

EFFECT OF MILK REPLACER ON KID PRE-WEANING GROWTH, MILK PRODUCTION AND FARM PROFITABILITY OF SHAMI GOAT

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SUMMARY

This study was carried out on 38 Shami female goats and 48 of their kids to investigate the effect of using milk replacer on growth performance of goat kids, goat's milk yield and composition, and economic efficiency. Two groups, (19 goats each) with their kids were used up to 12 weeks of age after kidding. The kids of first group were allowed free access to suckle their dams during the experimental period till weaning. The kids of the other group were fed milk replacer (MR) just after 3 days of receiving colostrum. A starter diet was offered after 4 weeks of age for all goat kids. Growth of kids and feed intake were measured. Milk from the dams was evaluated for yield and composition. The artificial feeding and natural suckling systems were evaluated economically to determine the farm profitability. Results showed that the MR fed kids had a better growth performance in terms of live body weight and average daily gain than the natural suckling kids. Milk production and composition were improved in MR fed kids than natural suckled counterparts. The net return (profit) was superior in MR feeding system (LE 1317.06/kid), than natural suckling (LE 419.09/kid). In this study, feeding MR to newly born goat kids instead of natural suckling had positive effects on kid growth, goat's milk yield and composition as well as the production profitability of the farm.

Keywords: Milk replacer, kid growth, profitability, Shami goats

INTRODUCTION

Goats are one of the most important economical component of animal production specially in developing countries. They live under hard environmental conditions in arid and semi-arid regions. Shami dual-purpose goats are known for their high milk production and high reproduction efficiency (Alsheikh, 2013). Milk produced till weaning including that suckled by the kids is ranged between 190 kg to 240 kg, depending on the length of the suckling period (Mavrogenis *et al.*, 2006). Kid rearing with natural suckling, where kids are kept with their dams, lasts between 45 and 75 days, and labor requirement is low, but kids may suckle more than enough and suffer from diarrhea resulting in economic loss (Keskin, 2002). Recently, milk replacer (MR) plays an important role in animal production especially for food producing animal (Keskin and Bicer, 2002). It is a very good source of liquid feed for calves, lambs and goat kids. MR manufacturing has been improved as well by formulation with ingredients that processed technically for the underdeveloped rumen of young kids (Bugti *et al.*, 2016). This innovate technology provides highly digestible nutrients, more stable and biosecured feed ingredients into high palatability. These MR are basically formulated from cow's milk, cereals, dried whey, whey protein concentrate and vegetable fat. Goat milk production is a dynamic and

growing industry that is important for the well-being and incomes for millions of people worldwide (Silanikove *et al.*, 2010). In many developing countries, goat milk is a primary product for human consumption (Haenlein, 2006) and is considered as a valuable product for cheese manufacturing. The aim of the present study was to evaluate the use of MR in feeding Shami goat kids in terms of growth performance, milk yield and composition of dams and the profitability of farm production.

MATERIALS AND METHODS

This study was carried out with Shami (Damascus) goats reared between November 2015 to January 2016 at the experimental farm of the Faculty of Agriculture, Benha University, Egypt.

Diet, experimental design and management:

Milk replacer (MR) for kids (Chivalac) was manufactured by Nutrifeed, Netherlands and purchased from Biovet, Egypt. MR contains coconut oil and dairy products for an easy digestion and is enriched with Imagro[®] (pre-and probiotics) to support immune system. The composition of MR is presented in Table 1.

Diet of goats was formulated according to NRC (2007) recommendations for goats. It was composed of crushed yellow corn, wheat bran, rice bran, soybean meal, cotton seed meal, molasses, clover and wheat straw, in addition to mineral and vitamin

supplements. A starter diet was formulated mainly from yellow corn, soybean meal and wheat bran was offered to all kids at 4 weeks of age. Feed ingredients of goat's diet and kid's starter and their chemical composition are presented in Table 2. Thirty eight female goats with their newly born kids (48) were divided into two equal groups (i.e. natural rearing and artificial rearing). Each group was composed of 14 goats with single kids and five goats with twin kids. Goats in both groups were fed the same formulated diet. Kids were ear-tagged just after birth and separated from does 3 days after birth. Within this

time, they received colostrum *ad libitum*. For natural rearing group (control), kids were allowed to suckle their dams, while goat kids of artificial rearing group were fed on MR just after receiving colostrum. Both rearing systems were applied till weaning (12 weeks). The MR was prepared according to the manufacturer's recommendations (180g/L) and fed two times a day using plastic bottles with rubber nipples. The daily feed intake of MR, suckled milk and starter feed were recorded for goat kids.

Table 1. Composition of Chivalac MR dry powder used in the experiment

Constituent	Unit	Qty	Constituent	Unit	Qty
Moisture (Max)	%	4.0	Choline chloride	mg	1000.0
Crude protein (Min)	%	22.0	Pantothenic acid	mg	40.0
Crude fat (Min)	%	18.0	Niacin	mg	50.0
Carbohydrates	%	46.4	Iron	mg	110.0
Minerals	%	9.5	Zinc	mg	150.0
Crude fiber	%	0.1	Manganese	mg	70.0
Lysine	%	1.7	Copper	mg	28.0
Lactose	%	41.0	Vitamin A	IU	55000
Iodine	mg	1.5	Vitamin D	IU	4500
Selenium	mg	0.5	Vitamin E	mg	80.0
Calcium	g	17.0	Vitamin C	mg	120.0
Phosphorus	g	9.5	Vitamin K	mg	6.0
Magnesium	g	1.8	Vitamin B1	mg	16.0
Potassium	mg	25.0	Vitamin B2	mg	15.0
Sodium	g	11.5	Vitamin B6	mg	8.0
Cobalt	mg	2.0	Vitamin B12	mcg	40.0

Table 2. Ingredients and chemical composition of goat's ration and kid's starter

Ingredients (g/kg)	Goat's ration	Kid's starter
Yellow corn	310	600
Rice bran	-	185
Wheat bran	50	100
Wheat straw	230	-
Soybean meal	180	100
Cotton seed meal	40	-
Molasses	50	-
Egyptian clover	100	-
Sodium chloride	10	10
Calcium carbonate	5	-
Limestone	10	-
Di-calcium phosphate	5	-
Ammonium chloride	5	-
Vitamins and minerals mixture ¹	5	5
Chemical composition (g/kg)		
Dry matter	904.5	931.0
Crude protein	151.6	246.1
Ether extract	35.0	78.5
Nitrogen free extract (NFE) ²	545.0	565.6
Crude fiber	159.6	47.5
Neutral detergent fiber (NDF)	323.5	214.5
Acid detergent fiber (ADF)	206.7	77.5
Ash	108.8	62.3
Metabolizable energy (ME, Mcal/kg DM) ³	2.71	3.18

¹Each 1 kg of vitamins and minerals mixture contain: Vit. A = 4,000,000 IU, Vit. D₃ = 833333.33IU, Vit. E = 5,000 mg, Zn = 20,000 mg, Mg = 23333.33 mg, Fe = 20,000 mg, Cu = 10,000 mg, I = 1666.66 mg, Se = 100 mg, Co = 333.33 mg and Calcium carbonate up to 1 kg. ²NFE calculated as [100-(CP+ EE + ash + CF)].

³ME (MJ/kg DM) = 0.012 CP + 0.031 EE + 0.005 CF + 0.014 NFE (calculated according to MAFF, 1975) and changed to Mcal (* 4.184).

All kids were individually weighed every two weeks to the nearest 10 grams till the weaning time (12 weeks of age) to estimate average daily gain (ADG).

Goats with their kids were housed individually in hygienic metallic pens and supplied with clean water all time.

The routine vaccination program against infectious diseases and medications against internal and external parasites were applied. Milk yield of goats in both groups was measured weekly. In natural rearing group, measuring milk yield was carried out by separating kids from their dams at night, then on the next day, body weight of kids was recorded before and after suckling then goats were milked for the rest of milk if any and the total milk yield was recorded (Coombe *et al.*, 1960). In artificial rearing group, goats were milked two times daily and the milk yield was measured.

Chemical analysis:

Samples of goat's diet, MR and kid's starter were analyzed according to A.O.A.C. (1995). Dry matter (DM) was measured using a hot air circulation oven (Heraeus Ut20, Germany) at 105 °C for 4 hours (method no. 930.15). Ash was measured using Burnout furnace Ney Vulcan D-550, USA (method no. 942.05). Crude protein (CP) was determined using Kjeltac[®] system 2100, FOSS-Sweden (method no. 984.13), and ether extract (EE) with Soxtec[®] system 2045, FOSS-Sweden (method no. 920.39). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were estimated according to the method of Van Soest *et al.* (1991). Organic matter (OM) was calculated from the difference between DM and ash.

Approximately 20 ml of milk samples were prewarmed at 40 °C in water bath and thoroughly mixed in clean glass beaker. Milk analysis was carried out for total solids, fat, proteins, lactose, and non-fat solids using Milk-Scan kit (Lactostar[™], Funk Gerber, Germany).

Economic efficiency:

Finance analysis was made to evaluate the production profitability of using milk replacer instead of normal suckling of goat kids. The net return (NR) was calculated according to Sankhyan (1983) from the difference between total income (TI) and total costs (TC). Total income and total costs were individually calculated for each kid. The total costs include: the feeding costs (milk, milk replacer, and ration), the labor costs (price of a farmer working hour multiplied by the number of hours employed per kid (Paez Lama *et al.*, 2013), veterinary care costs (drugs, vaccines, and veterinary supervision). Water, electricity, equipment maintenance in addition to costs of litter and building rent value were also calculated per kid for each group. The total income included: income value from marketable milk (goat) and final live body weight (kid). All these parameters

were estimated in L.E. over the course of the experiment.

Statistical analysis:

Statistical analysis was carried out using the least squares procedure for analysing data with unequal subclass number using SAS (2004). The statistical models used being as follows:

$$Y_{ijk} = \mu + R_i + B_j + (RB)_{ij} + e_{ijk} \text{ (Model 1)}$$

Where: Y_{ijk} = observation of k goat milk; μ = overall mean; R_i = fixed effect of i^{th} rearing system ($i= 1, 2$ while, 1= natural suckling and 2= artificial feeding); B_j = fixed effect of j^{th} birth type ($j= 1, 2$ while, 1= single and 2= twin); $(RB)_{ij}$ = the interaction between rearing system and birth type; e_{ijk} = random error associated with the individual observation and assumed as NID ($0, \sigma_e^2$).

$$Y_{ijkl} = \mu + R_i + B_j + S_k + (RB)_{ij} + (RS)_{ik} + (BS)_{jk} + (RBS)_{ijk} + e_{ijkl} \text{ (Model 2)}$$

Where: Y_{ijkl} = observation of l kid pre-weaning growth; μ = overall mean; R_i = fixed effect of i^{th} rearing system ($i= 1, 2$ while, 1= natural suckling and 2= artificial feeding); B_j = fixed effect of j^{th} birth type ($j= 1, 2$ while, 1= single and 2= twin); S_k = fixed effect of j^{th} kid sex ($j=1, 2$ while, 1= male and 2= female); $(RB)_{ij}$ = the interaction between rearing system and birth type; $(RS)_{ik}$ = the interaction between rearing system and kid sex; $(BS)_{jk}$ = fixed effect of the interaction between birth type and kid sex; $(RBS)_{ijk}$ = the interaction among rearing system, birth type and kid sex; e_{ijkl} = random error associated with the individual observation and assumed NID ($0, \sigma_e^2$). Tests of significance for differences between means were carried out according to Duncan (1955).

RESULTS AND DISCUSSION

Kids preweaning growth performance:

Final live body weight (LBW) did not show significant ($P<0.01$) differences between milk replacer fed and naturally suckled kids. LBW at 28 and 56 days of age were insignificantly ($P>0.05$) higher in MR fed kids than in naturally suckled kids. The average daily gain (ADG) from 56 to 84 days of age was significantly higher ($P<0.01$) in MR fed kids than the milk suckling ones (168 vs 138 g/day). Also, ADG from birth to weaning at 84 days of age was higher ($P<0.01$) in MR fed kids than the milk suckling counterparts (130 vs 120 grams/day) as presented in Table 3. The single born kids had the heaviest LBW at birth, 28 and 56 days of age. The ADG from birth to 28 days of age was higher in the single born kids than the twin born kids (122 vs 105 g). The male kids had heavier LBW than the female kids at birth, 28, 56 and 84 days of age ($P<0.001$). The ADG from birth to 28 days was higher ($P<0.01$) in the male kids than the female ones (125 vs 102g). The ADG from birth to 84 days of age was higher ($P<0.05$) in the male kids than the female kids (129 vs 120g).

In this study, the MR fed kids had better LBW and ADG than the milk suckled kids. Such

differences might be due to the MR composition and the feed intake by kids. New technology in manufacturing MR improved its quality, taste, stability, and digestibility as well as feed additives that improve growth and feed utilization such as pre- and probiotics in Chivalac. Most recent MR used for feeding newly born ruminants is characterized by convenience and biosecurity. They offer a variety of feed additives such as antibiotics, coccidiostats, probiotics, prebiotics, and ionophores. Also pasteurization of ingredients of MR during

manufacturing can prevent diseases caused by bacteria and viruses transmitted to newly born animals from their dams in normal suckling system. Results of Ghorbani *et al.* (2007) showed that feeding MR was important for the development of rumen of lambs and therefore improved creep intake ensued. Similarly, Alvarez-Rodríguez *et al.* (2010) found that early-weaned lambs had a higher creep feed intake than suckling lambs.

Table 3. Effect of milk replacer on LBW (kg) and ADG (g) of kids from birth to 84 days of age for different rearing systems, kidding types and sexes

Item	Rearing system (RS)		Kidding type (KT)		Sex (S)		P					
	Natural	Artificial	Single	Twin	Male	Female	RS	KT	S	DI ¹	TI ²	
No. of kids	24	24	28	20	27	21						
Live weight (kg)												
0-28d	3.39±0.04	3.50±0.1	3.53±0.04 ^a	3.31±0.05 ^b	3.65±0.03 ^a	3.19±0.05 ^b	NS	**	***	NS	NS	
28-56d	6.4±0.2	6.84±0.2	6.97±0.16 ^a	6.27 ^b ±0.20	7.16±0.15 ^a	6.07±0.2 ^b	NS	**	***	NS	NS	
56-84d	10.35±0.2	10.47±0.3	10.85±0.2 ^a	9.97 ^b ±0.25	11.02±0.19 ^a	9.80±0.25 ^b	NS	**	***	NS	NS	
0-84d	14.22±0.2 ^b	15.19±0.3 ^a	15.04±0.22	14.38±0.28	15.34±0.22 ^a	14.07±0.28 ^b	**	NS	***	NS	NS	
ADG (g/day)												
0-28d	106±5	121±6	122±5 ^a	105 ^b ±6	125 ^a ±5	102 ^b ±6	NS	*	**	NS	NS	
28-56d	141±5	129±7	138±5	132±7	138±5	133±7	NS	NS	NS	NS	NS	
56-84d	138±5 ^b	168±6 ^a	149±5	157±6	154±5	152±6	**	NS	NS	NS	NS	
0-84d	120±2 ^b	130±3 ^a	127±2	123±3	129±2 ^a	120±3 ^b	**	NS	*	NS	NS	

*P < 0.05; **P < 0.01; ***P < 0.001; NS: not significant, P > 0.05.

¹DI= double interaction, ²TI= triple interaction.

^{a, b} Means within a row with different letters differ significantly (P < 0.05).

LBW = live body weight, ADG= average daily gain.

This result did not agree with those of Delgado-Pertínez *et al.* (2009a) who recorded significant differences in weight and ADG, although the milk suckling kids weighed slightly more than the MR fed kids. Paez Lama *et al.* (2013) found that differences between kids LBW at 45 days of age and ADG from 3 to 90 days of age were affected significantly (P < 0.05 and P < 0.01, respectively) by Criollo kid's rearing systems. On the other hand, Keskin and Bicer (2002) recorded that the growth rate of Shami kids was not significantly affected by the kid rearing system.

Single born kids in this study had higher LBW and ADG than twin born kids. Single born kids maintained their weight superiority up to weaning and after. Results of Delgado-Pertínez *et al.* (2009a), Paez Lama *et al.* (2013), and Rojo-Rubio *et al.* (2015) are not in agreement with the current results regarding weaning weight and ADG. The sex of kid affected LBW and ADG. Such observation was noted by Rojo-Rubio *et al.* (2015) who found that male kids reached a heavier weaning weight than female kids (20 versus 18.13kg, respectively). The same authors noted that the higher daily weight gain at weaning for male than female kid was probably due to the male anabolic hormonal pattern which favours the growth of muscular tissues.

Goat's milk yield and composition:

Concerning daily milk yield (DMY), the female goats with MR fed kids had a higher yield than goats with natural suckling kids (P < 0.01) (2.03 vs 1.49 kg/day). Goats with MR fed kids exceeded the goats with natural suckling kids in total milk yield (TMY) during 12 weeks of lactation (170.62 vs 125.88 kg) (Table 4). Goats kidded twins had a significantly (P < 0.05) higher DMY than those kidded single kids (1.99 vs 1.53 kg/day). Also, goats kidded twins had greater TMY (P < 0.05) during 12 weeks of lactation than those kidded single kids (167.68 vs 128.81 kg). Several factors affecting milk yield (genetic, feeding system, stage of lactation, production system and suckling/milking frequency). These results could be attributed to the ability of goats with MR fed kids to empty the udder by complete milking twice daily, especially during the early lactation period. This might stimulate the udder to produce more milk. These results agree with those obtained by Peris *et al.* (1997) who found that milking Murciano-Granadina goats had higher (P < 0.001) milk production during first seven weeks of lactation than suckling goats (91 vs 37 liters).

Otherwise, Delgado-Pertínez *et al.* (2009a) with Payoya dairy goats, found that the rearing system affected the TMY from birth to the 30th week of lactation, manifesting higher milk yields from the natural suckling system. Other studies using the same

breed revealed that kid rearing system did not affect the milk yield (Keskin, 2002; Keskin and Bicer, 2002). The greater milk yield by goats which kidded twin kids is in accordance with previous findings by Carnicella *et al.*(2008) which showed an increase of 27% in milk with single fetus and 47% with twin fetuses due to systemic effects of increased secretion of placental lactogen. Rojo-Rubio *et al.* (2015) attributed such effect to the stimulation exerted by more than a kid goat suckling on the udder; leading

to an increase in milk production, in addition to hormonal effects during pregnancy.

The pattern of milk quality in terms of its chemical composition (fat, protein, total solids and lactose) is presented in Table 5. Generally, fat, protein and total solids during the first 4 weeks of lactation were insignificantly higher ($P < 0.05$) in milk from goats with MR fed kids than that of goats with natural suckling kids (4.30, 3.30 and 13.15% vs 5.23, 3.58 and 13.90%, respectively). However, lactose and non-fat solids showed an increase trend.

Table 4. Least-squares means (\pm SE) of milk yield from Shami goats (kg) during the experimental period.

Item	Rearing system (RS)		Kidding type (KT)		P		
	Natural	Artificial	Single	Twin	RS	KT	RS×KT
Number of goats	19	19	28	10			
	Weeks 1-4						
Daily yield	1.6 \pm 0.2	1.7 \pm 0.2	1.4 \pm 0.1 ^b	1.9 \pm 0.2 ^a	NS	*	NS
Total yield	43.9 \pm 4.9	47.4 \pm 4.8	39.0 \pm 4.1 ^b	52.4 \pm 5.7 ^a	NS	*	NS
	Weeks 5-8						
Daily yield	1.8 \pm 0.2	2.1 \pm 0.1	1.6 \pm 0.1 ^b	2.2 \pm 0.2 ^a	NS	*	NS
Total yield	49.6 \pm 4.3	57.5 \pm 4.2	46.2 \pm 3.6 ^b	60.9 \pm 4.9 ^a	NS	*	NS
	Weeks 9-12						
Daily yield	1.2 \pm 0.1 ^b	1.5 \pm 0.1 ^a	1.1 \pm 0.1 ^b	1.5 \pm 0.1 ^a	*	*	NS
Total yield	32.5 \pm 3.1 ^b	41.2 \pm 3.0 ^a	31.5 \pm 2.6 ^b	42.2 \pm 3.6 ^a	*	*	NS
	Weeks 1-12						
Daily yield	1.5 \pm 0.14 ^b	2.0 \pm 0.1 ^a	1.5 \pm 0.12 ^b	1.99 \pm 0.2 ^a	**	*	NS
Total yield	125.9 \pm 12.3 ^b	170.6 \pm 12.0 ^a	128.8 \pm 10.1 ^b	167.7 \pm 13.9 ^a	**	*	NS

* $P < 0.05$; ** $P < 0.01$; NS: not significant, $P > 0.05$.

^{a, b} Means within a row with different letters differ significantly ($P < 0.05$).

Table 5. Least-squares means (\pm SE) of milk composition from Shami goats (kg) during the experimental period

Item	Rearing system (RS)		Kidding type (KT)		P		
	Natural	Artificial	Single	Twin	RS	KT	RS×KT
Number of goats	19	19	28	10			
	Weeks 1-4						
Total solids	13.15 \pm 0.2	13.90 \pm 0.29	13.97 \pm 0.2	13.07 \pm 0.29	NS	NS	NS
Fat	4.30 \pm 0.4	5.23 \pm 0.47	5.51 \pm 0.4	4.02 \pm 0.47	NS	NS	NS
Protein	3.30 \pm 0.2	3.58 \pm 0.2	3.65 \pm 0.2	3.23 \pm 0.24	NS	NS	NS
Lactose	4.26 \pm 0.26	4.17 \pm 0.3	3.62 \pm 0.26 ^b	4.81 \pm 0.3 ^a	NS	*	NS
Non-fat solids	8.85 \pm 0.19	8.66 \pm 0.2	8.46 \pm 0.19	8.05 \pm 0.2	NS	NS	NS
	Weeks 5-8						
Total solids	12.87 \pm 0.2	12.84 \pm 0.18	13.16 \pm 0.18	12.55 \pm 0.2	NS	NS	NS
Fat	3.55 \pm 0.35	3.63 \pm 0.29	4.01 \pm 0.29	3.17 \pm 0.35	NS	NS	NS
Protein	3.34 \pm 0.2	2.98 \pm 0.18	3.25 \pm 0.18	3.07 \pm 0.2	NS	NS	NS
Lactose	4.79 \pm 0.17	4.24 \pm 0.15	4.38 \pm 0.15	4.66 \pm 0.17	NS	NS	NS
Non-fat solids	9.32 \pm 0.1	9.21 \pm 0.1	9.15 \pm 0.1	9.38 \pm 0.1	NS	NS	NS
	Weeks 9-12						
Total solids	13.01 \pm 0.1 ^a	12.58 \pm 0.09 ^b	12.84 \pm 0.08	12.75 \pm 0.1	*	NS	NS
Fat	3.57 \pm 0.2	3.43 \pm 0.2	3.50 \pm 0.2	3.50 \pm 0.26	NS	NS	NS
Protein	3.05 \pm 0.1	2.69 \pm 0.1	2.86 \pm 0.1	2.87 \pm 0.1	NS	NS	NS
Lactose	4.12 \pm 0.2	4.67 \pm 0.2	3.86 \pm 0.2	3.93 \pm 0.27	NS	NS	NS
Non-fat solids	9.43 \pm 0.2	9.15 \pm 0.2	9.34 \pm 0.19	9.24 \pm 0.2	NS	NS	NS
	Weeks 1-12						
Total solids	12.98 \pm 0.17	13.05 \pm 0.16	13.3 \pm 0.15 ^a	12.72 \pm 0.18 ^b	NS	*	NS
Fat	3.76 \pm 0.28	4.03 \pm 0.27	4.29 \pm 0.25	3.49 \pm 0.30	NS	NS	NS
Protein	3.20 \pm 0.13	3.05 \pm 0.12	3.23 \pm 0.11	3.01 \pm 0.14	NS	NS	NS
Lactose	4.40 \pm 0.16	3.98 \pm 0.15	3.95 \pm 0.14 ^b	4.44 \pm 0.17 ^a	NS	*	NS
Non-fat solids	9.21 \pm 0.13	9.02 \pm 0.13	9.01 \pm 0.12	9.22 \pm 0.15	NS	NS	NS

* $P < 0.05$; NS: not significant, $P > 0.05$.

^{a, b} Means within a row with different letters differ significantly ($P < 0.05$).

The twin-kidded goats had a significantly ($P<0.05$) higher lactose during the first 4 weeks of lactation than the single-kidded goats (4.81 vs 3.62%). During the 12 weeks of lactation, there were significant ($P<0.05$) effects on contents of total solids and lactose. Total solids increased in the single-kidded goat than the twin-kidded ones (13.31 vs 12.72%). On the other hand, lactose was greater in the twin-kidded goats than the single-kidded ones (4.44 vs 3.95%). There were no significant differences regarding milk fat, non-fat solids and protein contents. Results in this study showed a decrease in milk fat, total solids and protein in the early stage followed by an increase in later stage of the study. These results were consistent with findings by Prasad *et al.* (2005). Such variation could be explained by the negative correlation between milk yield with fat and total solid content (Merkhan, 2011). Effect of birth type was only significant regarding contents of total solids and lactose where the goats with single births produced higher total solids compared with those with twins which produce

milk with high lactose contents. These results are in contrast with those of the study by Delgado-Pertínez *et al.* (2009a) who obtained non-significant effect of birth type on lactose contents.

Economic efficiency:

Data of costs, income and net return are shown in Table 6. The total costs (TC) of kids raised on suckling goat milk were significantly higher ($P<0.05$) than TC of kids raised on MR. For the natural rearing system, total costs included the cost of suckled milk (LE 419.60/kid), cost of feed intake (LE32.19/kid), labor cost (LE 26/kid), building rent value (LE 13.20/kid), water and electricity (LE 1.50/kid), and total veterinary management (LE 9/kid). Concerning total costs of feeding MR system, it included the cost of MR (LE 245.75/kid), suckling equipment cost (LE 10/kid), feed intake cost (LE 35.59/kid), labor cost (LE 55/kid), building rent value (LE 13.20/kid), water and electricity (LE 1.70/kid), and total veterinary management (LE 9/kid).

Table 6. The effect of feeding milk replacer on farm production profitability

Item	Rearing system	
	Natural	Artificial
Marketable milk yield (kg/goat)	60.67±10.87	163.90±8.99
Income from marketable milk (L.E./goat)	424.68±76.06	1147.30±62.90
Live weight gain (kg/kid)	11.02±0.23	12.0±0.19
Income from live weight (L.E. /kid)	495.90±11.96	540.00±9.84
Milk replacer cost (L.E. /kid)	-	245.75±2.66
Suckled milk cost (L.E. /kid)	419.60±50.17	-
Feed intake (kg/kid)	9.20±0.14	10.17±0.21
Feed cost (L.E. /kid)	32.19±0.49	35.59±0.73
Labor cost (L.E. /kid)	26	55
Suckling equipment cost (L.E. /kid)	-	10
Building rent value (L.E. /kid)	13.20	13.20
Electricity and water cost (L.E. /kid)	1.50	1.70
Total management cost (L.E. /kid)	9	9
Total costs (L.E. /kid)	501.49 ^a ±50.37	370.24 ^b ±5.52
Total income (L.E. /kid)	920.58 ^b ±80.66	1687.30 ^a ±65.38
Net return (L.E. /kid)	419.09 ^b ±75.07	1317.06 ^a ±63.79

Price of goat milk: 7 (L.E./Kg); Price of milk replacer: 2.5 (L.E./Kg);

Price of live weight of kid: 45 (L.E./Kg).

^{a, b} Means within a row with different letters differ significantly ($P<0.05$).

These differences in the total costs were due to the feed cost that comprised 60 to 70% of total production costs. In the present study, the suckled milk cost in natural suckling system was significantly higher than MR intake cost, this could be due to difference in market prices of goat milk and MR, goat milk was between 30 and 40% more expensive than MR. These results are in agreement with those reported by Perez *et al.* (2001) and Delgado-Pertínez *et al.* (2009a).

Labor costs were significantly ($P<0.05$) higher in MR feeding system than those of natural suckling system. These results agree with those of Delgado-Pertínez *et al.* (2009a) who found that MR feeding system required twice more labor than that with the

natural suckling system. Contrary to the present results, other authors found that total operating costs of kids raised on MR were significantly higher than the costs of kids raised on goat milk. Galina *et al.* (1995) found that feeding MR was more expensive than feeding on goat milk, whereas Delgado-Pertínez *et al.* (2009b) found no major differences between natural and artificial rearing. The total income obtained from marketable milk sales and final live weight price were significantly ($P<0.05$) higher for the MR system (LE 1687.30/kid) than natural suckling (LE 920.58/kid). Net return was significantly higher ($P<0.05$) in the MR system (LE 1317.06/kid) than that for natural suckling system (LE 419.09/kid). Financial analysis of the kid rearing

systems showed that MR feeding system earned about LE 897.97/goat more profit than the natural suckling system. This may be due to that MR feeding system increased marketable milk yield by about 103.23 kg/goat more than the natural suckling system during the experimental period. In addition, kids in the MR feeding system gained 1 kg/ kid extra live weight.

Therefore, results of the present study showed that providing MR instead of goat milk for rearing Shami goat kids increases farm profitability.

CONCLUSION

Raising goat kids on MR just after colostrum period till weaning had positive effects on kid pre-weaning growth, dam's milk yield and composition and production profitability. Recent manufacturing technology provides high quality and biosecured MR for newly born animals. Therefore, dairy goat producers should rear their kids by such system for more milk yield, kid pre-weaning growth and more production profits.

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تأثير بديل اللبن على نمو صغار الماعز قبل الفطام وانتاج اللبن والعائد للمزرعة في الماعز الشامى

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أجريت هذه الدراسة على ٣٨ من أمهات الماعز الشامى و ٤٨ من صغارها لبحث تأثير إستخدام بديل اللبن على نمو الصغار وانتاج لبن الأمهات ومكوناته كذلك عائد المزرعة. قسمت الأمهات الى مجموعتين (١٩ أم فى كل مجموعة) مع صغارها بعد الولادة وحتى عمر ١٢ أسبوع. تم السماح لصغار الماعز فى المجموعة الأولى برضاعة الأمهات خلال فترة التجربة حتى الفطام عند عمر ١٢ أسبوع. غذيت صغار الماعز بالمجموعة الأخرى على بديل اللبن بعد ٣ أيام من الولادة والتغذية على السرسوب. تم تقديم باديء غذائى لصغار الماعز فى المجموعتين ابتداء من عمر ٤ أسابيع. تم تقدير نمو صغار الماعز كذلك حساب الغذاء المأكول. تم حساب محصول اللبن من الأمهات وتحليل مكوناته وعمل تقييم مالى لكل من التربية الصناعية على بديل اللبن ونظام الرضاعة الطبيعية لتقدير الكفاءة الإقتصادية للانتاج. أظهرت النتائج الأتى: أعطت صغار الماعز المغذاه على بديل اللبن أفضل معدل نمو ووزن جسم ومتوسط زيادة يومية عن المغذاه على الرضاعة الطبيعية. أنتاج اللبن اليومي والكلى ومكوناته لأمهات الماعز فى مجموعة بديل اللبن أفضل عن مجموعة الرضاعة الطبيعية. أعطت مجموعة بديل اللبن أعلى عائد صافى (الربح) (١٣١٧.٠٦ جنيه/ حيوان) عن مجموعة الرضاعة الطبيعية (٤١٩.٠٩ جنيه/حيوان). أتضح فى هذه الدراسة أن التغذية على بديل اللبن له تأثير أيجابى على نمو صغار الماعز و انتاج اللبن للأمهات والعائد للمزرعة.