EFFECT OF SUPPLEMENTING LACTATING GOATS RATIONS WITH MARINE ALGAE AND SUNFLOWER OIL ON MILK PRODUCTION, CHEMICAL COMPOSITION AND MILK FATTY ACIDS PROFILE

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SUMMARY

The present study aimed to evaluate the effect of rations supplementation with marine algae (MA) or/and sun flower oil (SFO) on experimental rations digestibility and nutritive values, efficiency of goats milk production, milk chemical composition and milk fatty acids profile. Twenty four lactating (Damascus x Baldi) goats at the last 6 weeks of gestation and until 16 wks. lactation period were randomly assigned into four nutritional groups (6h/ group) to receive one of the following experimental rations; R1 control (basal ration without additives); R2 (basal ration +2% *Nanno chloroprssis* powder (MA)); R3 (basal ration+ 2% Sun flower oil (SFO) and R4; (basal ration + 1% MA + 1% SFO). Experimental groups were offered their daily requirements *ad lib*.. Daily basal ration consisted of pelleted concentrate feed mix. (14% CP and 60% TDN) + Egyptian green clover (*Trifolium Alexandrium*). Results obtained pointed out to positive significant effects ($p<0.05$) of dietary supplements with MA or/and SFO on improving goats milk production in terms of fat-corrected milk FCM(kg) /h/d and milk energy value MEV kcal/kg milk, and insignificantly energy-corrected milk ECM kg/h/d, goats milk efficiency, as (kg. DMI/ kg. FCM) and as FCR (kg. milk/ kg. DMI). Dietary supplemented rations affected ($p<0.05$) goats milk chemical composition in compare with the dietary control group and within the dietary supplemented groups, G3 (SFO) surpassed ($p<0.05$) the other supplemented ones in most milk productive and milk chemical composition traits. As for milk FA's profile, results indicated that milk from goats receiving (SFO) or *Nannochloropssis* or their mixture (*Nanno*.xSFO) supplementation displayed an improvement in the FA's profile, with an increased PUFA and monounsaturated FA's contents and a decrease in SFA's content.

Keywords: *Sun flower oil, Marine algae (Nannochloropssis), saturated fatty acids, polyunsaturated fatty acids, goats milk production and goats milk fatty acids.*

INTRODUCTION

Ruminant milk is one of the most consumed beverages in the world and its importance for human nutrition and health is well known given its protein, sugar, fat, vitamins and mineral content. In the last twenty years, several studies have focused on improving the nutritional and nutraceutical quality of milk, and at providing it with an added nutritional value (Altomonte *et al*., 2018). Lipid composition is one of the most important components of the nutritional quality of goat milk. The nutritional advantage of goat milk fat compared to cow's milk may be attributed to the high content of C6:0 to C10:0 fatty acids (FA's), the high percentage of the short- and medium-chain FA's, and to the small size of fat globules; hence making goat's dairy product easily digestible than cow's dairy product (Chilliard *et al*., 2006).

Even though consumption of ovine milk might have several nutritional advantages over bovine milk consumption, such as its higher mineral (*e.g.*, Ca, P, and Mg), and caprylic (C8:0) and capric (C10:0) acid contents and its easier digestibility (Recio *et al*., 2009), Microalgae are photoautotroph unicellular or multicellular micro-organisms which are smaller than 400 μm. They can be used as an economical unconventional animal feed source, since they are very efficient in converting solar energy, are not dependent on external environmental conditions, and characterized by higher productions per unit area than traditional crops (Priyadarshani and Rath, 2012). Adding marine lipids, rich in long chain n-3 polyunsaturated fatty acids (PUFA's) to sunflower oil (SO) supplements, can induce further increases in milk conjugated linoleic acids (CLA) content (Palmquist and Griinari, 2006). With the incorporation of these microalgae to the livestock feeding, two goals are wanted: improving the quality of the products,

enhancing the nutritional quality, and reinforce the immune system of these animals. The effects of marine algae (MA) are inconsistent and may depend on basal diet composition and algae dosage (Papadopoulos *et al*., 2002; Reynolds *et al*., 2006).

Microalgae-based feeds in ruminant diets are introduced in order to supplement the ration, as a source of: a) Energy: used in the partial substitution of corn or concentrate (Boeckaert *et al*., 2008; Da Silva *et al*., 2016), or added to the lipid supplementation (Toral *et al.*, 2010b; Stamey *et al*., 2012), b) Protein: in partial replacement of soy (Reynolds *et al*., 2006; Póti *et al*., 2015) or rapeseed (Lamminen *et al*., 2017), c) Enhance the antioxidant defense system and oxidant status of products (Tsiplakou *et al*., 2018) given the natural content of natural antioxidant compounds. The objectives of the present study were: 1- Studying the effect of ration supplementation with some feed additives of marine algae and sunflower oil on goat's milk production and composition. 2- Aimed to compare sunflower oil and *N. oculata* microalgae, as UFA's sources, to alter ruminal fermentation, digestibility and nutritive value rations.

MATERIALS AND METHODS

Twenty-four lactating (Damascus x Balady) does at the last 6th weeks of gestation were used until 16 weeks after parturition. Experimental animals were randomly divided at the 17th week of gestation into four similar groups according to live body weight, age and parity of lactation.

Experimental rations:

Does were weighed at the start of the study and biweekly intervals thereafter to adjust their feeding requirements according to live real changes in body weight during the feeding trails. Rations were offered *ad lib*. and residuals were daily estimated. Fresh water was available all the days' time and animals were kept in semi-opened pens. The four feeding groups (Table 1) were offered their daily requirements according to (NRC recommendations, 2001), while treated groups were supplemented with 0% additives (control), control + 2% *Nannochloropssis* powder of DM (R2), control + 2% sunflower oil (R3), and control + 1% *Nano*. + 1% sunflower oil (R4), the control ration based on a pelleted concentrate feed mixture (14% CP and 60% TDN) + 2kg Egyptian clover (*Trifolium Alexanrium*) / h/ day. Chemical analysis of the experimental ingredients and chemical composition of the different experimental rations containing SFO and *N. oculata* (on DM basis %) are presented in Tables (2 & 3), respectively.

Table (1): Experimental design.

Treatments	**R1**	**R2**	**R3**	**R4**
Rations	Control	Control + 2% *Nannochloropsis*	Control + 2% Sunflower Oil	Control + 1% *Nannochloropsis* + 1% Sunflower Oil
NO. Does	**6**	**6**	**6**	**6**

Table (2): Chemical analysis of the experimental ingredients (on DM basis %).

Items	**DM**	**OM**	**CP**	**CF**	**EE**	**NFE**	**Ash**
Nanno- Chloropssis	91	71.6	28.5	10.75	10.76	21.59	19.4
Bean straw	92.63	87.87	4.55	37.74	0.71	44.87	12.13
Yellow corn	90.36	89.35	7.88	2.09	4.03	75.35	10.65
Wheat bran	90.25	89.81	14.51	11.32	3.14	60.84	10.19
Soy bean meal	93.22	91.86	43.50	4.89	6.89	36.58	8.14
Molasses	60.46	51.18	1.76	-	-	49.42	9.28

Table (3): Chemical composition of the experimental rations (%).

Rations	DM	OM	CP	CF	EE	NFE	ASh
(G1) Control	91.47	89.13	14.96	15.48	3.10	55.59	10.87
(G2) control + 2% *N.oculata*	91.34	89.2	15.22	15.38	3.7	54.90	10.8
(G3) control + 2% S.F.O	91.36	88.53	14.95	15.62	4.5	53.48	11.47
(G4) control +1%*N.oculata* +1% S.F.O	91.35	88.86	15.08	15.5	4.1	54.5	11.14

Milk determination:

Milk yield was recorded once weekly all over 16 weeks' lactation period, starting at the second week post parturition, according to (Salama technique, 2018) Kids are separated from their dams for a 12-hour period (from 8:00 PM to 8:00 AM). During this time, does were fitted with cloth udder covers designed with a single opening to expose one teat, allowing the kids to rear from the exposed teat over 12-hours interval, while the other teat remained fully covered. At the end of the 12-hours period, the covered teat was manually milked, and the milk volume was measured. On the following day, the previously exposed teat was covered and the kids were permitted to nurse from the teat that was covered during the preceding 12-hour period. After 12 hours, the milk yield from the newly exposed teat was similarly measured. The total udder milk production was estimated by doubling the measured milk volume from a single teat. This alternating process was weekly repeated over 16 weeks to collect several measurements, from which the average daily milk yield for both teats was calculated. Lactating does were hand milked, while milk yield was recorded individually. A composite sample (10% of total daily milk yield) was immediately collected and stored in plastic bottles (100 ml) with few drops of formalin and stored at (-18C^0) till later chemical analysis.

Milk chemical composition:

Milk samples from does were chemically analyzed to fat, protein, total solids (TS), solids not fat (SNF) and ash percentages. Milk fat content was determined according to Gerber methods, described by ling (1963), protein was determined by the semi micro-kjeldahl distillation methods according to ling (1963), total solids (TS) were determined in 10ml milk sample to a constant weight at 105C^o for 24hrs. According to AOAC (1997). ash was determined by evaporating 10ml milk until dryness and aching in muffle furnace at 450c for 2hr and solids not fat (SNF) were calculated by the difference between total solids and fat content.

MEV, FCM, and ECM measurements:

Milk energy value (MEV), fat-corrected milk (FCM) and energy-corrected milk (ECM) were estimated according to Baldi *et al.* (2002), NRC (2001) and Sjaunja *et al.* (1991) equations, respectively.

Ruminal parameters:

Samples of ruminal fluids were collected before feeding (0 time), at 3 and 6 hours post feeding using a polyethylene collection tube. Strained rumen liquor was stored in glass bottles (45 ml) with few drops of toluene and paraffin oil just to cover the ruminal surface liquor and stored at (-18C^o) till analysis for ammonia nitrogen (NH_3-N) and total volatile fatty acids (TVFA's). Ruminal pH was determined (before rumen liquor storage) by using digital pH meter (model M90, Corning Inc., Corning, NY, USA), TVFA`s were determined by steam distillation as described by Warner (1964) and NH3-N was determined according to (Abou-Akkada and Osman, 1967).

Proximate chemicals analysis:

Samples of feedstuffs ingredients, complete mixed rations, residues and feces were analyzed for moisture, crude protein (CP), ether extract (EE), crude fiber (CF), Nitrogen free extract (NFE), ash and urinary nitrogen according to AOAC (1997).

Statistical analysis:

Data obtained were statistically analyzed according to SAS, 2002. The differences between groups were estimated by the L.S.D test according to Duncan (1955). Two-way analysis of variance was adopted using the following equation: -

$$Y_{ijkl} = \mu + T_i + P_j + R_k + E_{ijkl}$$

Y_{ijkl} = the observation of the parameter
μ = overall means
T_i= the effect of dietary rations
P_j = the effect of period
R_k =the effect of replication
E_{ijkl} = the random error term
Y expressed every observation of the kk^{th} animal in the j^{th} period given i^{th} treatment, T expressed the treatment effect, P expressed the periods effect R expressed the animals effect and E expressed the experimental error.

RESULTS AND DISCUSSION

Digestibility coefficients of the experimental rations:

Data presented in (Table 4) pointed out to significant differences ($p<0.05$) among different experimental groups on the average daily DM intake. Does of (G3) showed higher ($p<0.05$) DMI and OMI (g/h/d) in compare with the other different groups. Does of the control group (G1) indicated the lowest values ($p<0.05$) *i.e*., 1200 and 1060.3 g/h/d respectively, while both of G2 and G4 indicated relatively lower ($p<0.05$) daily DMI and OMI / h/ d, but higher than that of G1 (the control). Digestion coefficient values for dry matter (DM %) were 57.98% with control ration and increased ($p<0.05$) to 59.86%, 62.05%, and 61.73% for (G2, G3, and G4), respectively. Statical analysis showed lower ($p<0.05$) digestibility for control ration than the supplemented ones. (OMD %) was insignificantly lower for different treated groups in compare with the control.

CP digestibility values indicated higher ($p<0.05$) values for different treated groups without significant differences among them, but higher ($p<0.05$) than that of the control one (68.82%). These results clearly indicated that *N. oculata* and sunflower oil improved ($p<0.05$) CP digestibility in compare with that of the control group. This may be referred to the positive effect of rations supplementation on improving ruminal nitrogen, enhanced ruminal fermentation with the microalgae supplementation (kucuk *et al*., 2004).

Supplementing experimental ration with Algae and /or SFO improved ether extract (EE) digestibility in compare with the basal ration (control). Digestibility coefficient of both CF and NFE showed insignificant differences among different groups, including the control group. The high content of *N. oculata* and sunflower oil from USFA, was expected to negatively affect fiber digestion due to the adverse effect of UFA on the ruminal microbes activity.

Table (4): Effect of adding *N. oculata* and SFO to goat diets on dry matter intake, nutrients intake, digestibility and ration nutritive values.

Items	G1	G2	G3	G4
DM intake (g/h/day)	1200^{d}±35.15	1210^{c}±37.33	1226^{a}±36.23	1220^{b}±39.00
OM intake (g/h/day)	1060.3^{d}±30.34	1065.4^{c}±31.37	1079.6^{a}±30.87	1073.8^{b}±32.20
Digestibility coefficients(%):				
DM	57.98^{b}±2.89	59.86^{ab}±3.52	62.05^{a}±2.49	61.73^{a}±4.55
OM	67.00±4.29	62.39±4.94	63.10±4.04	63.95±4.61
CP	68.82^{b}±3.97	70.15^{ab}±4.99	72.77^{a}±3.39	71.78^{ab}±5.70
CF	54.95±2.11	55.15±3.27	53.05±1.51	54.60±0.70
EE	75.45^{b}±2.56	80.20^{a}±4.29	82.07^{a}±3.72	81.15^{a}±1.86
NFE	66.25±3.59	67.70±3.46	68.25±2.15	68.05±1.66
Nutritive value (%)				
TDN	60.88^{b}±3.33	63.01^{ab}±2.68	63.99^{a}±2.05	63.82^{a}±3.71
DCP	10.29±1.02	10.68±2.70	10.88±1.80	10.82±2.89

Different small letters in the same row indicated significant difference ($p<0.05$)
G1=Control, G2 Algae group, G3 Oil group, G4Algae + Oil group

Nutritive values of the experimental rations in terms of Total Digestible Nutrients (TDN) and Digestible Crude Protein (DCP) pointed out to lower ($p<0.05$) TDN values for the control ration than that of the different supplemented ones. DCP value indicated insignificant differences among different nutritional groups, including that of the control and showing a very close trend like that of TDN nutritive values. Results of digestibility confirmed that of (Alves *et al.*, 2018), who reported that the UFA in *N. oculata* are

in a protected form, which means that minimal ruminal bio-hydrogenation occurs to microalgae UFA and prevents their negative effects on ruminal microbiota. Otherwise, the increased nutrient digestibility indicates improved rumen microflora population activity with the supplementation. Supplementing treated rations with UFA decreases the number of protozoa which causes parallel increasing in total bacterial population as number, or reduced predation of bacteria by protozoa occurs.

Rumen fluid parameters:

Table (5) are considered as an important indicator for the effect of *N. oculata* and sunflower oil on rumen environment, microbial activity and subsequently, the metabolism in the rumen (Gabr *et al.,* 2015 and El-Emam *et al*., 2016), with small ruminants (sheep and goats). Some of these indicative parameters studied were ruminal pH, ammonia nitrogen and TVFA's in rumen liquor of doe's and bucks as affected by experimental rations. As a general phenomenon, results of ruminal parameters were within the normal ranges.

Ruminal pH value indicated insignificant differences among different treated groups. However, G2 group recorded higher insignificant value (6.77), while G3 recorded the lower insignificant value (6.27). As a general evidence, different pH values were within the normal optimum value for ruminal microbical activity. Regarding the effect of sampling time, it could be noticed that the ruminal pH values decreased gradually until reaching the lowest value at 6 hours post-feeding. This trend was observed in all the experimental rations. These results are in agreement with those obtained by (Abdel-Aziz, 1985) who found that rumen pH value in goats reached to the minimum values at 3-4 hours post-feeding. Similar results were observed by (El-Emam *et al.* 2016 and Abdel-Gawad and El-Emam 2018) on growing lambs and *Zaraibi* kids.

Table (5): Effect of adding *N. oculata* and SFO to doe's ration on ruminal pH, ammonia- nitrogen (mg/100ml) and total volatile fatty acids (meq/100ml).

Items	Time (hrs)	Experimental rations				Overall mean
		G1	G2	G3	G4	
pH values	0	6.76±0.69	6.88±1.27	6.6±1.85	6.75±2.30	6.75±1.35
	3	6.60±1.15	6.77±0.74	6.25±1.27	6.55±1.47	6.54±2.63
	6	6.56±0.69	6.65±1.02	5.95±2.42	6.48±2.88	6.41±2.18
	Overall mean	6.64±2.24	6.77±1.54	6.27±0.89	6.59±0.99	
Ammonia –N (mg / 100ml)	0	23.7±1.85	24.64±3.00	25.5±1.90	24.2±1.27	24.51^{c}±3.68
	3	30.8±2.42	32.7±1.85	33.14±2.48	32.1±3.34	32.18^{a}±4.94
	6	27.9±1.85	28.7±4.04	29.44±3.00	29.1±4.17	28.78^{b}±3.39
	Overall mean	27.47^{b}±1.89	28.68^{ab}±2.56	29.36^{a}±5.01	28.47^{ab}±4.55	
Total VFA`s (meq /100ml)	0	11±1.27	11.88±2.42	12.76±3.02	12.2±1.27	11.96^{b}±1.94
	3	13.15±1.85	14.25±3.03	15.75±3.61	14.96±4.30	14.53^{a}±3.27
	6	10.25±1.27	11.1±1.89	12.35±2.05	11.83±3.27	11.38^{b}±2.57
	Overall mean	11.47^{b}±1.03	12.41^{ab}±3.08	13.62^{a}±3.97	13.00^{ab}±1.57	

Different small letters in the same row or same column indicated significant difference (p<0.05).
G1=Control, G2 Algae group, G3 Oil group, G4Algae + Oil group

Ruminal ammonia (NH_3-N); at any given time is a function of its production, utilization by rumen microbes, absorption through the rumen wall and passage to lower gut (Church, 1988). As for the effect of algae and SFO to does rations, (Table 5), it was observed higher ($p<0.05$) differences in favor of the different supplemented groups. G3 group recorded the higher insignificant value (29.36mg/ 100ml.) in compare with the different supplemented groups. Results herein agreed with those obtained by (Abddel-Gawad and El-Emam 2018) when used linseed and sunflower oils as supplementation in goats' ration. They found also that ammonia-N concentration was declined ($p<0.05$) with incorporation of sunflower and linseed oils in the rations of lactating goats in comparison with the control ration. Ruminal ammonia–N concentration was greatly higher ($p<0.05$) post-feeding than before feeding and the maximum values ($p<0.05$) were attended at 3 hrs. post-feeding (32.18mg/ 100ml). At 6 hrs. Post-feeding NH3-N generally decreased within different groups, indicating lower significant values. These results are in close agreement

with those obtained by (Abdel-Hafez,1983; Abdel-Aziz *et al.*,1993) who mentioned that NH3-N concentration varied with time post-feeding, depending on type of feed. Ammonia-N concentration significantly increased ($p<0.05$) to reach the peak value at 3 hours post-feeding then it was decreased, thereafter. These results are in a good agreement with those obtained by (Abdel-Aziz *et al*.,1993).

Total volatile fatty acids (TVFA's) concentration was affected ($p<0.05$) by experimental rations and followed the same trend like that observed with NH3-N concentration. Results obtained showed that feeding rations supplemented with sunflower oil and/ or *N. oculata* increased ($p<0.05$) TVFA's concentration in rumen liquor at all sampling times in compare with those of the control group, although (G3) still relatively indicating higher ($p<0.05$) value in compare with the other treated ones. Ruminal TVFA's concentration values were parallely coincide with the corresponding trend recorded with pH values. Similar results were reported by (Shafie and Ashor, 1997) at that time and depended on many factors including nutrients digestibility, rate of absorption, rumen pH, rate of digesta passage from rumen, as well as the microbial population in the rumen and their activities. The higher concentrations of TVFA's with SS or SO dietary supplement pointed out to more efficient anaerobic fermentation, which may be referred to an increase in organic matter and fibers digestibility (Khattab *et al*., 2011).

Milk production:

Milk production results are shown in (Table 6); expressed as an actual milk yield was higher ($p<0.05$) for does fed rations supplemented with *N. oculate* and/or SFO (G2&G3&G4) in compare with the control group. These results could be attributed to an increase in dietary feed intake (energy) of the experimental rations with *N. oculata* and SFO and/ or may be due to an improvement in rations nutritive values as shown in (Table 4). These results are in agreement with those obtained by (Mohamed *et al.* 2017 and kholif *et al.* 2020). Toral *et al.* (2010a and 2010b) found that the yield of actual milk response due to SFO and *N. oculata* addition was improved ($p<0.05$). This effect might be mediated *via* growth hormone stimulation which tended to be higher significantly with supplemented rations than the control one. Moreover, those additives improved lactation performance due to increasing dietary energy consumed by experimental animals. The average daily milk yield within 16 wks. lactation period was significantly different ($p<0.05$) among different experimental groups (704.80, 848.90, 805.28 and 878.62 g/day) for (G1, G2, G3 and G4), respectively. It was also of interest to note that milk production increased rapidly after kidding, and the average daily milk yield/ h/ group reached the peak production at the 4th week of lactation for different groups. Afterwards, it was decreased ($p<0.05$) with the progressive in lactation period to reach the minimum level at the end of lactation period (16wks). These results are like those obtained by Abdel-Moneim, (1998). Results herein suggested that changes in daily milk yield and composition during lactation period may be due to the level of prolactin hormone secretion, efficiency of the udder secretory cells and/ or some other factors.

Table (6): Daily milk yield (g/h/d) of goats receiving the experimental rations during the different experimental period (16 weeks).

Weeks	Experimental groups				
	Group 1	Group 2	Group 3	Group 4	Overall mean
W2	693.53±17.64	850.30±26.90	920.69±14.76	876.65±8.15	835.29^{d}±32.90
W4	1031.89±17.25	1259.40±17.64	1222.50±14.17	1205.36±26.90	1179.78^{a}±35.14
W6	979.25±14.76	1051.80±26.90	1043.95±8.15	1113.56±28.34	1047.14^{b}±40.15
W8	846.86±26.90	970.50±14.76	889.17±17.64	991.07±8.15	924.40^{c}±23.38
W10	659.86±32.76	837.50±17.64	741.46±28.34	883.00±14.17	780.45^{e}±17.61
W12	592.32±8.15	787.2514.17	686.0126.90	821.19±14.76	721.69^{f}±32.90
W14	534.42±14.17	677.03±14.76	617.41±17.64	739.07±26.90	641.98^{g}±35.14
W16	300.24±28.34	357.45±8.15	321.05±14.76	399.10±17.64	344.46^{h}±40.15
Avg milk yield/ h/d (g)	704.80^{d}±32.90	848.90^{b}±23.38	805.28^{c}±35.14	878.625^{a}±40.15	

Different small letters in the same row or same column indicated significant difference ($p<0.05$).
G1=Control, G2 Algae group, G3 Oil group, G4Algae + Oil group.

The increased milk yield obtained with marine algae (MA) and sunflower oil (SO) diets may be due to the increased TVFA`s concentration in rumen of goats fed supplemented diets in compare with the control group (Table 5) and/ or an apparent increase in the efficiency of N utilization, as well as an improved conversion and availability of nutrients for milk synthesis. The current results are in agreement with those of Abu Ghazaleh and Holmes (2007) and Castro *et al*., (2009) who reported that addition of sunflower

seeds oil to cows ration increased milk yield. However, other studies reported a reduction in goats milk production by feeding animals on sunflower whole seeds (Petit *et al*., 2004; Mohammed *et al*., 2011) or no change as a result of addition of sunflower oil or sunflower seeds (Ollier *et al*., 2009).

When data were analyzed due to time of weaning stage *i.e.* (0-8wks) *vs.* (8-16wks) post weaning (Table 7), it was clearly detected significant decrease ($p<0.05$) in dose average milk yield / h/ group/ season. Moreover, it was of interest to point out to significant differences among different experimental groups within each stage, in favor of dietary supplemented groups in compare with the non-supplemented one (the control). On the other side, it was detected significant differences ($p<0.05$) among the different supplemented groups within the same milking season, being as high ($p<0.05$) for (G4) in both the two weaning stages *i.e.*, 58.81kg and 39.66 kg/ h/ season pre and post weaning, respectively. Usually, fat is supplemented to the diets of lactating ruminants to increase energy density of the diet or/and increase milk production/ Se.

However, Bernal-Santos *et al.* (2003) stated that dairy cows supplemented with a fat source exhibited an apparent increase in milk yield during the early lactation period, but not at later lactation weeks. However, Bernard *et al*. (2005) indicated different response to different fat sources on milk production of mid-lactating fat supplemented dairy cows.

Energy corrected milk (ECM) pointed out to non-significant difference among different does groups. However, it was higher (non-significant) with the treated groups than the control. On the other hand, milk energy values (MEV kcal/kg) were the highest ($P<0.05$) with G3 group in compare with both of G2, G4 and the control group, but without significant differences among the later mentioned groups *i.e*., control, G2 and G4, respectively. The ECM is a correction of milk production for its content of fat and protein. Published literature concerning the effect of fat supplementation on ECM of goats is very scarce.

Table (7): Effect of adding *N. oculata* and SFO to doe's ration on goats milk production, FCM, ECM, MEV, and milk feed conversion ratio.

ITEMS	G1	G2	G3	G4
Milk production/ h (kg)				
0-8 weeks (weaning age)	$49.72^{c}\pm1.80$	$57.85^{b}\pm1.24$	$57.18a^{b}\pm1.66$	$58.81^{a}\pm0.66$
8-16 weeks (post weaning)	$29.17^{d}\pm3.72$	$37.34^{b}\pm0.66$	$32.96^{c}\pm0.70$	$39.66^{a}\pm0.70$
Total milk yield /h/season	$78.89^{d}\pm1.66$	$95.19^{b}\pm1.80$	$90.14^{c}\pm0.66$	$98.47^{a}\pm1.24$
Daily milk yield	704.8±0.12	848.9±0.12	805.28±0.23	878.62±0.47
Fat corrected milk (kg)				
Total FCM/h/season	$74.51^{b}\pm0.66$	$89.62^{a}\pm3.72$	$90.01^{a}\pm1.80$	$94.04^{a}\pm1.66$
Daily FCM/h/d	0.665±0.47	0.8±0.12	0.804±0.23	0.84±0.12
ECM kg/h/d	0.874±0.12	0.926±0.23	0.952±0.47	0.939±0.12
MEV kcal/kg	$255.1^{b}\pm1.24$	$256.25^{b}\pm0.66$	$258.73^{a}\pm1.24$	$256.62^{b}\pm1.80$
Daily feed intake/h as:				
DMI (kg)	1.2	1.21	1.226	1.22
TDN (kg)	60.88	63.01	63.99	63.82
Feed conversion ratio:				
Kg DMI/ FCM	1.8	1.51	1.52	1.45
Milk efficiency				
Milk/DMI	0.554	0.661	0.656	0.688
ECM/DMI	0.729	0.765	0.776	0.77

a,b,c,d means with different superscripts within the same row are different ($P<0.05$)

ECM = (0.3246 × milk yield) + (12.86 × fat yield) + (7.04 × protein yield), (AbuGhazaleh et al., 2002)

MEV = 203.8 + (8.36 × fat %) + (6.29 × CP %), (Baldi et al., 2002)

To our knowledge, only AbuGhazaleh *et al*. (2002) reported no changes in ECM of dairy cows supplemented with different fat sources or their blends. Sampelayo *et al*., (2002) also showed no effect on milk energy yield due to fat supplementation by either 9 or 12% protected fat (rich in PUFA); the result which agreed with our results.

Productive performance of experimental does as feed conversion ratio or/ and does milk efficiency (Table 7) pointed out to insignificant effect of both *N.oculata* and/ or S.F.O dietary supplements on experimental goats productivity or/ and (milk efficiency). Although, different supplemented groups exhibited more efficient feed conversion (FC) and feed efficiency (FE) ratio in compare with that of the

control group. Lack of significance among different supplemented groups in both the two efficiency measurements are mainly referred to lack of significancy in both of daily feed intake as DMI or/ and TDN in one hand and daily FCM/ h/ day from the other hand (Table7).

Milk chemical composition:

Milk chemical Composition (Table 7) showed the effect of both of *N. oculata* or/ and SFO dietary supplements on does milk composition, *i.e*.: total solids (TS) %, Fat %, protein (CP) %, Lactose %, SNF% and Ash% during 3 months of lactation. Total solids (TS) and Solids not fat (SNF) showed that there were significant differences in the percentage of milk total solids among different experimental groups. However, averages of total solids for all groups were very close. In the present experiment, total solids % of milk, increased at the 2nd month and tended to decrease until the 3rd month of lactation for G1 and G2. On the contrarily, it tended to increase gradually for both of G3 and G4 until the end of lactation process. Data obtained (Table 8) pointed out to higher ($P<0.05$) TS value for G3 (12.93%) in compare with the other experimental groups. This result might clear and favored SFO as a sole dietary effective agent ($p<0.05$) in improving milk TS in compare with both of Algae group and the combination of both Algae and oil supplemented group (G4). Similar results were obtained by (Tomar *et al.,* 1996). Generally, results indicated that total solids contents of goat's milk in all groups were almost similar during all stages of lactation. Changes in the milk total solids during early lactation period may be due to the change in the hormonal status, efficiency of secretory cells in the udder and/or some other factors (Chouinard *et al*., 1998). SNF content was found to be significantly higher ($P<0.05$) for treated groups in compare with the control, but without significant differences among G2, G3 and G4. SNF (%) ranged between as low as (8.57%) as an average for the control group to as high ($p<0.05$) as (9.09%) for G2 and without significant differences among different supplemented groups *i.e.,* ranged between 8.94% (G3) and 9.09% (G2). Fat content and total crude protein of goat's milk during different stages of lactation showed significant differences among groups. Average of fat % ranged between as low ($p<0.05$) 3.61 for G2 and to as high ($p<0.05$) as 3.99% for G3, while average of protein % ranged between as low as 3.33% for G1 (control) to as high ($p<0.05$) as 3.59% for G2. And as a general phenomenon, different dietary supplemented groups indicated higher ($p<0.05$) CP values in compare with the control group (3.33%), without significant differences among each other's.

Table (8): Effect of adding *N. oculata* and SFO to experimental ratio on the chemical composition of goat's milk.

Group	Months	TS	SNF	Fat	Protein	Lactose	Ash
G1	1	12.16±1.37	8.54±0.37	3.62±1.13	3.31±0.42	4.38±0.42	0.85±0.10
	2	12.35±1.01	8.63±0.70	3.72±0.94	3.41±0.42	4.39±1.01	0.83±0.37
	3	12.08±0.70	8.54±0.38	3.54±0.50	3.26±0.70	4.44±0.65	0.84±0.32
	A.V	12.20^{c}±1.01	8.57^{b}±0.40	3.63^{b}±0.80	3.33^{b}±0.45	4.40^{b}±0.6	0.84±0.20
G2	1	12.74±1.35	9.11±1.73	3.63±1.13	3.58±0.70	4.98±0.80	0.55±0.80
	2	12.76±0.37	9.11±0.94	3.65±0.37	3.64±0.42	4.63±0.42	0.84±0.37
	3	12.61±2.10	9.05±1.73	3.56±0.70	3.56±1.13	4.65±0.37	0.84±0.32
	A.V	12.70^{b}±0.40	9.09^{a}±1.01	3.61^{b}±0.40	3.59^{a}±0.80	4.65^{a}±0.43	0.84±0.27
G3	1	12.69±1.30	8.69±1.01	4±0.42	3.32±0.37	4.52±0.70	0.85±0.37
	2	12.96±1.59	9.02±0.70	3.94±0.42	3.37±0.42	4.81±1.13	0.54±0.80
	3	13.13±1.41	9.1±1.73	4.03±0.94	3.59±0.37	4.66±0.42	0.85±0.32
	A.V	12.93^{a}±1.2	8.94^{a}±0.7	3.99^{a}±0.45	3.43^{ab}±0.43	4.66^{a}±0.44	0.85±0.37
G4	1	12.37±0.94	8.85±0.37	3.52±1.01	3.32±0.70	4.69±0.94	0.84±0.32
	2	12.73±0.40	8.97±0.70	3.76±1.13	3.47±0.42	4.65±0.37	0.55±0.80
	3	12.99±1.13	9.16±0.70	3.83±0.37	3.64±0.42	4.67±1.01	0.85±0.37
	A.V	12.70^{b}±0.37	8.99^{a}±0.80	3.70^{b}±1.00	3.48^{ab}±0.50	4.67^{a}±0.53	0.85±0.22

Different small letters in the same column indicated significant difference ($p<0.05$)
G1 (Control), G2 (Algae group), G3 (Oil group) and G4 (Algae + Oil) group.

Results herein indicated higher ($p<0.05$) fat values for different supplemented groups in compare with the un-supplemented one. These results agree with those obtained by Toral *et al*. (2010a) who found that addition of sunflower oil led to increase milk fat (%) with sheep. On the contrarily, Kholif *et al*. (2020) reported that addition of *Nannochloropssis* led to decrease milk fat (%) with *Nubian* goats. Moreover, such differentiation in fat percentage in does milk in compare with sheep might be referred to either animal species in one hand and/ or to experimental treatments, in the other hand. As for sampling time, it was noticed significant difference among all sampling times (months). The same trend was also previously detected with that of total solids (%). These results are in accordance with those given by (Toral *et al*.,

2010b). As for protein (%) of goat's milk during lactation period, it was in full agreement with those reported by (Morsy *et al*., 2015). This increment in protein (%) may be due to an increase efficiency of N utilization, as well as an increased conversion and availability of nutrients for milk synthesis.

Lactose and ash percentage: it could be noticed that lactose and ash percentage of goat's milk within the different groups showed almost similar values with an advance of lactation period. The average of lactose and ash values ranged between 4.40 – 4.67% and 0.84 – 0.85%, respectively for different groups. The content of Total Solids was found to be higher ($P<0.05$) for dietary supplemented groups than the control one. This result agrees with Kholif *et al*., (2020) who reported that *N. oculata* increased the concentration of lactose (by 5 and 6.3% for NOM5 and NOM10 treatments respectively) as a result of an increase in propionic acid production. Propionic acid, the precursor for gluconeogenesis and lactose synthesis, favorably affect milk production and chemical composition (Kholif *et. al*., 2020). On the light of the present results, it could be concluded that dietary supplements of both of Algae and/ or SFO led to improve ($p<0.05$) experimental does milk chemical composition in different items in compare with the non-supplemented one (control).

Fatty acids profile:

As shown in (Table 9) an increase concentrations of milk C6:0, C8:0, C12:0, C14:1, C:15, C:17 and C16:1, C18:1n9c, C18:1N9T, C18:2 trans-10, cis-12, C18:2 cis-9, trans-11, C18:3N3, C18:3N6 FA and TUFA and Total CLA with decreasing C4:0, C10:0, C11:0, C16:0, C18:0 and TSFA concentrations were obtained with supplemented groups in compare with the control.

Table (9): Effect of adding *nannochloropssis* and sunflower oil to doe's ration on milk fatty acid profile.

Items	G1	G2	G3	G4
C4:0	2.31	2.3	2.06	1.72
C6:0	1.55	1.69	1.79	2.09
C8:0	2.41	2.46	2.6	2.63
C10:0	5.94	5.87	5.41	5.29
C11:0	0.45	0.43	0.42	0.44
C12:0	3.18	3.21	3.32	3.38
C14:0	9.66	9.57	9.52	9.5
C14:1	0.41	0.55	0.76	1.03
C15:0	0.42	0.43	0.45	0.55
C16:0	27.25	25.38	25.03	24.15
C16:1	0.65	1.74	2.57	3.36
C17:0	0.98	1	0.73	0.33
C18:0	15.32	14.69	13.69	12.45
C18:1N9T	24.25	25.59	26.07	27.04
C18:1N9C	3.29	3.55	3.9	3.82
C18:2 trans-10, cis-12	0.16	0.18	0.21	0.29
C18:2 cis-9, trans-11	0.14	0.15	0.16	0.18
C18:3N3	0.13	0.14	0.16	0.18
C18:3N6	0.34	0.35	0.39	0.49
C20:0	0.76	0.76	0.76	0.77
C20:5n-3	0.17	0.2	0.19	0.19
C22:5n-3	0.22	0.25	0.23	0.24
TSFA	70.23	67.79	65.78	63.30
TUFA	29.76	32.70	34.64	36.82
MUFA	28.99	31.88	33.72	35.68
PUFA	0.77	0.82	0.92	1.14
Total CLA	0.30	0.33	0.37	0.47
N6/N3	2.62	2.50	2.44	2.72
UFA/ SFA	0.42	0.48	0.53	0.58

Fatty acids can be originated from plasma (60%) or by the synthesis in the mammary gland from acetate and hydroxybutyrate originated from rumen fermentation involving acetyl CoA carboxylase enzymes and fatty acid synthetase (Mesquita *et al*., 2008; Kholif *et al*., 2014). Polyunsaturated FA's are not synthesized by ruminants, so that their concentration in milk depends on the amount of PUFA absorbed from the

intestines. Milk from goats receiving sunflower oil or *Nannochloropssis* or the mixture (*Nanno*.xSFO) supplementation displayed an improvement in the FA's profile, with an increased PUFA and monounsaturated FA's contents and a decrease in SFA's content. These results are in agreement with other studies (Castro *et al*., 2009; Mohammed *et al*., 2011), which reported similar changes in milk fat when sunflower seeds supplements were used. In the present study, the decrease in C14:0 and C16:0 FA's contents in milk from goats fed SO or *Nanno.* may be a positive goal from a human health perspective, because high proportions of C14:0 and C16:0 FA's has been associated with human cardiovascular problems (Noakes *et al*., 1996).

Moreover, the increased C18:1 content with SO and *Nanno*. could be a result of partial biohydrogenation of C18:2 and C18:3 FA and of the desaturation of C18:0 in the mammary gland (Kennelly, 1996). Most of CLA isomers levels were increased when the goat fed diets supplemented with sunflower oil or *Nanno*. Mir *et al*., (1999) suggested that the substantial increase in CLA content in milk of small ruminants could be achieved by feeding PUFA rich oilseeds. The increased dietary intake of C18:3 with SO or *Nanno*. resulted in an increasing level of C18:1 trans-11 and increased CLA C18:2 cis-9, trans-11 by Δ9-desaturase activity. There are some studies tried to increase milk content from CLA; using a dietary addition of sunflower oil or Algae (Castro *et al*., 2009; Mohammed *et al*., 2011; Morsy *et al*., 2015; Kholif *et al*., 2020). Moreover, Omega 6 FA's concentrations in milk were increased in SO or/ and *Nanno*. supplemented goats in compare with the non-supplemented ones. The percentage of omega 6 to omega 3 FA's ratio in milk was affected by the diet, with treatments ranking from the highest to the lowest ratio as follows: Mixture (SOx*Nanno*.), control, *Nanno*. and SO, respectively, while the UFA to SFA ratio was (0.58, 0.53, 0.48, 0.42) for {Mixture (SOx*Nanno*.), SO, *Nanno*., control}, respectively.

CONCLUSION

On the light of the present results, it was of interest to point out to the importance of MA and SFO as dietary supplements to dairy goats. Such dietary supplements led to enrich diets of dairy goats with USFA which was positively reflected on rations digestibility and in turn on goat's milk production and its features.

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تأثير تدعيم علائق الماعز الحلابة بالطحالب البحرية وزيت دوار الشمس علي كفاءة انتاج اللبن وتركيبه الكيماوي وخصائص احماضه الدهنية

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اجريت هذه الدراسة بالمزارع البحثية لقسم الإنتاج الحيواني، جامعة الأزهر بالقاهره بالتعاون مع قسم بحوث الألبان بالمركز القومي للبحوث بالدقي- الجيزة- جمهورية مصر العربية.

الهدف من الدراسة: دراسة مقارنة عن تأثيراضافة زيت دوار الشمس أو الطحالب البحريه *N. Oculata* أو كلاهما معا كمصادر للأحماض الدهنية الغير مشبعة UFA's في علائق الماعز الحلابة بمعدل 2% من المادة الجافة علي عمليات التخمر بالكرش والقيمة الهضمية والغذائية للعلائق وعلي كفاءة انتاج اللبن وخصائصه.

استخدم في هذه الدراسة عدد 24 من الماعز الخليط (دمشقيxبلدي) في اخر الحمل وقبل 6 اسابيع من ميعاد الولاده المنتظره و لمدة 16 اسبوع اضافيه بعد الولاده (فترة الحليب)، تم تقسيم الامهات عشوائيا الي 4 مجاميع تجريبيه بمعدل 6 امهات في كل معامله حيث يتم تغذيتها اثناء فترة الحمل وبعد الولاده علي عليقة من العلف المركز(14% بروتين خام و 60% TDN) +2كجم برسيم أخضر, تغذية حرة *ad lib* طبقا لمقررات الـ (NRC 2001) وكانت المجاميع الغذائيه المختبره كالاتي: الأولي : كنترول (بدون اضافات), الثانيه: كنترول +2% طحالب *N. Oculata*, الثالثه: كنترول + 2% زيت دوار الشمس و الرابعه: كنترول +1% طحالب *N. Oculata* + 1% زيت دوار الشمس .

النتائج:-

أظهرت النتائج المتحصل عليها عدم وجود فروق معنويه في قيمة الأس الهيدروجيني pH بين المجاميع كنتيجه لدعم علائقها بالطحالب البحريه وزيت دوار الشمس وحيث تراوحت مابين (6.27-6.77), وجود فروق معنويه بين المجاميع في درجة تركيز الأمونيا و الأحماض الدهنيه الطياره لصالح العلائق المدعومه غذائيا بالمقارنه مع مجموعة الكنترول، مع عدم وجود فروق معنويه بين المجاميع المدعومه غذائيا. وجود فروق معنويه بين المجاميع لمتوسط إنتاج اللبن للرأس/ يوم خلال الفتره من (صفر- 8 اسابيع ، 8- 16 اسبوع) وكذلك في كمية الحليب الكليه (للراس/ خلال 16 اسبوع) لصالح المجاميع المدعومه غذائيا مقارنة بمجموعة الكنترول.

أظهرت النتائج وجود فروق معنويه في كمية اللبن المعدل الدهن في المجاميع لصالح الحيوانات المدعومه غذائيا مقارنة بمجموعة الكنترول ، وكذلك في MEV كيلو كالوري /كجم لبن أما بالنسبه لمعدل (إنتاج اللبن المعدل الدهن / للراس/ يوم) وكذا محتوي الطاقه في اللبن المعدل الدهن فلم تكن هناك فروق معنويه بين المجاميع المعامله ومجموعة الكنترول

أما فيما يختص بكفاءة التحويل الغذائي للبن (بمعدل DMI كجم /كجم لبن معدل الدهن / للراس) ,فلم تكن هناك فروق معنويه بين المجاميع وان كانت المجاميع المدعومه غذائيا أفضل في كفاءتها التحويليه من المجموعه المقارنه (1.8 كجم ماده جافه /كجم لبن معدل الدهن) وكانت أكفأ المجاميع المعامله (المجموعه الرابعه) المدعومه بخليط من الطحالب وزيت دوار الشمس (1.45 كجم ماده جافه /كجم لبن معدل الدهن).

بالنسبه للتركيب الكيميائي للبن علي مدار 3 شهور كانت هناك أفضلية معنوية للعلائق المدعومة غذائيا مع وجود فروق معنوية بينها مقارنة بمجموعة الكنترول كان لدعم علائق الماعز الحلابة بالطحالب البحرية وزيت دوار الشمس اما منفردة أو مجتمعة (2% من المادة الجافة) تأثير ايجابي معنويا علي رفع نسبة الـ Monosaturated FA's and PUFA's بالتزامن مع حدوث انخفاض معنوي في تركيز الـSFA's.

التوصيـــات:-

علي ضوء النتائج المتحصل عليها يمكن التأكيد و التوصيه باهمية (إضافة الطحالب البحريه وزيت دوار الشمس) كإضافات أعلاف للماعزالحلابه، نظرا لإرتفاع محتواهما من الأحماض الدهنيه الغير مشبعه وما ثبت لهما من تاثير إيجابي علي صفات وكفاءة العلائق المقدمه للماعز الحلابه وكذلك علي كفاءة التحويل الغذائي للبن المعدل الدهن وزيادة نسبة MonosaturatedFA's and PUFA's باللبن.