed to increasing energy content of the fat supplemented diets with protected fat and may be to an improvement of feeding values of tested diets. Weiss and Pinos-Rodríguez (2009) suggested that bypass fat supplements more effectively convert gross energy (GE) and digestible energy (DE) to net energy for lactation (NEL), thereby increasing the milk yield. The positive effect of fat supplementation on milk yield could also be due to the sparing of glucose for the production of lactose, that considering the major osmoregulator of milk in mammary gland wherein concentration remains relatively constant (Lohrenz et al., 2010). Glucose is one of the carbon sources for the regeneration synthesis of fatty acids for milk fat synthesis (Palmquist, 2006). However, dairy cows supplemented with bypass fat transfer those fatty acids directly and more efficiently into milk fat than regeneration synthesis (Chalupa et al., 1991). These results are in agreement with those recorded by Alba *et al.* (1997), Gabr *et al.* (2008) and Titi *et al.* (2008) for sheep fed diets supplemented with fats and Zeedan *et al.* (2010) for Damascus goats that their diets supplemented with dry fat. The highest ($P < 0.05$) total solids, milk fat, and protein (%) were obtained by 6% fatty acids-supplemented group followed by 4% fatty acids-supplemented group and then the lowest values were recorded in control group (Table 6), being the differences were significant between the tested groups and control one. Similar trends respecting milk solids non fat and ash contents were observed among dietary treatments, where treatment FA₆ had the highest contents, while the FA₀ (control) had the lowest values. Otherwise lactose content had the vice versa trend, being 4.80, 4.39 and 4.42% for FA₀, FA₄ and FA₆, respectively. However, an increasing trend of milk fat content was observed due to bypass fat supplementation.

Table (6): Effect of fatty acids supplementation on milk yield and its composition of ewes during suckling period.

Item	Treatments			SE
	FA ₀	FA ₄	FA ₆	
Daily milk yield (g/h/d)	725.6 ^c	775.6 ^b	822.4 ^a	2.11
Improvement (%)	-	6.89	13.34	
Total solids (%)	16.89 ^c	17.39 ^b	17.88 ^a	0.07
Fat (%)	6.12 ^c	6.58 ^b	6.79 ^a	0.02
Solids not fat (%)	10.77 ^b	10.81 ^b	11.03 ^a	0.01
Protein (%)	5.19 ^b	5.58 ^a	5.78 ^a	0.02
Lactose (%)	4.80 ^a	4.39 ^b	4.42 ^b	0.01
Ash (%)	0.78 ^b	0.84 ^{ab}	0.89 ^a	0.02
Av. fat yield (g/h/d)	44.41 ^c	51.03 ^b	55.84 ^a	0.33
Av. Protein (g/h/d)	37.66 ^c	43.29 ^b	47.53 ^a	0.45
Av. Lactose (g/h/d)	34.83	34.05	36.35	0.48
4% (FCM) yield (kg/day)	0.956 ^b	1.076 ^a	1.167 ^a	0.01

^{a, b, c} values in the same row not sharing the same superscripts are significantly different ($P < 0.05$).

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

The availability of long-chain fatty acids from the supplemented fat could be the reason to observe such trend of increased milk fat content (Ranaweera *et al.*, 2020). Hashem and El-Zarkouny (2017) reported that during early to mid-lactation period, protected-palm oil (50 g/ewe/d) supplementation increased serum triglycerides concentration which was effectively used as an energy yielding nutrient for improving milk production. They were added that glucose concentration was in its lowest level ($P<0.05$) in the protected-palm oil group. So Ewes in the protected-palm oil had the highest ($P<0.05$) milk yield compared with those in the sugar cane molasses group and control one. In supporting to the current results Atkare *et al.* (2018) found that supplementation of bypass fat improved the energy balance of lactating buffaloes and significantly increased milk yield as well as positively modify the composition of fat and TS of milk. These results also probably attributed to the higher of blood serum glucose and albumin concentration of animal fed fatty acids supplemented rations as shown in Table (5). The present results are in consistent with those obtained by El-Shafie and Ashmawy (2010) who concluded that replacing of 5% or 10% of concentrates by whole sunflower seeds (contained 21.74% EE) of the goats rations improved nutrient digestibility, ruminal parameters, milk yield, milk fat percentage and decreased serum cholesterol. Fatty acids supplementation improved daily milk yield and its composition in supplemented groups than those of control group. Likewise, supporting findings to the current results are recorded by Zedan *et al.* (2010) with dairy goats where their outcome revealed that supplementation of dry fat by 3 or 5 % into the diets of goats had positive effects on digestibility, rumen fermentation and milk production and its qualities. They added that fat can avoid some problems such as ruminal acidosis and liver abscess. Similar results are recovered by Alba *et al.* (1997), Gabr *et al.* (2008) and Titi *et al.* (2008) for ewes fed supplemented diets with fats.

Lambs growth performance:

Data in Table (7) showed that lambs in FA supplemented groups had higher values of birth weight as compared with control group, but the differences only significant between the tested ration that supplemented with 6% fat level (FA₆) and control one (FA₀). By the other words, birth weight was increased by 7.19% and 19.93% for FA₄ and FA₆ rations, based on control value, respectively. These results are in consistent with the results of Gabr *et al.* (2008) who pointed that lambs born from ewes offered diets supplemented with fish oil had higher ($P<0.05$) birth weight and lamb growth rate than control diet. Zeedan *et al.* (2010) recorded the same result for kids of Damascus goats at birth. Similarly, weaning weight was significant higher in the tested groups being 15.11 and 15.72 kg for 4% and 6% FA supplemented groups, respectively than that of control one (13.51 kg). The highest significantly total gain ($P<0.05$) were achieved with 6% FA supplemented group followed by 4% FA supplemented group and then control group. The same trend among dietary treatments was observed with daily gain of kids over pre-weaning period. Similar results with the diets supplemented with protected fat and oil fed to an improvement in both birth and weaning weights in goats and buffaloes (Zeedan *et al.*, 2010, 2014 and 2016 and Atia, 2015). Inclusion of fat in ruminant diets could be improved (methanogenesis process) energy efficiency due to the lower ruminal production of methane and direct use of long-chain fatty acids in the metabolic pathways of fat synthesis, without potentially need for acetate and glucose (Doreau and Chilliard, 1997).

Table (7): Effect of feeding the experimental diets on productive performance of lambs during pre-weaning period.

Item	Treatment			SE
	FA ₀	FA ₄	FA ₆	
Birth weight (kg)	3.06 ^b	3.28 ^{ab}	3.67 ^a	0.02
Improvement,%	-	7.19	19.93	-
Weaning weight (kg)	13.51 ^c	15.11 ^b	15.72 ^a	0.05
Improvement,%	-	11.84	16.36	-
Total gain (kg)	10.45 ^c	11.83 ^b	12.05 ^a	0.03
Improvement,%	-	13.21	15.31	-
Daily gain (g/day)	174.17 ^c	197.16 ^b	200.83 ^a	1.01
Improvement,%	-	13.20	15.31	-

^{a, b, c} values in the same row not sharing the same superscripts are significantly different ($P<0.05$).

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

On the other hand, Titi *et al.* (2008) reported that weaning weight and daily gain of the new born kids from Shami does and Awassi ewes did not affected by fat supplementation. Litter weight was not different for ewes, but it was higher ($P < 0.05$) for treated does with no differences between 3% and 5% supplemented fat groups.

Feed intake and feed efficiency:

The results of total daily feed intake as DM, TDN and DCP of the experimental rations are presented in (Table 8). Results of total daily DMI showed no significant differences among all experimental rations. The highest values of DMI intake was occurred with control ration, while the lowest values were observed with FA6 ration. Results regarding DMI in current study are in agreement with that obtained by Zeedan *et al.* (2010), where they were found that its values were decreased with both groups that supplemented with 3% or 5% of dry fat compared with free supplementation one (control).

On the contrary, the values of TDNI and DCPI was insignificant higher when animals fed FA₄ and FA₆ rations compared to those fed control one, with also no significant differences between the two tested rations. These results are in agreement with those recorded by Gabr *et al.* (2008), Zeedan *et al.* (2014 and 2016) and Atia (2015). It could be shown that FA supplementation perhaps make a favorable effect for animals to get the best ingredient from their rations, and also tended to improve digestibility and feeding value for experimental rations, thus led to an increase in utilization of rations. A part of modulatory effects of the increase in digestibility may be resulted from the reduction of DM intake that occurred with fat supplementation rations. Lohrenz *et al.* (2010) also reported that increased milk production among bypass-supplemented cows despite unchanged DMI and suggested that the effect could be due to sparing of glucose.

Feed efficiency expressed as amounts of 4% fat corrected milk yields produced from one kg DM intake (Table 8) appeared to be higher for fat supplemented rations than those fed control one. However, differences in feed efficiency between FA₄, FA₆ and FA₀

Table (8): Effect of dry fat supplementation on feed intake and feed efficiency of Suffolk x Ossimi ewes.

Item	Groups			SE
	FA ₀	FA ₄	FA ₆	
Daily feed DM intake (kg /h/d) as				
CFM	1.26	1.26	1.26	-
Berseem	0.42	0.40	0.35	-
R.S.	0.42	0.34	0.29	-
Total DMI	2.10	2.00	1.90	0.02
Total TDNI	1.35	1.40	1.40	0.03
Total DCPI	0.170	0.183	0.193	0.01
4% fat correct milk yield (FCM), kg / day	0.956 ^b	1.076 ^a	1.167 ^a	0.01
Feed efficiency:				
4% FCM / kg DMI	0.46	0.54	0.61	-
4% FCM / kg TDNI	0.71	0.77	0.83	-
Feed conversion:				
DMI / 4% FCM	2.20	1.86	1.63	-
TDNI /4% FCM	1.41	1.30	1.20	

FA₀= Control, FA₄=4% FA (based on DM intake) and FA₆=6% FA (based on DM intake).

groups were insignificant. Improvement in feed efficiency for groups consumed FA supplementation might be attributed to lower DM intake, higher milk yield and improvement of digestion coefficients and feeding values (TDN and DCP). This was in consistent with the results recognized by Gabr *et al.* (2008), Zeedan *et al.* (2010) and Atia (2015). Earlier, Mostafa *et al.*, (1995) had been obtained close compare all results to that outcomed in the current study, respectively feed intake (DMI) and feed efficiency of lactating buffalos. Sharma *et al.* (2016) indicated that feed efficiency of the supplemented fat group was higher ($P < 0.01$) than that of control one during the post-partum period of hurrah buffaloes. In pertinent, incorporation of 4% calcium soap fat could be improved feed utilization of the 30% roughages diet be comparable of that containing 90% concentrate without adverse effects on rumen metabolism and blood plasma metabolites (El-Bedawy *et al.*, 2004). Lastly, fat as a constituent of the ruminant diet is an

expensive commodity, as well as dietary fats may affect the microbial metabolism in the rumen and the extent of supplementation has to be carefully controlled.

CONCLUSION

The findings of this study revealed that, supplementation of protected fatty acids to diets of Suffolk x Osimi crossbred ewes at different levels (4 or 6%) had positive and beneficial effects on digestion and feeding values, rumen fermentation and ewes productive performance as well as fat can avoid some problems such as ruminal acidosis and liver abscess.

REFERENCES

- AOAC (1990). Association of Official Analytical Chemists. Official Methods Analysis 15th ed. Washington, DC, USA.
- Abdel-Hafez, M. A. M. (2002). Studies on reproductive performance in sheep. Ph. D. Thesis, Fac. Agric. Zagazig Univ., Zagazig, Egypt.
- Abo-Donia, F. M. A. (2003). Using different sources of soap-stock as non-conventional source of energy in sheep rations. *Egypt. J. Nutr. and Feeds* 6 (Special Issue): 1381.
- Alba, L. M.; S. Cavalcanti; M. Hernandez; A. Marin and G. Marin (1997). Calcium soaps of olive fatty acids in the diets of Mancheg dairy ewes: effect on digestibility and production. *J. Dairy Sci.* 80: 3316.
- Atia, E. S. A. (2015). The effect of the using of dry fat on productive performance of Egyptian dairy buffaloes. Ph. D. Thesis. Anim. Prod. Dept. Uni. Tanta, Egypt.
- Atkare, V.G., A.D. Shambharkar and S.M. Khupse (2018). Effect of feeding of bypass fat mineral mixture on productive performance and quality of milk of buffaloes in Armori Tahsil. *Int. J. Curr. Microbiol. App. Sci* 7(1): 2949-2957.
- Avila, C. D., E. J. Depeters, H. Perez-Montl, S. J. Taylor and R. A. Zinn (2000). Influences of saturation ratio of supplemental dietary fat on digestion and milk yield in dairy cows. *J. Dairy Sci.*, 83: 1505.
- Basiony, A.K. (1998). Growth performance of post weaned buffalo calves fed fat supplemented rations. M. Sc. Thesis. Anim. Prod. Dept. Cairo Univ., Egypt.
- Bendary, M.M., I.A. Abou-Selim, M. R. M. Moustafa, A. M. Mahmoud and A. E. M. Khinizy (1994). Performance of fattening buffalo calves fed different levels of palm oil for two different periods. *Egyptian J. Anim. Prod.* (31). Suppl. Issue, Nov. 613-626.
- Chalupa, W., D.S. Kronfeld, P.L. Schneider and D. Sklan (1991). Methods of increasing milk yields in ruminants. In: Google Patents. United States Patent. [1https://patents.google.com/patent/US5004728A/en](https://patents.google.com/patent/US5004728A/en). Accessed 14 Dec 2018
- Chan, S. C.; J. T. Huber; C. B. Theurer; Z. Wu; K. H. Chen and J. M. Simas (1997). Effects of supplemental fat and protein source on ruminal fermentation and nutrient flow to the duodenum in dairy cows. *J. Dairy Sci.*, 80: 152.
- Chilliard Y., Ferlay A., Rouel J. and Lamberet G. (2003). A review of nutritional and physiological factors affecting goat milk lipid synthesis and lipolysis. *J. Dairy Sci.* 86, 1751-1770.
- El-Shafie, M.H. and T. El-Ashmawy (2010). Performance of goats fed rations containing whole sunflower seeds. *J. Sheep and Goat Sci.*, 5(2): 1-8.
- Doreau, M. and Y. Chilliard (1997). Digestion and metabolism of dietary fat in farm animals. *Br. J. Nutr.* 78, S15-S35.
- Duncan, D. B. (1955). Multiple range and multiple F-test. *Biometrics*, 11: 1.

- El-Ashry, M. A.; B. Brittot; A. Z. EL-Basiony; H. S. Soliman and H. M.El-Sayed (1997).The effect of lipid supplement on starch digestion by ruminants. Egyptian. J. Nutr. and feeds / (Special Issue):99 – 108.
- El-Bedawy, T. M., S. M. Ahmed, M. A. I. Salem, and H. A. A. Omer (2004). Effect of dietary protected fat and roughage level on digestion, rumen metabolism and plasma lipids of growing-finishing lambs, Egyptian J. Anim. Prod., vol. 41, pp. 219-236.
- El-Bedawy, T. M. (1995).Preparation of sunflower oil calcium soap as a protected fat and its use in ruminant nutrition. J. Agric. Sci. Mansoura Univ. 20 (1): 231-237.
- El-Bedawy, T. M.; A. A. Abd El-Gawad; M. A. Gabra and F. A. Scander (1994a). Full fat sunflower seeds oil as fat supplement for dairy cows. Egypt. J. .A Anim.Prod.,31(suppl.): 147.
- El-Bedawy, T. M.; H. M. El-Husseini; S. M. Allam and F. H. Shahin (1994b).Effect of dietary fat and calcium supplements on in Vivo digestibility, rumen fermentation and some blood constituents of sheep. Egyptian J. Anim. Prod.Vol. 31 suppl. Issue, Nov. 59-73.
- El-Bedawy, T.M.;I. A. Gomrnaa; Sabbah M. Allam and F.M. Abu-Donia (2005). Production of calcium salts of fatty acid from soap-stock on semi industrial scale and its use in finishing rations of Friesian bulls. Egyptian J. Nutrition and Feeds (200.1) 8 (2): 175-185
- El-Bedawy, T. M.; M. A. I. Salem and E. A. Badr (1996). Effect of dietary fat on growth performance and carcass characteristics of finishing bulls. Egyptian J. Anim. Prod. 33. Suppl. Issue, Nov. 103-111.
- El-Shafie, M.H. and T. El-Ashmawy (2010). Performance of goats fed rations containing whole sunflower seeds.Egyptian. J. of Sheep & Goats. Sci., Vol. 5 (1), P: 269.
- Gabr, A. A.; M. M. El-Shinnawy; B.E. EI-Saidy and M.M. El-Badawy (2008). Influence of diets supplemented with fish oil on nutrients digestibility, some rumen parameters, blood constituents, productive and reproductive performance of ewes. J. Agric. Sci. Mansoura Univ., 33(2):991-1007.
- Garnsworthy, P.C., (1997).Fats in dairy cow diets.In:p.c.Garnsworthy, J.Wiseman (Editors). Recent advances in animal nutrition. Nottingham University Press, pp.87-104.
- Hashem, N. M. and S. Z. El-Zarkouny (2017).Metabolic attributes, Milk production and ovarian activity of ewes supplemented with a soluble sugar or a protected-fat as different energy sources during postpartum period. Ann. Anim. Sci., Vol. 17(1): 229–240.
- Hill, G. M. and J. W. West (1991). Rumen protected fat in kline barley or corn diets for beef cattle: digestibility physiological, and feedlot responses. J. Anim. Sci. 69:337
- Horn, G. W.; T. L. Mader; S. L. Armbruster and R. R. Frahn (1981).Effect of monensn on ruminal fermentation, forage intake and weight gains of wheat pasture stocker cattle. J. Anim. Sci., 52: 447.
- Jenkins, T.C. (1993). Lipid metabolism in the rumen. J. Dairy Sci.,76:3851.
- Khatab, H. M.; H. M El-Sayed; M.A El-Ashry; I. M. Gomaa and F. M. Omar (2001). Performance of fattening lambs fed rations containing different levels of soylecithin and sunflower soap stock as non conventional fats.1 – Effect of nutrients digestibility, nitrogen and water balance. Egyptian J. Nutr. and Feeds 4: 667.
- Kowalski Z.M. (1997). Rumen fermentation, nutrient flow to the duodenum and digestibility in buuls fed calcium soaps of rape seed fatty acids and soybean meal coated with calcium soaps.Anim.Feed Sci.Tech.69:289-303.
- Kumar, M. (2017). By pass fat in animal feeding-A review. J. of Entomology and Zoology Studies, 5(6): 2251-2255.
- Lohrenz, A.,K. Duske,F. Schneider,K. Nürnberg,B. Losand, H.M. Seyfertand , C.C. Metges (2010). Milk performance and glucosemetabolism in dairy cows fed rumen-protected fat during midlactation,Journal of Dairy Science, 93, 5867–5876.
- Manston, R. and W. M.Allen (1981).The use of blood chemistry in monitoring the health of farm Livestock. Br. Vet. J., 137: 241 – 253.
- Maynard, L.A.; J. K. Loosli; H.S.Himtz and R.G. Wamer (1979). Animal Nutrition. McGraw Hill Book Co. Inc. NY.

- Moawd, R. I. (2003). Effect of feeding mushroom cultivating by-products on performance of pregnant and suckling ewes. *J. Agric. Sci. Mansoura Univ.*, 28(8): 5985 – 5993.
- Mostafa, M.R.M., M.M. Bendary, A.M. Mahmoud, I.A. Abou- Selim and W.H. Abdel- Malik (1995). Productive performance of lactating buffaloes fed rations containing different levels of vegetable fat. *Proc. 5th Sci.conf. Animal Nutrition*, Vol.1: 103- 113, Ismailia, Dec. 1995.
- Murphy J.J., McNella G.P., Connolly J.F., Glesson P.A., (1990). Effect in cow performance and milk fat composition of including of full fat soya bean and rape seed in the concentrate mixture for lactating cows. *J. Dairy Res.* 57:295-306.
- Nestel, P. J.; A. Poyser; R. L. Hood; S. C. Mills; M. R. Willis; L. J. Cook and T. W. Scott (1978). The effect of dietary fat supplements on cholesterol metabolism in ruminants. *J. Lipid Res.* Volume 19 : 899.
- NRC (1981). National Research Council. Nutrient requirement of domestic animals. Nutrient requirements of goats. National Academy of Science, Washington, D.C., USA.
- Omer, F. M. A. (1999). Using protected fat prepared from soap industry by-products in finishing rations of Friesian bulls. Ph. D. Thesis. Anim. Prod. Dept. Cairo Univ., Egypt
- Palmquist, D.L. (2006). Milk Fat: Origin of Fatty Acids and Influence of Nutritional Factors Thereon, In: P. F. Fox and P. L. H. McSweeney (eds), *Advanced Dairy Chemistry*, (Springer International) Publishing: New York, 43–92
- Palmquist, D.L. and H. R. Conrad (1978). High fat rations for dairy cows. Effects on feed intake, milk production and serum metabolites. *Dairy Sci.*, 6 (1): 890.
- Palmquist, D.L. and T.C. Jenkins (1980). Fat in lactation rations: Review. *J. of Dairy Science* 63:1-14.
- Ranaweera K.K.T.N., M.B.P. Kumara Mahipala and W.M.P.B. Weerasinghe (2020) Influence of rumen bypass fat supplementation during early lactation in tropical crossbred dairy cattle. *Tropical Animal Health and Production* (2020) 52:1403–1411
- Rouse, R. H. (1988). Fat source and quality. *Rouse marketing Inc. Cincinnati, OH.*
- Saleh, H. M. (2004). Effect of supplementing fenugreek seeds as galactagogue on performance of lactating ewes. *Egyptian J. Nutr. and Feeds*, 7 (2) : 155 – 165.
- Sanz Sampelayo M. R.; L. Pérez; J. J. Martín Alonso; F. Gil Extremera and J. Boza (2002). Effects of concentrates with different contents of protected fat rich in PUFAs on the performance of lactating Granadina goats: 1. Feed intake, nutrient digestibility, N and energy utilization for milk production. *Small Ruminant Research J.*, Vol 43 (2):133-1
- Shafie, M. M. and G. Ashour (1997). Anticipated role of the rumen in complementary adaptation to environment. *Egyptian J. Nutr. and Feeds*, 1:21.
- Sharma, S., Singh, M., Roy, A.K. and Thakur, S. (2016). Effect of pre-partum prilled fat supplementation on feed intake, energy balance and milk production in Murrah buffaloes. *Vet. World*, 256-259.
- Simas, J.M.; J.T. Huber; C.B. Theurer; K.H. Chen; F. A. P. Santos and Z. Wu (1998). Influence of sorghum grain processing on performance and nutrient digestibilities in dairy cows fed varying concentration of fat. *J. Dairy Sci.*, 81: 1966.
- SPSS (2012). *SPSS User's Guide Statistics Version 19*. Copyright IBM, SPSS Inc., USA.
- Stasiniewicz, T., J. Strzetelski, J. Kowalczyk, S. Osieglowski and H. Pustkowiak (2000). Performance and meat quality of fattening bulls fed complete feed with rapeseed oil cake or linseed. *J. Anim. And Feed Sci.* 9:283-296.
- Storry, J.E. (1981). The effect of dietary fat on milk composition. In *Recent Advances in Animal Nutrition* (W. Haresign, Ed.) pp.3-33
- Strzetelski J.A., lipiarska E., Kowalczyk J., Stasiniewicz T. and Maciaszek K. (1992). The use of rape seed in a complete feed in intensive fattening of Young bulls. *J. Anim. Feed Sci.* 1:107-115.
- Suharti, S., L. Khotijah, A. Riski Nasution, D. A. Warmadewi, I. G. L. Oka Cakra, Ch. Arman and K. G. Wiryawan (2017). Productive and reproductive performances and blood profile of Bali cows supplemented with calcium soap-soybean oil. *Pak. J. Nut.* 16(11): 882- 887.

- Titi, H.H.; M. Alnimer; M.J. Tabbaa and W.F. Lubbadeh (2008). Reproductive performance of seasonal ewes and does fed dry fat during their postpartum period. *Livestock Science* 115: 34–41
- Titi, Tjardes, K. E.; D. B. Faulkner; D. D. Buskirk; D. F. Parrett; L.L. Berger; N. R. Merchen and F. A. Ireland (1998). The influence of processed corn and supplemental fat on digestion of limit - fed diets and performance of beef cows. *J. Anim. Sci.* 76: 8 -17.
- Warner, A.C. I. (1964). Production of volatile fatty acid in the rumen. Methods significantly of measurements. *Nutr. Abstr. and Rev.*, 34: 339.
- Weiss, W.P. and J.M. Pinos-Rodríguez (2009). Production responses of dairy cows when fed supplemental fat in low and high- forage diets. *Journal of Dairy Science*, 92: 6144–6155
- White, T. W.; L. D. Bunting; L. S. Sticher; F. G. Hembry and A. M. Saxton. (1992). Influence of fish meal and supplemental fat on performance of finishing steer exposed to moderate or high temperatures. *J. Anim. Sci.* 70: 3286-3292.
- Zeedan, KH. I. I. (2003). Effect of dietary fat on performance, rumen fermentation and some blood parameters on buffalo. Ph.D. Thesis. Anim. Prod. Dept. Menoufia, Egypt.
- Zeedan, Kh. I. I., Abdel-Latif, M.A., El-Bltagy, E.A. and El-monayer, T.I. (2014). Effect of the addition of oil and dry fat on productive and reproductive performance on Egyptian buffaloes – cow's ration. *Egyptian J. Nut. and Feeds*, 17 (3): 457- 472.
- Zeedan, Kh. I. I.; M. A. Abdel-Latif, E.A. El-Bltagy, S.I. Weld Abd-Elkader, A.A. El-Giziry and A. H. Ghoniem (2016). Effect of supplementation dietary dry fat on productive and reproductive performance on Egyptian lactating buffaloes. *Egyptian J. Nutrition and Feeds*, 19 (3): 399-413
- Zeedan, Kh. I.I., O.F. Komonna, K.E.I. Etman and Kh. M. M. Mousa (2010). Effect of using different levels and sources of fats and roughages on productive performance, rumen fermentation and some blood parameters in ruminant. 1- Effect of dry fat supplementation on productive and reproductive performance of Damascus goats. *Egyptian J. Nut. And Feeds*, 13 (1): 21-40.

تأثير إضافة الأحماض الدهنية المحمية الى العلائق على الاداء الإنتاجي لنعاج السافولك مع الأوسيمي خلال مراحل الإنتاج المختلفة

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¹ قسم بحوث تغذية الحيوان - معهد بحوث الإنتاج الحيواني - مركز البحوث الزراعية - الدقي - الجيزة - مصر.

² قسم الإنتاج الحيواني - كلية الزراعة - جامعة طنطا - طنطا - مصر.

أجريت هذه الدراسة لتقييم تأثير إضافة الأحماض الدهنية المحمية بالكالسيوم على هضم العناصر الغذائية ، ومقاييس الكرش ، وبعض مكونات الدم ، وإنتاج الحليب ومكوناته ، وأداء نمو الحملان خلال فترة ما قبل الفطام (شهرين) وذلك على النعاج الخليط (سافولك * أوسيمي). تم تقسيم إجمالي 36 نعجة حامل يبلغ متوسط وزنها 1.57 ± 64.89 كجم في الموسم من الثاني إلى الرابع وتتراوح أعمارهم بين 2.5 - 4.5 سنة إلى ثلاث مجموعات متشابهة وفقاً لوزن الجسم (12 نعجة لكل منها). بدأت تجربة التغذية قبل الولادة بـ 60 يوماً (فترة الحمل المتأخرة) واستمرت 60 يوماً بعد الولادة (فترة الرضاعة). تم تقديم العلائق التجريبية للحيوانات بمعدل 4% و 6% أحماض دهنية محمية بالكالسيوم (على أساس المادة الجافة المأكولة). تم تسجيل وزن الجسم ، ومعدل الزيادة اليومي للحملان حديثي الولادة خلال فترة ما قبل الفطام (فترة الرضاعة). تكونت عليقه المقارنه من 60% علف مركز و40% مواد خشنة (30% برسيم + 10% قش أرز. أجريت ثلاث تجارب هضم باستخدام تسعة كباش خليط (سافولك x أوسيمي) بمتوسط وزن 62 كجم وتتراوح أعمارهم بين 2 و 2.5 سنة. لتحديد قيم الهضم للعلائق التجريبية. أظهرت البيانات أن معاملات الهضم كانت أعلى معنوياً لكلا من المادة العضوية ، البروتين الخام، الألياف الخام، مستخلص الإيثير والمستخلص الخالي من الأزوت لمجموعتي الدهون مقارنة بمجموعة المقارنه. مقاييس الكرش (درجة الحموضة وتركيز الأحماض الدهنية الطيارة الكلية والأمونيا) كانت أعلى في مجموعات الإضافة عن عليقه المقارنه. كانت تركيزات البروتين الكلي لبلازما الدم، والجلوكوز، والكوليسترول الكلي، والدهون الثلاثية والليبيدات الكلية في النعاج أعلى في مجموعات إضافة الدهون عن مجموعة المقارنه في كلا المرحلتين. إضافة الدهون المحمية أدت إلى زيادة معنوية في الوزن عند الولادة، الوزن عند الفطام ، العائد الكلي لوزن الحملان، وكانت أعلى القيم مع مجموعة 6% دهن محمي. كما ان إنتاج الحليب كان أعلى معنوياً في مجموعات إضافة الدهن المحمي عن مجموعة المقارنه بالإضافة إلى ارتفاع نسب مكونات اللبن بها (الدهون ، المواد الصلبة الكلية والبروتين). وبشكل عام خلصت الدراسة إلى أن إضافة الأحماض الدهنية المحمية بالكالسيوم بمستويات مختلفة (4% و6%) لعلائق النعاج أدى إلى تحسين قابلية الهضم والقيم الغذائية وزيادة وزن الحملان عند الولادة وإنتاج الحليب ونسب مكوناته إلى جانب تحسين الكفاءة الغذائية و كانت أفضل وأعلى النتائج مع العلائق المضاف إليها الدهن المحمي بنسبة 6% .