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EFFECT OF SUPPLEMENTED RUMEN PROTECTED METHIONINE AND/OR CHOLINE ON PERFORMANCE OF ZARAIBI GOATS:
1. PRODUCTIVE PERFORMANCE OF LACTATING GOATS

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ABSTRACT

Forty Zaraibi goats with average body weight of 34.64±0.79 kg and 3-4 years old were divided into four similar groups (10 in each). The goats were fed from the last two months of pregnancy till the fifth month of lactation the basal ration containing 0.8 kg concentrate feed mixture, 0.2 kg barley grain and 5.0 kg berseem without additive (control) or with 2 g/head/day rumen protected methionine (RPM) or 2 g/head/day rumen protected choline (RPC) or 2 g/head/day RPM + 2 g/head/day RPC (RPM+RPC). Results show that average daily dry matter intake (DMI) by goats was nearly similar for the different groups. The RPM+RPC group showed significantly (P<0.05) the highest digestibility coefficients and nutritive values followed by RPM and RPC groups, while the control group had the lowest values. Milk yield increased by 19.36, 12.62 and 31.31% for RPM, RPC and RPM+RPC groups, respectively. The RPM+RPC group showed significantly (P<0.05) higher milk composition. Milk yield was increased with the progress of lactation from 1^{st} to 2^{nd} month and decreased thereafter, while milk composition showed the opposite trend. Rumen protected methionine and/or choline additives increased significantly (P<0.05) body weight of goats during the different periods compared to control group. The concentrations of total protein, albumin and globulin in blood serum were significantly (P<0.05) the higher in RPM+RPC group. The total DM intake and total feed cost were nearly the same for the different groups. The RPM+RPC group showed significantly (P<0.05) higher total TDN and DCP intakes and lower amounts of DM, TDN and DCP required per kg milk. The RPM+RPC group recorded significantly (P<0.05) higher total and net revenue and net revenue improvement. The net revenue for RPM, RPC and RPM+RPC increased by 32.27, 21.75 and 53.19% compared to control group, respectively.

Keywords: Goats, protected methionine, choline, digestibility, milk yield, composition.

INTRODUCTION

Goats are widely distributed around the world with high demand to their meat in many developing and subtropical countries and arid regions (Casey *et al.,* 2003). In most of these countries, the productivity of goats is below their potential with inefficiency at primary production and post production system (Devendra, 1999; Matossian de Pardo, 2000).

Several studies have been carried out in the recent years in order to identify the limiting amino acids in milk production of goats (Madsen *et al.*, 2005). Some of the most frequently reported limiting amino acids for milk production in lactating goats are lysine and methionine (NRC, 2006). Supply of rumen bypass methionine has been shown to increase milk yield and milk protein production of dairy goats (Flores *et al*., 2009). The information in literature on dairy goats fed diets containing rumen-protected amino acids is scarce, but Madsen *et al*. (2005) showed positive effects on milk yield in early lactation of goats when dietary lysine and methionine were given in combination, concluding that mammary supply of these two amino acids were limiting for milk production when goats were fed the basal ration. In this respect, NRC (2006) indicates that is a common practice to supplement goats with rumen-protected methionine (RPM) in milking periods, but the optimal dose is unknown.

Methionine metabolism is closely linked to that choline and it is important in the dairy cow because it is required for milk protein synthesis. Methionine is involved in many pathways including the synthesis of phospholipids, carnitine, creatine and polyamines (Bequette *et al*., 1998; Berthiaume *et al*., 2006). In addition, methionine is the source of the methyl donor *S*-adenosyl methionine, the metabolite that provides methyl groups in a variety of reactions including the *de novo* synthesis of choline from phosphatidylethanolamine. Choline increases the supply of methyl groups, which can affect the availability of other methyl donor compounds (Frank and Karl-Heinz, 2006). Moreover, Emmanuel and Kennelly (1984) and Lobley *et al*., (1996) demonstrated that up to one third of the total methionine supplement can be lost due the need to synthesize choline. Because of these metabolic relationships, dietary supplementation of choline affects methionine requirements and methionine supply can affect choline metabolism. Since choline is susceptible to rapid ruminal degradation, the amounts available for absorption are limited (Erdman *et al*., 1984). Therefore, dairy cows may benefit from rumen protected supplementation of choline. Choline also participates, via the compound phosphatidylcholine in the removal of triglycerides from the liver by incorporation of triglycerides into lipoproteins (Pinotti *et al*., 2002). Lipotropic compounds have the ability to prevent and subsequent to a deficiency, correct excess fat deposition in the liver (Zeisel, 1992).

Researchers also have reported that dairy cattle can produce more milk when fed supplemental rumen protected choline (Erdman and Sharma, 1991; Pinotti *et al*., 2003). Methionine (Onodera, 1993) and choline (Atkins *et al*., 1988) are degraded by microorganisms in the rumen, so rumen protected forms are more effective at supplying the compounds to the cow than forms that are not protected. There has been extensive research conducted to develop and determine the effectiveness of technologies for protecting methionine (Schwab, 1996).

The objective of this study was to evaluate the effects of rumen protected methionine and/or choline additives on feed intake, digestibility, milk yield and composition and economic efficiency of lactating Zaraibi goats.

MATERIALS AND METHODS

The current work was carried out at Sakha Experimental Farm, belonging to the Animal Production Research Institute (APRI), Agricultural Research Center.

Forty Zaraibi goat does with average body weight of 34.64±0.79 kg and 3-4 years old were divided into four similar groups (10 in each). Goats were fed a basal ration containing 0.8 kg concentrate feed mixture, 0.2 kg barley grain and 5.0 kg berseem without additive and served as a control group (G1), basal ration supplemented with 2 g rumen protected methionine (RPM)/head/day (G2), 2 g rumen protected choline (RPC)/head/day (G3) or 2 g RPM + 2 g RPC/head/day (G4). Goats were fed to cover their maintenance and production requirements according to their body weight and milk yield (NRC, 1981) from the last two months of pregnancy till the fifth month of lactation.

Rumen protected methionine was in form of Methaionine Hydroxy Analogue, Calcium (MHA), Novus International, Inc, Missouri, USA. Rumen protected choline was in the form of choline chloride produced by Qingdao Worldwide International Trade Co. Ltd., China.

Concentrate feed mixture and barley grains were fed in two equal amounts at 9 a.m. and 3 p.m., while berseem was given at 11 a.m. Chemical composition of feedstuffs and basal ration are presented in Table (1). Animals were housed in semi open backyards. Water was available in build basin all the day round. Also, mineral blocks were available free choice in stalls for all animals.

Table (1): Chemical composition of feedstuffs and the basal ration.

Item	DM %	Composition of DM %					
		OM	CP	CF	EE	NFE	Ash
CFM*	91.23	90.95	13.98	9.08	3.12	64.77	9.05
Barley grain	89.77	97.53	12.25	8.54	2.52	74.22	2.47
Berseem	17.27	87.41	15.92	27.65	2.59	41.25	12.60
Basal ration**	29.56	89.88	14.75	18.06	2.80	54.27	10.12

*** CFM: Concentrate feed mixture consisted of 27% undecorticated cotton seed cake, 25% wheat bran, 25% yellow corn, 13% rice bran, 5% linseed cake, 2% molasses, 2% limestone and 1% common salt. ** Calculated chemical composition.**

Digestibility trial was conducted at the third month of lactation on three Zaraibi goats from each group to determine nutrient digestibility coefficients and nutritive values of different tested rations using acid insoluble ash (AIA) as a natural marker (Van Keulen and Young, 1977). The *ad libitum* intake from the tested rations was measured during the preliminary period and was restricted to 90% of the voluntary intake during the collection period to avoid any feed refusal. Animals were fed twice daily in two equal meals at 9 a.m. and 4 p.m. Water was freely available throughout the day. Representative samples of feedstuffs (at the beginning, middle and end of the collection period) and fecal samples were taken from the rectum of each doe twice daily at 12 h intervals during the collection period were chemically analyzed according to the methods of AOAC (1990). Digestibility coefficients were calculated from the equations given by Schneider and Flatt (1975).

All goats were weighed at the last month of pregnancy and biweekly thereafter until 5 months after kidding to determine the changes in body weight. During the suckling period (90 days), goats were hand-milked every two weeks twice daily at 6 a.m. and 5 p.m. to determine average daily milk yield. Feed intake was also recorded, and then feed conversion and economic efficiency were calculated. Milk samples were taken for fat, protein, lactose, solids not fat (SNF), and total solids (TS) determination using Milko-Scan (Model 133B), while ash was calculated by the difference.

Blood samples were withdraws from the jugular vein of goats using sterile needle into clean dry tubes and left in refrigerator for two hours, then centrifuged at 4000 rpm. for 15 minutes to obtain serum, which was stored at - 20 ^{o}C till analyses. Concentration of total protein and albumin as well as activity of asprtate (AST) and alanine (ALT) transaminases in blood serum were calorimetrically determined using commercial diagnostic kits (Test-combination, Pasteur lap.) and spectrophotometer.

Data were subjected to statistical analysis of General Linear Models procedures adapted by SPSS (2008) for user's guide using one-way ANOVA design. Duncan test within SPSS was done to determine the degree of significance between group means.

RESULTS AND DISCUSSION

Digestibility coefficients and nutritive values:

Averages of daily dry matter intake (DDMI), digestibility coefficients and nutritive values as affected by dietary additives are shown in Table (2). Average DDMI by does was nearly similar in all groups, ranging from 1773.7 to 1777.7 g/head/day. These results agreed with those obtained by Wang *et al.* (2010), who found no significant effect of dietary methionine supplementation on DM intake of dairy cows.

Results in Table (2) indicated that RPM+RPC (G4) significantly (P<0.05) improved nutrients digestibility and subsequently nutritive values as compared to the control (G1). Dietary supplementation of RPM+RPC (G4) showed significantly (P<0.05) the highest digestibilities of DM, OM, CP, CF, EE and NFE and a higher TDN and DCP values, followed by RPM and RPC groups, while the control group had the lowest values.

Table (2): Effect of rumen protected methionine and/or choline additives nutrient digestibility coefficients and nutritive values by Zaraibi goat does.

Item	Experimental group				SEM
	Control	RPM	RPC	RPM+RPC	
DM intake (g/day)	1773.68	1775.68	1775.68	1777.68	8.75
Nutrient digestibility (%):					
DM	65.09^{b}	67.12^{ab}	66.41^{ab}	68.28^{a}	0.48
OM	65.77^{b}	67.83^{ab}	67.10^{ab}	69.00^{a}	0.49
CP	68.59^{c}	72.07^{ab}	70.45^{bc}	73.42^{a}	0.65
CF	64.66^{c}	66.31^{bc}	67.70^{ab}	69.45^{a}	0.63
EE	71.13^{b}	72.90^{ab}	73.45^{a}	73.88^{a}	0.41
NFE	68.51^{b}	71.70^{a}	69.90^{ab}	71.87^{a}	0.54
Nutritive values (%):					
TDN	63.46^{b}	66.12^{a}	65.19^{ab}	67.04^{a}	0.51
DCP	10.12^{b}	10.63^{ab}	10.39^{ab}	10.83^{a}	0.11

a, b, c: Values within the same row with different superscripts are significantly different at P<0.05.

These results agreed with those obtained by El-Ganiny *et al.* (2007), who reported increases in nutrient digestibility coefficients and nutritive values of dairy cows fed diets containing RPM. Also, Mohsen *et al.* (2011) found that the digestibility coefficients and nutritive values significantly increased (P<0.05) with added RPC for lactating Friesian cows. The pronounced effect of RPM and RPC combination may be attributed to that up to one third of the total methionine supplement can be lost due the need to synthesize choline. So, dietary supply of choline affects methionine requirements and methionine supply can affect choline metabolism (Lobley *et al*., 1996).

Milk production:

Average daily milk yield (ADMY) and composition of goat milk as affected by dietary treatment at different lactation months are shown in Table (3). Results revealed that dietary RPM+RPC combination significantly (P<0.05) increased ADMY and improved milk composition of goats at each lactation month as compared to the control diet, showing the highest milk yield and the best composition, followed by RPM and RPC groups, while the control group had the lowest yields. Milk yield increased by 19.36, 12.62 and 31.31% for RPM, RPC and RPM+RPC groups, respectively. These results agreed with those obtained by Poljicak-Milas and Marenjak (2007), who reported that the milk production was significantly higher for goats, fed RPM than those fed control diet. Flores *et al.* (2009) found quadratic (P<0.05) increase in milk yield and milk fat and protein of goats as dietary RPM increased. In dairy cows, Elek (2008) stated that milk yield and fat and protein contents were significantly higher for cows fed RPC than those fed control diet. Also, Soltan *et al.* (2012) indicated that dietary RPM and/or RPC improved milk yield and milk composition of dairy cows.

Live body weight changes:

Results of body weight change in goats during different physiological statuses as affected by dietary supplementation are presented in Table (4). Body weight of goats increased gradually with the progress of pregnancy for the different groups. Rumen protected methionine and/or choline additives significantly increased (P<0.05) body weight of goats during the different periods compared to control group. These increase in body weight may attributed to the improvement of the nutritive values of the rations supplemented with rumen protected methionine and/or choline. These results agree with those obtained by Soltan *et al*. (2012), who found that cows fed on basal diet supplemented by both RPM and RPC was mobilizing less body tissue in the post-partum period.

Blood parameters:

Results in Table (5) showed significant (P<0.05) differences in concentration of total protein (TP), albumin (AL) and globulin (GL) in blood serum of does. Does in RPM+RPC group showed significantly (P<0.05) the highest concentration of TP, AL and GL, followed by RPM and RPC groups, while the control group had the lowest values.

Table (3): Effect of rumen protected methionine and/or choline additives on milk yield and composition of Zaraibi goats.

Item	Month	Experimental group				SEM
		Control	RPM	RPC	RPM+RPC	
Yield (kg/day)	1	2.17	2.57	2.43	2.83	-
	2	2.23	2.63	2.51	2.90	-
	3	2.15	2.58	2.41	2.83	-
	4	2.13	2.54	2.39	2.79	-
	5	2.04	2.43	2.32	2.69	-
	Mean	2.14^{c}	2.55^{b}	2.41^{b}	2.81^{a}	0.05
Milk composition (%):						
Fat	1	4.57	4.74	4.88	5.01	-
	2	3.98	4.13	4.25	4.36	-
	3	4.25	4.41	4.54	4.66	-
	4	4.56	4.63	4.77	4.89	-
	5	4.69	4.86	5.00	5.14	-
	Mean	4.41^{c}	4.55^{b}	4.69^{a}	4.81^{a}	0.03
Protein	1	2.51	2.66	2.60	2.69	-
	2	2.33	2.46	2.40	2.49	-
	3	2.43	2.57	2.51	2.60	-
	4	2.55	2.70	2.64	2.73	-
	5	2.68	2.83	2.77	2.87	-
	Mean	2.50^{c}	2.64^{ab}	2.58^{b}	2.68^{a}	0.01
Lactose	1	4.20	4.26	4.36	4.41	-
	2	4.01	4.07	4.17	4.22	-
	3	4.09	4.15	4.25	4.30	-
	4	4.29	4.36	4.46	4.51	-
	5	4.51	4.58	4.69	4.74	-
	Mean	4.22^{b}	4.28^{b}	4.39^{a}	4.44^{a}	0.02
SNF	1	7.42	7.64	7.69	7.82	-
	2	7.03	7.23	7.28	7.41	-
	3	7.22	7.43	7.48	7.61	-
	4	7.56	7.78	7.83	7.97	-
	5	7.92	8.15	8.20	8.35	-
	Mean	7.43^{c}	7.64^{b}	7.70^{ab}	7.84^{a}	0.03
Total solids	1	11.99	12.38	12.57	12.83	-
	2	11.01	11.36	11.53	11.77	-
	3	11.47	11.84	12.02	12.27	-
	4	12.02	12.41	12.60	12.86	-
	5	12.60	13.01	13.21	13.48	-
	Mean	11.84^{c}	12.19^{b}	12.39^{ab}	12.65^{a}	0.06
Ash	1	0.71	0.72	0.73	0.72	-
	2	0.69	0.70	0.71	0.70	-
	3	0.70	0.71	0.72	0.71	-
	4	0.71	0.72	0.73	0.72	-
	5	0.73	0.74	0.75	0.74	-
	Mean	0.71^{b}	0.72^{ab}	0.73^{a}	0.72^{ab}	0.002

a, b, c: Values within the same row with different superscripts are significantly different at P<0.05. ADMY: Average daily milk yield (kg/day).

Table 4: Effect of rumen protected methionine and/or choline additives /on body weight of Zaraibi goats.

Period (day)	Experimental group				SEM
	Control	RPM	RPC	RPM+RPC	
Before kidding					
60	33.62	33.56	33.48	33.46	0.68
45	33.84	33.91	33.97	34.18	0.73
30	34.57[b]	34.91[a]	35.16[a]	35.45[a]	0.79
15	35.45[b]	36.45[a]	36.87[a]	37.20[a]	0.91
At kidding	29.65[b]	30.90[a]	31.93[a]	32.10[a]	0.62
After kidding					
15	30.24[b]	31.52[a]	32.57[a]	32.74[a]	0.64
30	30.85[b]	32.15[a]	33.22[a]	33.40[a]	0.65
45	31.46[b]	32.79[a]	33.88[a]	34.06[a]	0.66
60	32.09[b]	33.45[a]	34.56[a]	34.75[a]	0.67
75	32.74[b]	34.12[a]	35.25[a]	35.44[a]	0.69
90	33.39[b]	34.80[a]	35.96[a]	36.15[a]	0.70

a, b, c: Values within the same row with different superscripts are significantly different at P<0.05.

Table 5: Effect of rumen protected methionine and/or choline additives on some parameters in blood serum of Zaraibi goats.

Item	Experimental group				SEM
	Control	RPM	RPC	RPM+RPC	
Total protein (g/dl)	6.96[c]	7.63[b]	7.27[bc]	8.05[a]	0.13
Albumin (g/dl)	3.14[c]	3.52[b]	3.41b[c]	3.87[a]	0.08
Globulin (g/dl)	3.82[b]	4.12[a]	3.85[b]	4.18[a]	0.05
AST (IU/l)	38.82	38.88	39.05	39.19	0.47
ALT (IU/l)	18.80	18.99	19.20	19.42	0.24

a, b, c: Values within the same row with different superscripts are significantly different at P<0.05.

Similarly, El-Ganiny *et al*. (2007) found that RPM increased TP, AL and GL in plasma of lactating cows. On the other hand, activity of AST and ALT was nearly similar in all groups, being within the normal range (40 and 70 IU/L) as reported by Kaneko (1989), indicating that RPM and RPC additives had no disorder effects on liver enzyme activity**.**

Feed intake and economic efficiency:

Feed intake presented in Table (6) revealed that the total DM intake was nearly the same for the different groups. These results agreed with those obtained by Wang *et al.* (2010) who found no significant difference in dry matter intake across treatment groups due to methionine supplementation. While, the RPM+RPC group showed significantly (P<0.05) the highest total TDN and DCP intakes followed by RPM and RPC groups, while the control group had the lowest intakes. Rumen protected methionine and/or choline additives improved feed conversion, which the RPM+RPC group showed significantly (P<0.05) the lowest amounts of DM, TDN and DCP required per kg milk followed by RPM and RPC groups, while the control group had the highest values. These results are in agreement with those obtained by El-Ganiny *et al.* (2007) who reported that cows fed rations supplemented with protected methionine were more efficient than those fed unsupplemented rations. Mohsen *et al.* (2011) found that rumen protected choline supplementation increased TDN and DCP intakes and decreased the quantities of DM, TDN and DCP per kg milk.

The total feed cost was nearly similar for the different groups as shown in Table (6). While, rumen protected methionine and/or choline additives significantly (P<0.05) improved the total and net revenue. The RPM+RPC group recorded significantly (P<0.05) the highest net revenue improvement followed by RPM and RPC groups, while the control group had the lowest values. The net revenue for RPM, RPC and RPM+RPC increased by 30.02, 18.71 and 49.50% compared to control group, respectively.

Table 6: Effect of rumen protected methionine and/or choline additives on feed intake and economic feed efficiency of Zaraibi goats.

Item	Experimental group				SEM
	Control	RPM	RPC	RPM+RPC	
Concentrate feed mixture:					
Intake (kg/head)	120	120	120	120	-
Price (LE/head)	273	273	273	273	-
Barley grains:					
Intake (kg/head)	30	30	30	30	-
Price (LE/head)	54	54	54	54	-
Berseem:					
Intake (kg/head)	750	750	750	750	-
Price (LE/head)	105	105	105	105	-
Additives:					
Intake (kg/head)	0.0	0.3	0.3	0.6	-
Price (LE/head)	0	9	3	12	-
Total DM intake (kg/h)	266.05	266.35	266.35	266.65	1.31
Total TDN intake (kg/h)	168.84^{b}	176.11^{a}	173.63^{ab}	178.76^{a}	1.36
Total DCP intake (kg/h)	26.92^{c}	28.31^{ab}	27.67^{bc}	28.88^{a}	0.25
Total milk yield (kg/h)	321.00^{c}	382.50^{b}	361.50^{b}	421.50^{a}	11.55
DM kg/kg milk	0.83^{a}	0.70^{c}	0.74^{b}	0.63^{d}	0.04
TDN kg/kg milk	0.53^{a}	0.46^{b}	0.48^{b}	0.42^{c}	0.03
DCP g/kg milk	83.86^{a}	74.01^{b}	76.54^{b}	68.52^{c}	1.73
Total feed cost (LE/h)	432.00	441.00	435.00	444.00	2.59
Total revenue (LE/h)	995.10^{c}	1185.80^{b}	1120.60^{b}	1306.60^{a}	35.82
Net revenue (LE/h)	563.10^{c}	744.80^{b}	685.60^{b}	862.60^{a}	33.86
Net revenue (%)	00.00^{d}	32.27^{b}	21.75^{c}	53.19^{a}	5.82

a, b, c: Values within the same row with different superscripts are significantly different at P<0.05. Price of one ton was 2275 LE for concentrate feed mixture, 1800 LE for barley grains, 140 LE for berseem and one kg was 30 LE for protected methionine, 10 LE for protected choline and 3.10 LE for milk.

These results are in accordance with those obtained by El-Ganiny *et al.* (2007) who found that animals fed rations supplemented with protected methionine were more economically efficient than those fed unsupplemented rations. Mohsen *et al.* (2011) reported that the income of milk yield increased with rumen protected choline supplementation.

CONCLUSION

Adding 2 g/head/day rumen protected methionine plus 2 g/head/day rumen protected choline for Zaraibi goats showed the best results concerning the feed intake, digestibility, milk yield and composition, blood serum proteins, feed conversion and economic efficiency.

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تأثير إضافة المثيونين و/أو الكولين المحمى فى الكرش على أداء الماعز الزرايبى:
١- الأداء الإنتاجى للماعز الحلاب

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استخدم فى هذه الدراسة ٤٠ من الماعز الزرايبى متوسط وزنها ٣٤.٦٤±٠.٧٩ كجم وعمر ٣-٤ سنوات قسمت إلى ٤ مجموعات متماثلة (١٠ بكل منها)٠ غذيت الماعز خلال الفترة من فى الشهرين الأخيرين من الحمل حتى الشهر الخامس من الحليب على العليقة الأساسية المكونة من ٠.٨ كجم مخلوط علف مركز + ٠.٢ كجم حبوب شعير + ٥.٠ كجم برسيم بدون إضافة (مجموعة المقارنة) أو مع إضافة ٢ جم/رأس/يوم مثيونين محمى فى الكرش (مجموعة المثيونين المحمى) أو مع إضافة ٢ جم/رأس/يوم كولين محمى فى الكرش (مجموعة الكولين المحمى) أو مع إضافة ٢ جم/رأس/يوم مثيونين محمى فى الكرش+ ٢ جم/رأس/يوم كولين محمى فى الكرش (مجموعة المثيونين+الكولين المحمى).

أظهرت النتائج تماثل المادة الجافة المأكولة بواسطة الماعز فى كل المجموعات٠ حققت مجموعة مجموعة المثيونين+الكولين المحمى معنويا عند مستوى ٠.٠٥ أعلى قيم لمعاملات الهضم والقيم الغذائية٠ زيادة إنتاج اللبن فى مجموعات المثونين المحمى، الكولين المحمى، المثيونين+الكولين المحمى بمقدار ١٨.٣٩، ١١.٢١، ٣٠.٠٤% عنه فى مجموعة المقارنة على التوالى٠ ارتفاع محتوى مكونات اللبن المختلفة معنويا عند مستوى ٠.٠٥ فى مجموعة المثيونين+الكولين المحمى٠ زيادة إنتاج اللبن مع تقدم الحليب من الشهر الأول الى الثانى ثم يقل بعد ذلك، بينما أظهر تركيب اللبن اتجاه مضاد٠ أدت إضافة المثيونين والكولين المحمى إلى حدوث زيادة معنوية عند مستوى ٠.٠٥ فى وزن الماعز أثناء الفترات المختلفة عن مجموعة المقارنة٠ ارتفاع تركيز البروتينات الكلية والألبيومين والجلوبيولين فى سيرم الدم معنويا عند مستوى ٠.٠٥ فى مجموعة المثيونين+الكولين، بينما لم تظهر إضافة المثيونين والكولين المحمى أى تأثير سلبى على نشاط أنزيمات الكبد٠ كانت كمية المادة الجافة الكلية المأكولة وتكلفة التغذية الكلية متماثلة تقريبا للمجموعات المختلفة٠ ارتفاع المأكول كلى من المركبات الكلية المهضومة والبروتين المهضوم معنويا عند مستوى ٠.٠٥ فى مجموعة المثيونين+الكولين المحمى٠ بينما انخفضت كمية كل من المادة الجافة، المركبات الكلية المهضومة والبروتين المهضوم اللازمة لإنتاج ١ كجم لبن معنويا عند مستوى ٠.٠٥فى مجموعة المثيونين+الكولين المحمى٠ لذلك ارتفع العائد الكلى والصافى وتحسن العائد الصافى معنويا عند مستوى ٠.٠٥ فى مجموعة المثيونين+الكولين المحمى٠ زيادة العائد الصافى فى مجموعات المثونين المحمى، الكولين المحمى، المثيونين+الكولين المحمى بمقدار ٣٠.٠٢، ١٨.٧١، ٤٩.٥٠% عنه فى مجموعة المقارنة على التوالى٠

نستخلص من هذه الدراسة أن إضافة ٢ جم مثيونين محمى فى الكرش + ٢ جم كولين محمى فى الكرش للرأس يوميا للماعز الزرايبى أثناء الشهرين الأخيرين من الحمل حتى الشهر الخامس من الحليب حققت أفضل النتائج من حيث كمية الغذاء المأكول، الهضم وإنتاج وتركيب اللبن وبروتينات الدم ومعدل التحويل الغذائى والكفاءة الاقتصادية٠

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