INFLUENCE OF ADDITION *SPIRULINA PLATENSIS* ALGAE POWDER ON REPRODUCTIVE AND PRODUCTIVE PERFORMANCE OF DAIRY ZARAIBI GOATS

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SUMMARY

The current work studied the addition of *Spirulina platensis* powder (SPP) to dairy nanny goat rations on the reproductive and productive performance. Fourteen dairy Zaraibi goats with an average body weight of 36.00 kg at 33.43 months of age were used in this study. The Zaraibi nanny goats were distributed randomly in two groups (n=7 in each). The first group control (G1) was fed concentrate feed mixture (CFM) plus roughage as Egyptian berseem hay (BH) and rice straws (RS) plus orally empty rice paper sack / head /day. While, the second group (G2) was serviced as trial group and nourished previous control ration plus 500 mg of SPP stuffed into rice paper sack given orally/ head / day. Experimental diet was offered to either G1 or G2 twenty-one days pre-breeding season till postnatal to study reproductive performance. After postnatal, similarly eight does in parity rate (n=4 in each) were selected from later G1 and G2 and continued to fed last rations to study changing in udder measurements, suckling milk amount, variable in body weight of does and their kids, milk yield and blood metabolites.The results indicated that litter size and the quaternary rate were lower values in G1 than G2. Moreover, reproductive parameters in G2 have booster ($P<0.05$) udder formation than G1 during suckling months. The highest ($P<0.05$) values of suckling milk observed in G2 at all suckling months compared to G1. The highest ($P<0.05$) suckling milk energy obtained with G2 compared to G1 that may be attributed to difference ($P<0.05$) percentage values of fat and protein. The growth rate and daily weight gain of does in G2 and their kids achieved greater weight than does in G1 during suckling months. Based on early seven weeks (peak lactation curve) of milk yield, does in G2 showed significantly ($P<0.05$) higher milk yield through first three weeks, but the lactation curve during another four weeks declines almost similar trend ($P>0.05$) in milk yield compared to G1. Also, blood biochemical parameters e.g. total protein and glucose in G2 had significantly ($P<0.05$) higher than G1. However, G1 had greater ($P<0.05$) in cholesterol, triglycerides, AST and ALT concentration than those does in G2. Intriguingly, there was no significant difference in the concentrations of urea among goats in G1 and G2. Also, the present results revealed that lower feed cost of milk production was 1.45 L.E in G2 compared to G1 group (1.84 L.E). The present study clearly demonstrates that the SPP could be incorporated in diets as an increment of milking production and non-specific resistance of organism.

***Keywords**: Dairy Zaraibi goats, production and reproduction performance and powder of Spirulina platensis algae.*

INTRODUCTION

Reproductive and productive traits of dairy goats are primary interest in terms of the economic efficiency of production systems and a process essential to the maintenance of a species. The survival of kids in extensive goats' production systems is a major contributing factor to the economic efficiency to the goats herd and is an indicator of good animal welfare. Starvation / exposure in the first week of newborn life occurred 60% of all newborn losses, so the first 12 hours of newborn life are critical for the stabilization of the normal maternal-offspring bonding process (Vacca *et al.*, 2014). According to this information, refinement feeding status of nanny goats around kidding should be maintained constant levels of suckling milk. Whilst, sudden changes in the diet can cause depart or dulcet feed intake lead to fade or increase suckling milk yield post kidding. Ideally, using natural and healthy feed additives have positive impacts on nutritive value, animal health, and perform. Thus, Khalifa *et al.* (2014) explained that plant feed additives such as *Yucca Schidigera Powder* could be improved production, reproduction performance and safely used for long term in dairy nanny goats. One strategy for modification of animals' diet is bioactive feed supplements like microalgae. The most of these microalgae species produce unique products like carotenoids, antioxidants, fatty acids, enzymes, polymers, peptides and sterols (Abu Aita, 2014). Among the most known a microalgae is Spirulina spp. (*Arthrospira*) belonging to the cyanobacteria, blue-green colored microalgae which are deemed as intermediate species between plant and bacteria (Parimi *et al.*, 2015). The *Spirulina platensis powder* (SPP) algae has been considered as a suitable nutritional additive because it includes B-complex vitamins, minerals, good quality proteins, gamma-linolenic acid and the super antioxidants, beta-carotene, vitamin E and trace elements (Vishnu and Sumathi, 2014). The most attention has been paid to its potential pharmacological properties of this micro alga to decrease blood cholesterol levels, free radical scavenging (Chu *et al.*, 2010) and also, stimulate the immunological system, reduce the nephrotoxicity of toxic metals and provides protection against the harmful radiation (Yaakob *et al.*, 2014). Earlier study in dairy Lithuanian Black and White cows showed an (supplementation 2 g of SPP /day/ cow during 60 days) improvement in milk, fat, protein and lactose yields and decrease somatic cell count in comparison with control group (Simkus *et al.*, 2007). Moreover, Heidarpour *et al.* (2011) studied on suckling calves demonstrated that addition of SPP to diet caused significant reduction in plasma cholesterol concentration while; other blood parameters like the blood urea nitrogen (BUN), albumin and globulin were not affected significant. On other hand, *Spirulina platensis* can be cultivated in a liquid medium and has been found to out-yield traditional protein-rich feed sources like soybeans, wheat, corn and barley in terms of production per land unit (Borowitzka, 2013). Subsequently, *Spirulina platensis* addition with basal diets that has been trialed and given goodness results in sheep (Holman *et al.*, 2012) and cattle (Panjaitan *et al.*, 2015).

Therefore, this study is to highlight the roles of *Spirulina platensis* powder on reproductive performance, udder morphology, suckling milk amount, body weight of does and their kids, commercial milk yield and blood metabolites.

MATERIALS AND METHODS

This investigate was performed at El-Serw Experimental Research Station using animal herd belongs to Animal Production Research Institute (APRI), Agriculture Research Center, Ministry of Agriculture, Egypt. The study work was managed from May 2014 to April 2015.

Animals and their management

Pre-breeding season till prenatal, fourteen dairy Zaraibi nanny goats were used to study reproductive performance. All goats had an average live weight 36.00±0.98 kg at 33.43±3.81 months of age and divided into two groups (7 in each). The first group (G1) was control and the second group (G2) serviced as trial group, they received the same basal ration daily that consisted of concentrate fed mixture (CFM) + roughages [as Egyptian berseem hay (BH) + rice straw (RS)]. In the morning, two rice paper sacks contained 0 or 500 mg levels of *Spirulina platensis powder* (SPP) was loaded into and offered to G1 or G2 orally / day / head, respectively.

Table (1): Chemical analysis of CFM, berseem hay and rice straw (on DM basis).

Chemical composition (%)	Basal experimental diets		
	CFM	BH	RS
Organic matter	91.14	85.17	84.55
Crude protein	14.40	12.88	3.36
Ether extract	3.04	1.68	1.24
Crude fiber	14.30	33.91	37.50
Nitrogen free extract	59.40	36.70	42.45
Ash	8.86	14.83	15.45

At postnatal, eight nanny goats were selected from G1 and G2 groups, as well as, in parity rate continued to nourish last similar up to early seven weeks of lactation to investigate changes in body weight of does and their kids, suckling milk amount and composition (i.e. fat % and protein %), udder measurements, commercial milk harvest and blood metabolites. The nanny goats were received fresh water, mineral blocks allowed freely and cared under veterinary through all experimental times. The experimental rations were presented according to recommendations of NRC (2007) to cover the nutrient requirements physiological status of goats. The chemical composition of experimental basal rations was done according to AOAC (2007) method and presented in Table (1). While, the chemical analysis of SPP had given in Table (2).

Table (2): The chemical composition of *Spirulina platensis* powder.

Item	Chemical composition								
Organic Matter	***CP % 65.0	***NFE% 18.0		***Fat % 5.0		*CF % 9.0		*Ash % 7.5	
***Vitamins (in10g of substances)	β-carotene 32000.00		B_1/mg 0.31	B_2/ mg 0.35	B_3/mg 1.46	B_5/µg 10.00	B_6/ µg 80.00	B_9/ µg 1.00	B_{12}/ µg 32.00
**Other vitamins	Vitamin A 29.0 µg	Choline 66.0 mg		Vitamin C 10.1 mg		Vitamin E 5.0 mg		Vitamin K 25.5 µg	
***Minerals (in10g of substances)	Ca/mg 100.0	P/mg 90.0	K/mg 120.0	Fe/ mg 15.0	Mn/mg 0.16	Zn/mg 0.3	Se/mg 0.003	Cu/mg 120.0	Na/mg 60.0
***Pigments (in10g of substances)		Phycotian / mg 1500					Chlorophyll / mg 115		
*Metabolic energy	Mcal/kg 3.15								

** Composition according to Heidarpour et al. (2011).*
*** Composition according to Kulshreshtha et al. (2008).*
****Composition according to Kupras et al. (2003).*

Data collection as follows:

Reproductive performance:

Both G1 and G2 does were received experimental rations twenty-one days pre-breeding (as flushing time) season, during mating season and at trimester (96 days of gestation). The reproductive performance was evaluated as conception rate (number of does conceived /does mated), twins rate (number of does kidded twins / total number of does kidded), triplet rate (number of does kidded triplet / total number of does kidded), quaternary rate (number of does kidded quaternary / total number of does kidded) and litter size = number of total born kids /number of does kidded.

Udder measurement during suckling periods:

The udder morphology measurements were taken in centimeter (cm) in the morning before feeding when doe adequately restrained in a standing position using flexible tape. The external udder parameters were measured at 0 (after one day of postnatal), 15, 30, 60 and 90 days of parturition. These measurements included udder length, rear udder depth, teat angle, teat length, cistern depth, udder width and udder circumference as illustrated in Fig. (1). Then, udder volume (UV) was derived by using the formula UV = 4/3 (π×r×3) as described by Amao (1999). The values of π = 22/7 and r = [udder length + udder width ÷4].

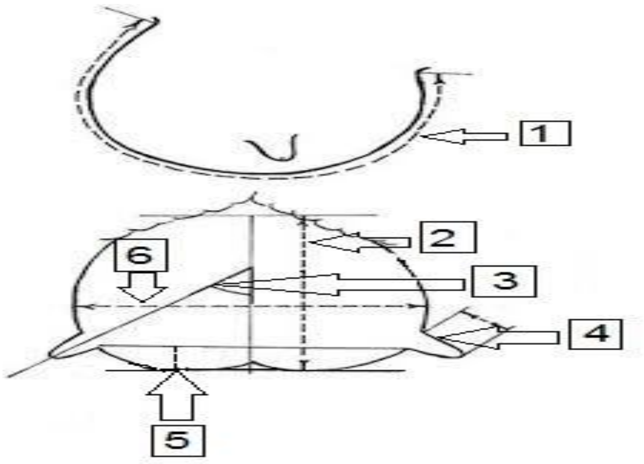


Fig. (1): The does' udder measurements (cm).

1- udder length (UL) , 2- rear udder depth (RUD) , 3- teat angle (TA) in degrees from vertical line (intramammary ligament) of the udder from a caudal view using protractor, 4- teat length (TL) using calipers and a metal reference ruler used to determine the diameter, 5- cistern depth (CD) , 6- udder width (UW) and udder circumference (UC) was measured circumference of the largest medium area of the udder .

Body weight, suckling milk amount, suckling milk fat, suckling milk protein, suckling milk energy and growth rate of does and their kids:

Changing in body weight of maternal and their kids recorded at 1 day of birth then, monthly at 30, 60 and 90 days of age. The daily gain of does (maternal) and their kids were evaluated between 1 to 30, 1 to 60, 1 to 90, 30 to 60, 30 to 90 and 60 to 90 days. Furthermore, metabolic mid-weight was calculated using this equation = (initial body weight (kg) + final body weight (kg) ÷ 2) $^{0.75}$ according to Willems *et al.* (2013).

In addition, daily suckling milk amount evaluated at 7, 15, 30, 60 and 90 days using oxytocin methods described by Khalifa *et al.* (2013). The suckling milk sample (100 ml / group) was taken at 15, 30, 45, 60, 75 and 90 days to analysis fat % and protein % using Milko-Scan (133B N. Foss Electric, Denmark). Also, the suckling milk energy value (SMEV, kcal/kg) was calculated as= 203.8 + (8.36 × fat %) + (6.29 × protein %) according to Baldi *et al*. (1992).

Milk yield during early lactation weeks (peak lactation):

At commencement of lactation after weaning, the total milk yield of a doe /group registered weekly up to seven weeks of lactation. Evaluation daily milk was considered to represent daily milking by added morning cooled milk and the evening milk samples ones.

Blood metabolites:

Blood samples were collected from the jugular vein at the seventh week of lactation. Eight blood samples (4 / group) were left to clot at room temperature, and then centrifuged at 3000 *g* for 20 min. The blood sera were then, separated and stored at −20°C as aliquots for further biochemical analysis. Total protein, glucose, cholesterol, triglyceride, aspartate amino transferase (AST) and alanine amino transferase (ALT) and blood urea were measured using commercial diagnostic kits (BIOLAPO SA, France) and finally measured using the UV spectrophotometer.

Statistical analysis:

Data were expressed to statistical analysis as means ± SE using one-way of IBM SPSS (Statistical package for social sciences version 22 Inc, Chicago, 2013). Differences among means were tested according to Duncan's New Multiple Range Test within SPSS program (to determine differences between means of treatments at significance rates of 0.05). Correlation between feeding and mean weaning parameters (represented in does body weight, kids' body weight, udder size, suckling milk flow and energy of suckling milk) were calculated using the Pearson's coefficients of SPSS programmes.

RESULTS AND DISCUSSION

Reproductive performance:

Reproductive performance as the conception rate, multiple offspring and litter size are illustrated in Table (3). The results were indicated that SPP offered to G2 improved total number of kidding (18.00 kids), triple rate (28.57 %), quaternary rate (14.29 %) and litter size (2.71) compared to G1 15.00, 14.29%, 00.00% and 2.14, respectively. Hence, mix of active substances possessed the ability to boost the reproductive parameter is natural products as the algae (*Spirulina platensis*) and plants extracts. Such results are in line with Abadjieva *et al.* (2011) found the SPP indicated that ovary have better response to the hormonal stimulation aimed superovulation thus reflect to the higher embryo outcome. Moreover, SPP could be stimulated steroid genesis and evokes the anterior pituitary gland to the process of secret and release gonadotropin hormones and initiation of folliculogenesis in the ovaries (Yener *et al.,* 2013). The beneficial affects of additive SPP related to the highest protein (EL-Sabagh *et al.*, 2014), vitamin as β-carotene (Meza-Herrera *et al.,* 2014), minerals mixture (Ahmad Fazel *et al.,* 2014) and energy (Kumar *et al.*, 2015) that played a major protective role in reproductive performance, increased fertility function, played a significant role in ovary cell signaling and immune responses.

Table (3): Reproductive performance of nanny goats in G1 and G2.

Parameter	Animal groups	
	G1	G2
No. of nanny goats mating	7.00	7.00
No. of nanny goats conceived	7.00	7.00
Conception rate, %	100	100
No. of nanny goats kidding	7.00	7.00
Total no. of kidding	15.00	18.00
Birth type:		
No. of nanny goats born twins	6.00	4.00
Twins rate, %	85.71	57.14
No. of nanny goats born triple	1.00	2.00
Triple rate, %	14.29	28.57
No. of nanny goats born quaternary	-	1.00
Quaternary rate, %	-	14.29
Litter size, %	2.14	2.71

Udder measurement during suckling periods:

Parameters were estimated from udder morphology of either G1 or G2 are summarized in Table (4). The result of this present study showed that clearly positive significant ($P<0.05$) between udder measurements and feeding SPP during 90 days of suckling. The G2 were achieved the highest udder formation compare to G1. This observation may be due to changes in tissue elasticity in the mammary gland which caused by placental hormones during gestation when SPP supplied. Mahboub *et al.* (2013) established an elevated and a positive correlation between placental hormones and placental development, expressed as a function of weight or size of udder and milk production. Further, energy in SPP may cause the majority of morphological and physiological development of the mammary gland under strict control of endocrinal factors and energy balance (Gregorio *et al.,* 2014). In addition, feeding of SPP to G2 could provide organic trace minerals especially zinc which maintaining udder health and integrity of skin due to its role in cellular repair and replacement and by increasing the speed of wound healing. This notion are defined by Davidov *et al.* (2013) who explained that after zinc absorbed; it transports to blood and whole body, including udder then increased concentrations of zinc in serum or whole blood have been related to

Table (4): Udder measurement during suckling periods in G1 and G2.

Evaluation days	Trial groups	Udder measurements							
		UL	RUD	UW	UC	CD	TL	TA	US
At 0 day	G1	35.25[b] ±1.70	23.75 ±1.03	18.25[b] ±0.25	39.00[b] ±1.41	7.50[b] ±0.86	5.75 ±0.47	36.75[a] ±1.75	160.89[b] ±7.09
	G2	43.25[a] ±0.47	25.00 ±0.41	20.00[a] ±0.40	43.00[a] ±0.42	9.25[a] ±0.25	5.75 ±0.48	32.50[b] ±1.44	195.43[a] ±1.64
At 15 days	G1	35.00[b] ±2.40	19.25[b] ±1.84	17.75[b] ±0.24	35.25[b] ±1.37	6.25[b] 0.63±	3.75[b] ±0.25	40.00 ±2.04	159.48[b] ±10.37
	G2	40.50[a] ±0.62	24.50[a] ±1.32	18.75[a] ±0.24	39.50[a] ±0.29	7.75[a] ±0.48	4.50[a] ±0.28	38.75 ±1.25	183.19[a] ±2.83
At 30 days	G1	31.50[b] ±1.44	18.50 ±1.26	17.25[b] ±0.84	32.75[b] ±1.11	5.00[b] ±0.09	4.00 ±0.70	43.75 ±2.39	144.49[b] ±5.92
	G2	35.50[a] ±1.04	21.25 ±0.85	20.50[a] ±0.65	38.75[a] ±0.75	6.25[a] ±0.28	4.25 ±0.25	41.42 ±1.25	163.63[a] ±3.93
At 60 days	G1	31.50[b] ±1.19	18.75 ±0.85	19.25[b] ±0.25	32.00[b] ±1.47	5.75 ±0.63	4.00 ±0.09	48.75 ±1.25	145.99[b] ±4.78
	G2	35.75[a] ±0.85	20.75 ±0.48	20.75[a] ±0.63	37.25[a] ±0.85	6.75 ±0.25	4.00 ±0.08	45.00 ±2.04	164.86[a] ±3.72
At 90 days	G1	27.75[b] ±0.95	16.25[b] ±0.75	16.75 ±0.63	28.50[b] ±1.56	4.50[b] ±0.64	3.50 ±0.29	51.50[a] ±2.39	128.45[b] ±3.83
	G2	30.75[a] ±0.85	18.25[a] ±0.25	18.50 ±0.28	32.00[a] ±1.29	6.00[a] ±0.41	4.00 ±0.08	45.00[b] ±2.04	142.29[a] ±3.39

Means within the same columns with different superscripts are significantly different (P<0.05).
Udder length (UL), rear udder depth (RUD), udder width (UW), udder circumference (UC), cistern depth (CD), teat length (TL), teat angle (TA) and udder size (US).

reduce somatic cell count, reduced mastitis and improved immunological function of udder. Accordingly, nourishment of SPP to G2 might protect udder tissues and renovation udder cells by free radical scavenging that attributed the most udder parameters by kept tissues flexible and extended (Yaakob *et al.*, 2014). It is important to mention this result, the relationship between udder traits and dairy performance was strong however, udder length (UL) and udder depth (UD) are more associated with the total milk produced per lactation and length. Hence, the evaluation of udder morphology might be useful auxiliary traits for the genetic improvement of milking ability due to close genetic correlations (Sadeghi *et al.*, 2014). In any event, Akporhuarho (2015) concluded that the size of udder during lactation achieved significant determinant of average partial daily milk yield and the regression analysis revealed that udder circumference (UC) was the most important single measurement accounted for over 22 % of variation of partial daily milk yield in West African Dwarf goat. On the other hand, Hafez *et al.* (2015) indicated that positive relationship between either feed type or udder formation or suckling milk amount or growth rate of Rahmani lambs.

Suckling milk amount, suckling milk fat, suckling milk protein, suckling milk energy and growth rate of does and their kids:

Productive performance during suckling period such as suckling milk yield, its fat content, protein content and energy content as affected by dietary treatments are presented in Figs (1), (2 and 3) and (4), respectively. Furthermore, average growth rate of does and their kid are calculated in Tables (5 and 6), respectively.

Suckling milk amount:

The greatest values of suckling milk observed in G2 at all 90 days; which may attribute to improvement of udder measurements compared to G1 (Table 4). The statistically data were appeared high (P<0.05) in suckling milk amounts at 7 days (2975 and 2025g), 60 days (2400 and 1500 g) and 90 days (1950 and 1500 g) for G2 and G1, respectively. However, suckling milk amount shown non-significant values among G1 and G2 at 15 and 30 days of suckling periods. Otherwise, the suckling milk between 7 and 90 days had increased by 34.35% and 25.92% in G2 and G1, respectively. Actually, higher udder measurement in G2 could receive large amounts of blood biochemical than G1; which important indicators of the metabolic activity in lactating animals. This mention agree with carried out by Darwesh *et al.* (2013) who observed that during lactation, secretary cells of mammary gland utilize 80% of the blood circulating metabolites for milk synthesis, depending on the speed of infiltration of precursors of milk compounds (*i.e*. free amino acids, glucose and fatty acids). Accordingly, authors reported that SPP could improve milk amount in lactation cows (Christaki *et al.*, 2012). In addition, the ingredients of SPP as zinc appeared an essential function in milk amount. Similar trends were obtained by Davidov *et al.* (2013) on dairy cows that zinc plays an important role in the proper function of the first mechanism of milk products and it also affects the degree of keratinisation of the teat canal, thereby protecting the udder against bacterial penetration after milking. A related study demonstrated that deficiency of Zn was a result of the depression in appetite of animals and consequently milk yield, feed dry matter intake, digestibility and nutritive feed values which reflect on the decrease of the available nutrients to the mammary gland.

Suckling milk fat, suckling milk protein and suckling milk energy:

The highest (P<0.05) effect of suckling milk energy in G2 related to significantly (P<0.05) greater values of suckling milk fat (Fig. 2) and protein contents (Fig. 3) than G1 noticed in Fig. (4). Similarly, Simkus *et al*, (2007) showed an increase in milk fat (between 17.6% and 25.0%), milk protein (up by 9.7%) and lactose (up by 11.7%) in cows receiving *Spirulina* compared to those non- receiving *Spirulina*. The current results are in agreement with those observed in milk of cows fed SPP (Christaki *et al.*, 2012) revealed that dietary *Spirulina* increased monounsaturated and polyunsaturated fatty acids and enhancement milk with health-associated unsaturated fatty acids. Also, the highest average sucking milk protein (2.69%) in G2 compared to (2.39%) in G1 might be related to boost essential amino acids and protein content in SPP (Parimi *et al.,* 2015).

Growth rate of does and their kids:

In response to the addition of SPP in G2, it presents the greatest (P<0.05) average body weight during suckling period compared with those does in G1. However, average daily gains (ADG) of G2 appeared higher (P>0.05) values than G1 except ADG between 60 and 90 days it was 41.67 and 66.67g/day, respectively (Table 5). This result confirms the findings of Holman *et al.* (2012) indicated that an increase in live weight of sheep with dietary *Spirulina* along with an increase in body condition and other body conformation traits. Interestingly, improvement growth rate of does fed SPP ration was associated with increasing digestibility coefficients of most nutrients and nutritive values of this ration as compared to other not receive SPP rations. This corresponds to the opinion of Panjaitan *et al.* (2014) who stated that *Spirulina* intake with 5.7 g could be provided greater increases microbial crude protein (MCP) production, feed intake, could also be fed safely at higher levels of nitrogen (N) intake, increasing rumen degradable protein (RDP) and growth rate in cattle. The findings from the current study established that kids nursed by G2 showed higher average body weight and daily gain without significant than those auspices in G1. However at birth, care kids by G2 nanny goats showed significantly (P<0.05) higher in average body weight than kids patronage by G1 (Table 6). This difference is certainly related to the respective milk production (quality and quantity) in G2 compared to G1. Hence, feeding of SPP to pregnant does provided adequate energy, protein, minerals, vitamins to support embryonic, fetal growth, maintenance of metabolic processes, mammary gland growth, colostrum and milk yield. These studies go along with the evidence of Mahboub *et al.* (2013) who noticed that the best nutritional during fetal life effects on postnatal growth, reproductive performance and metabolism. On the other hand, milking of *Spirulina* animals contains phycocyanin and polysaccharides, both known to have antioxidant properties. In generally, SPP energy could display better growth performance (by secretion leptin hormones) in G2 and their kids than G1. These results are in identity with those reported by Gregorio *et al.* (2014) who indicated that leptin helps of metabolism, preventable negative energy balance, activates growth rate and builds mammary epithelial cells during early phase of pregnancy and lactation.

Fig. 1: Suckling milk amount of nanny goats fed either control (G1) or treatment diet (G2).

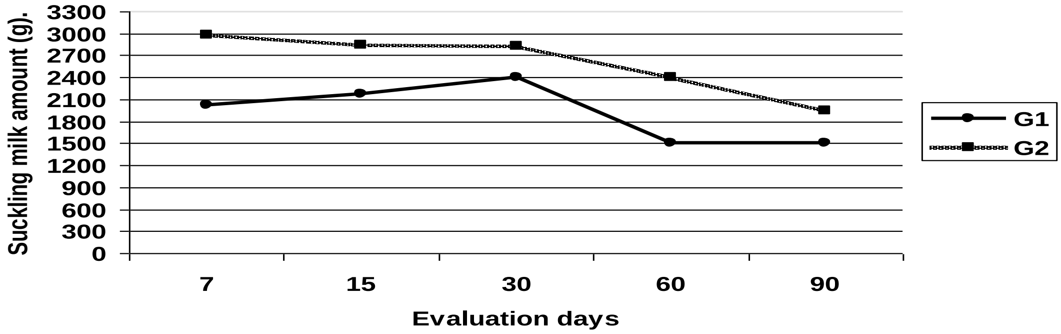


Fig.2: Suckling milk fat % of nanny goats fed either control (G1) or treamtment diet (G2).

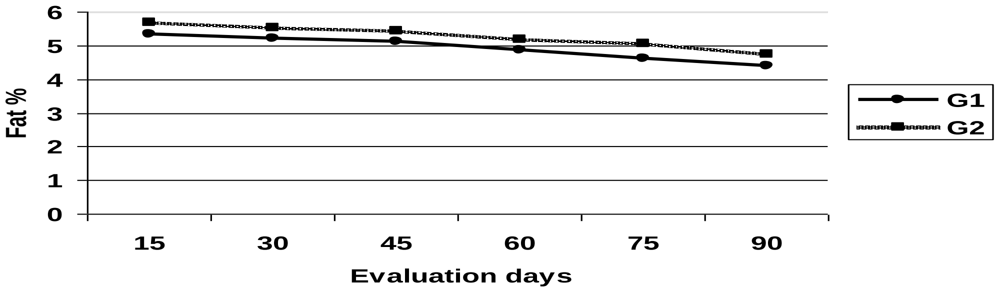


Fig.3: Suckling milk protein % of nanny goats either control (G1) or treatment diet (G2).

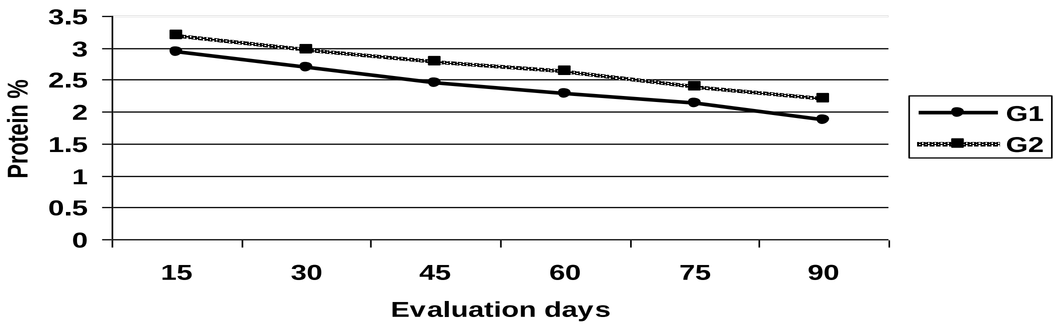


Fig.4: Suckling milk energy of nanny goats fed either control (G1) or treatmemt diet (G2).

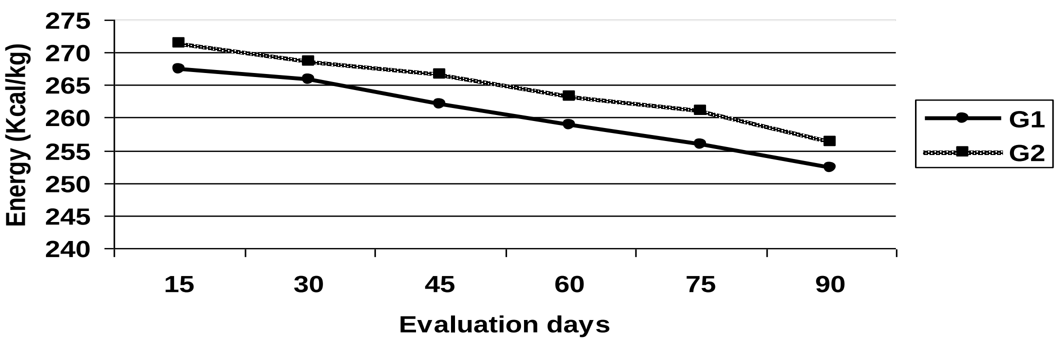


Table (5): Body weight and daily gain of dams in G1 and G2.

Specification	Animal groups	
	G1	G2
Body weight at parturition as day 1, kg	42.25±2.14[b]	47.25±1.03[a]
Body weight at 30 days, kg	39.00±1.58[b]	43.75±0.75[a]
Body weight at 60 days, kg	37.50±1.32[b]	41.75±0.25[a]
Body weight at 90 days, kg	36.25±1.11[b]	39.75±0.24[a]
Metabolic mid-weight, kg	21.66±1.26	23.45±1.32
Daily gain of dams (g/d)		
1-30 days	112.07±21.69	120.69±19.95
1-60 days	80.51±14.47	93.22±14.71
1-90 days	67.42±12.14	84.27±8.42
30-60 days	50.00±9.62	66.67±9.25
30-90 days	45.83±7.98	66.67±9.17
60-90 days	41.67±6.84[b]	66.67±7.13[a]

Means within the same row with different superscripts are significantly different (P<0.05).

Table (6): Body weight growth and daily gain of kids depending on suckling milk in G1 and G2.

Specification	Animal groups	
	G1	G2
Body weight of kid at birth as day 1, kg	1.99±0.13[b]	2.39±0.17[a]
Body weight of kid at 30 days, kg	5.83±0.26	6.58±0.42
Body weight of kid at 60 days, kg	8.53±0.30	9.31±0.47
Body weight of kid at 90 days, kg	10.46±0.56	11.34±0.73
Metabolic mid-weight of kid, kg	4.40±0.46	4.78±0.52
Daily gain of kids (g/d)		
1-30 days	132.37±7.70	144.18±9.93
1-60 days	110.83±5.11	117.16±6.46
1-90 days	95.24±5.69	100.49±6.72
30-60 days	90.00±11.81	91.04±7.43
30-90 days	77.29±5.88	79.38±5.70
60-90 days	64.58±17.84	67.71±12.10

Means within the same row with different superscripts are significantly different (P<0.05).

Correlation coefficients between feeding and does body weight, kids' body weight, udder size, suckling milk flow and energy of suckling milk:

In Table (7), it could be concluded that correlation coefficients between feeding and does body weight, kids' body weight, udder size, suckling milk flow and energy of suckling milk reflected positively correlation. The udder volume revealed significant effect on weaning weight and growth rate of kids. Thus, the results allow possibility to predict milk yield of does from the linear regression of udder confirmation. These results agree with what stated by El-Gendy *et al.* (2014) who reported in Zaraibi and

Table (7): Correlation coefficient among feeding and weight of does and their kids, suckling milk and udder volume.

Item	Feeding	BWD	BWK	UV	SMA	SME
Feeding	1	0.571	0.563	0.578	0.684	0.515
BWD		1	1.000**	1.000**	0.990	0.998*
BWK			1	1.000**	0.998*	0.998*
UV				1	0.991*	0.997**
SMA					1	0.978

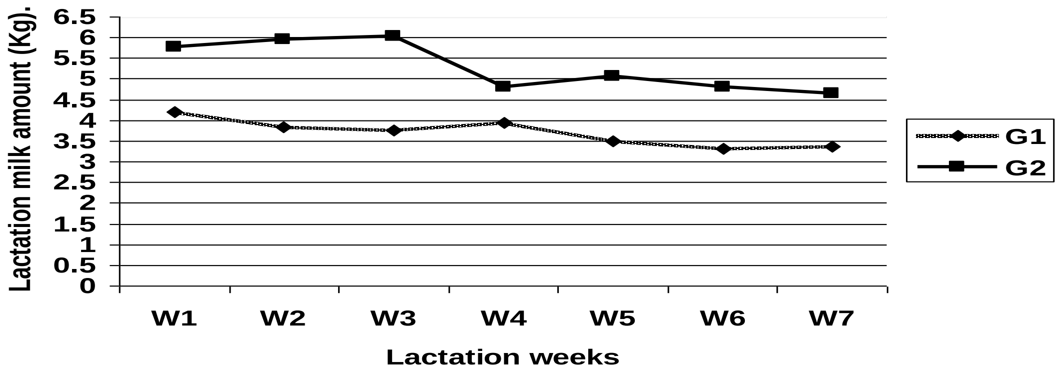
BWD = Body weight of does at weaning, BWK= body weight of kids at weaning, UV= udder volume at weaning, SMA= suckling milk amount at weaning and SME= suckling milk energy at weaning.
**Correlation is significant at the (P<0.05).*
***Correlation is significant at the (P<0.01).*

Damascus dairy goats, significant correlations between udder traits and milk yield and kid growth rate. It was observed that the noticed improvement in milk yield of does fed SPP ration was associated with increasing udder measurements and growth rate of dams and their kids (Vishnu and Sumathi, 2014, Akporhuarho, 2015 and Hafez *et al.,* 2015).

Milk yield during early lactation weeks (peak lactation)

The overall means of milk production throughout seven weeks of lactation was 3.704 kg in the G1 and 5.297 kg in the G2 and the difference was found to be statistically significant ($P<0.05$) among groups during first three weeks of lactation (Fig. 5). While, advancing of lactation curve another four weeks does in G2 was appeared non-significantly booster in milk harvest than those does in G1. Hence, the milk production was affected by orally SPP nutrition to nanny goats. Thus, these results are reported by other authors show certain differences in this respect (Christaki *et al.,* 2012). According to Yaakob *et al.* (2014) demonstrated that spirulina has been frequently used in feed supplements due to its excellent nutrient compounds and digestibility, also found that the spirulina has proved to be effective significantly an increased milk yield.

Fig. 5:Lactation milk amount of nanny goats fed either control (G1) or treatment diet (G2).



Blood metabolite parameters:

The significant differences ($P<0.05$) of the blood biochemical concentrations such as total protein, glucose, cholesterol, triglycerides, AST and ALT were found between the G1 and G2. Moreover, there was no significant difference in the concentrations of urea among G1 and G2 Table (8). Addition of SPP to G2 induced high significant elevation ($P<0.05$) in total protein, glucose while significantly reduced ($P<0.05$) the cholesterol, triglycerides, AST and ALT concentrations compared to G1. Furthermore, increasing ($P>0.05$) in urea with an unexpected increase in total protein concentrations in G2. In the present study there was higher total protein concentration in blood of G2 than those in G1. Increasing concentrations of total protein may be related to the high protein contents in *Spirulina* (Parimi *et al.,* 2015). On the other hand, SPP has been reported to ameliorate total protein levels without any risk in kidneys function of lambs (EL-Sabagh *et al.,* 2014). The results demonstrated that blood glucose level in G1 was drastically reduced to 56.25 mg/dI compared to G2 it was significantly increased to 60.50 mg/dI. These results are in accordance with those noted by Liping *et al.* (2011) who defined that blood glucose concentration of rat was significantly increased 128.1, 157.8, 167.4 and 171.5 and mg/dl when SP supplemented at levels 0, 50, 100 and 200 mg/kg for 6 weeks, respectively. Also, these authors reported that gluconeogenesis carries out the major role of glucose homeostasis in endurance exercise and SPP addition must be brought about by an improvement in the physiological function or metabolic control of exercise as well as by an activation of energy metabolism. The blood cholesterol levels of G2 were 77.75 mg/dl, which significantly decreased compared to that in the G1 83.25 mg/dl. Otherwise, the hypercholesterolemia activity of spirulina is related to the large amount of cystine found in the C-phycocyanin protein of spirulina hence, a negative correlation was reported between the blood cholesterol concentrations and the level of cystine in dietary protein in mice fed a high cholesterol diet (Vedi *et al.,* 2013). There was significant difference among triglycerides concentration, the unexpected decrease in the triglycerides in G2 in this study may imply that the SPP might be exerted its lipid-modulating properties. So, the mechanism in which SPP plays a significant role in lipid metabolism should not be directly due to its lipid contents. Ruitang and Chu (2010) in human triglycerides reduction has been stated as the effect of SPP on lipoproteins metabolism and the increase of the lipoprotein enzyme activity levels. Results of the current study were found that SPP showed slight high without significant in blood urea in G2 goat

Table (8): Blood metabolites parameters in G1 and G2.

Parameters	Animal groups	
	G1	G2
Total protein, g/dI	5.50±0.29[b]	6.25±0.25[a]
Glucose, mg/dI	56.25±0.25[b]	60.50±0.65[a]
Cholesterol, mg/dI	83.25±0.48[a]	77.75±0.47[b]
Triglyceride, mg/dI	81.25±0.25[a]	74.75±0.48[b]
Urea, mg/Di	22.50±0.28	23.75±0.25
AST, U/l	184.25±0.48[a]	175.00±1.08[b]
ALT, U/l	15.50±0.64[a]	11.50±0.65[b]

Means within the same row with different superscripts are significantly different (P<0.05).

(23.75mg/dl) compared to those does in G1 (22.50 mg/dl). Hence, the SPP itself significantly improved the damages of hepatocytes and renal tissues specifically glomerulus filtration for they normalized the activities of these hepato-renal markers. At all events, the blood urea levels recorded in this study were within the reference of urea values (12-28 mg/dl) for normal goats reported by Kalio *et al.* (2014). On the other hand, Liping *et al.* (2011) found that the urea concentration were 8.68, 6.25, 6.01, 5.84 mmol/L when rat received SPP at levels at 0, 50, 100 and 200 mg/kg, respectively. The parameters of SAT and ALT were consistent with the references reported that normal range of liver enzymes. The AST level was varied from 167 to 513 U/l while, ALT between 9 and 19 U/l (Rumosa-Gwaze *et al.*, 2012). In the present study, G2 showed a significant decrease in AST (175.00U/l) and ALT (11.50 U/l) compared with G1 that obtained that AST (184.25 U/l) and ALT (15.50U/l). This result is symmetrical with Azab et al. (2013) who indicated that SPP may play a protective role against liver dysfunctions. On the other hand, Mazokopakis *et al.* (2014) reported that spirulina supplementation in human food has strong and multiple beneficial metabolic effects and improves mean levels of AST, ALT, triglycerides and total cholesterol were significantly decreased: 38.5%, 37.5%, 24.8% and 9.1% respectively, whereas the mean levels of high-density lipoprotein and hemoglobin were significantly increased: 4.2% and 4.1% respectively.

Economic efficiency of milk production during seven weeks:

Economic estimation of rations and milk production whole seven weeks of lactation period are presented in Table (9). The economic efficiency of milk production during seven weeks of lactation was depended on offered ration to either G1 or G2 as 1.200 kg of CFM at 8.00 a.m., 1.000 kg of BH twice daily (500 g at 11.00 a.m. and 500 g at 3.00 p.m.), RS 300 g all day and 500 mg / G2 daily in the morning. The current results obtained that milk yield / feed efficiency and feed conversion for G2 was the best while, those fed the control ration showed the poorest values. The cost of kg milk was the lowest (1.45 L.E) for doe in G2 and the highest (1.84 L.E) for the G1 does. Interestingly, such trend was reflected in the highest economic efficiency (%) of milk production 55.96 and 44.15 in G2 followed by those in G1, respectively. Furthermore, G2 was obtained higher economic efficiency relative (127.27 %) than control (G1).

CONCLUSION

The result of the present study tends to show that SPP improved reproductive performance, suckling milk (quantity and quality), live body weight gain of nanny goats and their weaning kids. The SPP could be mitigated liver enzyme activities, cholesterol, triglycerides and increased total protein, glucose without organics dysfunction. Also, SPP indicated slightly increasing in urea concentration despite high total protein. Hence, SPP could currently be used as an additive food substance without adverse impact on dairy goats and their offspring.

Table (9): Economic efficiency of milk production in G1 and G2 during peak lactation.

Item	Animal groups	
	G1	G2
CFM intake during seven weeks, kg/4 does	235.20	235.20
BH intake during seven weeks, kg/ 4 does	196.00	196.00
RS intake during seven weeks, kg/ 4 does	58.80	58.80
SPP intake during seven weeks, kg/ 4 does	-	0.098
Total nutrients intake, kg/doe ^{A}	490.000	490.098
Cost of rations intake and sale milk, LE		
Cost of CFM /4 does	611.52	611.52
Cost of BH / 4 does	137.20	137.20
Cost of RS/ 4 does	14.72	14.72
Cost of SPP/ 4 does	-	98.00
Total cost of rations intake / 4 does ^{B}	763.44	861.44
Total milk yield / 4 does, kg ^{C}	103.72	148.32
Price of sale milk, LE^{D}	337.09	482.04
Economic efficiency		
Feed efficiency, $^{C/A}$	0.21	0.30
Feed conversion, $^{A/C}$	4.72	3.30
Feeding cost of producing milk / 4 does $^{B/C}$	7.36	5.81
*Feeding cost of producing kg milk /doe	1.84	1.45
Economic efficiency (EE), $^{D/B}$	0.44	0.56
**Economic efficiency (EE), %	44.15	55.96
***EE (%) relative to control	100.00	127.27

Price of sale kg of goat milk is 3.25 (EGP).
Price in year 2015 for CFM, BH, RS and SPP were 2600, 700, 250 EGP /ton and 1.00 EGP / g, respectively.
** Feeding cost of producing kg milk /doe = Feeding cost of producing milk / 4 does ÷ 4.*
***Economic efficiency (%) = money out put (price of buy milk) ÷ money input (total price of feed consumed) ×100.*
**** EE (%) relative to control with G2= EE of G2 – EE of G1÷ EE of G1×100 +100 (conceder EE of G1 is 100%).*

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تأثير اضافة مسحوق طحلب الأسبيرولينا على الأداء التناسلى والإنتاجى للماعز الزرايبى الحلاب

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إجرى هذا العمل لدراسة إضافة مسحوق طحلب الأسبيرولينا الى علائق الماعز الحلاب لتقييم الأداء التناسلى والإنتاجى. استخدمت الدراسة 14 أنثى ماعز حلاب بمتوسط وزن 36 كجم عند عمر 34و33 شهروقسمت الماعز الى مجموعتين 7/مجموعة. كانت المجموعة الأولى ج1 مقارنة وغذيت على العلف المركز + دريس البرسيم المصرى + قش الأرز + كيس فارغ من ورق الأرز بالفم / رأس / يوم. بينما المجموعة الثانية ج2 غذيت على نفس العليقة السابقة + كيس من ورق الأرز يحتوى على 500 مليجرام من مسحوق طحلب الأسبيرولينا بالفم / رأس / يوم. وقدمت العلائق قبل وخلال موسم التلقيح وفى الثلث الأخير من الحمل لدراسة الأداء التناسلى. وبعد الولادة تم إختيار 8 ماعزمتماثلة من ج1و ج2 (4/ مجموعة) واستمرت تغذية الحيوانات على نفس العليقة السابقة وعلى نفس مستويات الطحلب. وذلك لتقييم التغيرات فى مقاييس الضرع أثناء أشهر الرضاعة , وكمية ونسبة الدهن والبروتبن فى لبن الرضاعة, والتغيرات فى أوزان الماعز الجداء،وكمية لبن الحليب بعد الفطام، وأيض الدم. و أوضحت النتائج أن القياسات التناسلية فى ج1 أقل من ج2 وكان معدل الولادة الرباعية صفر، 29 ،14% على التوالى. ومقاييس الضرع كانت أعلى معنوية *(P<0.05)* مع ج2 مقارنة مع ج1. وكمية ونسبة الدهن والبروتين وطاقة لبن الرضاعة كان اعلى معنوية *(P<0.05)* مع ج2 مقارنة مع ج1. ومعدلات النمو لكلا من الماعز والجداء أعلى معنوية مع ج2 مقارنة مع ج1 . وكان إنتاج اللبن خلال 7 أسابيع الأولى من الحليب عالى معنويا خلال الثلاث أسابيع الأولى وغير معنوي خلال 4 أسابيع التالية لصالح ج2 مقارنة مع ج1 .وكان البروتين الكلى والجلوكوز أعلى معنويا مع ج2 مقارنة مع ج1 .بينما ج1 أعطت معنوية عالية فى الكوليستيرول، الجليسريدات الثلاثية ، والإنزيمات مقارنة مع ج2 ولاتوجد فروق معنوية فى مستوى يوريا الدم بين كلا من ج1و ج2. وكانت تكلفة إنتاج واحد كجم من اللبن1.45, 1.84 فى كلا من ج2، ج1 على التوالى.وتوصى الدراسة أن إضافة مسحوق طحلب الأسبيرولينا هام لتغذية الماعز الحلاب وكمضاد للتاكسد ومنشط لجهاز المناعة وإنتاج اللبن ولا يقاوم اجهزه الجسم.