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EFFECT OF RUMINAL DEGRADABILITY OF CRUDE PROTEIN AND NON STRUCTURAL CARBOHYDRATES ON THE PERFORMANCE OF LACTATING GOATS:
2. FEED DIGESTIBILITY, SOME BLOOD CONSTITUENTS AND MILK PRODUCTION AND ITS COMPOSITION

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ABSTRACT

Twenty four lactating Zaraibi goats in mid lactation were used in a 2 x 2 factorial experimental design to evaluate two different sources of ruminally degradable non structural carbohydrates (high and low RDNSC) and two different sources of ruminally degradable protein (high and low RDP). Four experimental diets were formulated to study their effects on digestion coefficients, some blood constituents and milk production and its composition.

The obtained results indicated that digestibility coefficients for DM, OM, CP and NFE and the nutritive value in terms of TDN and DCP% were significantly (P<0.05) higher for goats received low RDP and high RDNSC diets than those received high RDP and low RDNSC diets. The concentration of plasma urea-N was decreased (P<0.05) when goats were fed low RDP diets than those fed high RDP ones, whereas the concentrations of total protein, albumin and globulin were increased indicating once more better utilization of low RDP. Regardless the RDP, plasma urea-N was significantly (P<0.05) lower in goats fed high RDNSC diets than in those fed low RDNSC diets.

Yields of milk, 4% fat-corrected milk (4%-FCM) and milk components were higher (P<0.05) when goats fed low RDP diets than those fed high RDP ones. Milk non-protein-nitrogen (NPN) was lower (P<0.05) with low RDP diets. On the other hand, yield of true protein nitrogen, casein nitrogen, whey nitrogen and unsaturated fatty acids in milk were higher (P<0.05) with goats fed low RDP than those fed high RDP. Regardless the RDP content of the tested diets, a slight improvement in milk yield and 4%-FCM detected for goats given high RDNSC diets compared to those given low RDNSC ones without significant differences. Goats received low RDP with high RDNSC (diet 4) were higher and more persistent for milk yield during the experimental period. On the other hand goats received diets contained high RDP with high RDNSC produced the lowest milk yield.

Keywords: Goats, live weight, milk production, milk protein fractions, milk fatty acids, degradability, NSC, intake, digestibility, blood constituents.

INTRODUCTION

While formulating diets for dairy animals, the attention must be paid towards the importance of synchronization between ruminal degradability of NSC and rumen degradable protein (RDP) to maximize microbial protein synthesis which supports animals' growth and milk production. Since Clark *et al.* (1992); Hoover and Stokes (1991); Nocek and Russell (1988) and Nocek and Tamminga (1991) reported that bacterial-N and microbial protein synthesis have been altered by varying NSC sources and its ratio to RDP for lactating cows.

Varying the source and degradability of nonstructural carbohydrates (NSC) and rumen degradable protein (RDP) in the first part of this series of experimental (El-Deeb *et al.*, 2010) was found to increase efficiency of ruminal fermentation thereby reduce the amount of supplemental rumen undegradable protein (RUP) sources needed by lactating dairy animals. High levels of dietary concentrations of NSC have increased the utilization of ruminal NH_3-N for synthesis of microbial protein (Nocek and Russell, 1988 and Nocek and Tamminga, 1991). Hoover and Stokes (1991) reported that decreasing the NSC to RDP ratio increased the quantity of microbial protein synthesized *in vitro* and *in vivo*. Milk yield and its protein can be affected by the amount of CP flow into the small intestine (Hof *et al.*, 1994). In order to elevate available protein supply, undegradable protein must be added to the diet above the amount of microbial protein synthesised in the rumen (NRC, 1989).

Corn and barley are major cereal grains fed to dairy animals. Corn and barley differ in their respective concentrations of fat, fiber, and NSC, and barley starch may be more rapidly fermented in the rumen than is corn starch (McCarthy *et al.,* 1989 and Herrera-Saldana *et al.*, 1990). Some lactation studies (Bilodeau *et al.*, 1989; Casper and Schingoethe, 1989 and McCarthy *et al.,* 1989) compared barley with other ruminally degradable starch sources and reported that there is a decrease in milk production and dry matter intake (DMI). However, milk production and DMI reported to be similar or increased in other studies (Casper *et al.*, 1990; Grings *et al.*, 1992; Herrera-Saldana and Huber, 1989 and Sniffen and Rubinson, 1987). South Dakota researchers (Casper and Schingoethe, 1989 and Casper *et al.*, 1990) demonstrated little benefit when the barley diet contained large amounts of soluble and degradable CP, since they reported that cows fed barley with additional RDP (supplied by urea) had decreased milk production and DMI than did cows fed barley and soybean meal (SBM). Casper *et al.* (1990) suggested that differences in NSC solubility (more so than degradability) may result in differences in animal responses. Perhaps the synchronization of NSC and RDP, by reducing instead of increasing CP degradability, improves performance of lactating dairy cows fed barley-based diets.

On the light of the above mentioned information, the aim of this study was to determine the effect of feedstuffs differed in their source and degradability of its nonstructural carbohydrates (NSC) and rumen degradable protein (RDP) on feed utilization and milk production and its constituents of Zaraibi goats.

MATERIALS AND METHODS

The current investigation was carried out at El-Serw Experimental Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. The same experimental diets, animals and design used in the first part of this series (El-Deeb *et al.*, 2010) were used in the present study to study the influence of degradable protein and non-structural carbohydrate on milk production and its composition. Twenty four Zaraibi goat does after parturition (during lactation period) were assigned to four similar experimental groups (6 does each) taking into account parity, milk yield and their body weights. Animals of each group were housed in stalls (6 x 4 m) and fed in groups. Fresh and clean drinking water was available all times. The experiment started after weaning and began after 10 days of adaptation with the tested diets and lasted for 12 weeks. The experimental design was a 2 x 2 factorial arrangement of the treatments.

Four experimental diets were formulated using local resources of ingredient materials, i.e. corn silage (CS) as roughage, yellow corn grains (low RDNSC) or barley grains (high RDNSC) as tested carbohydrate sources and the tested protein sources were soybean meal (high RDP) and corn gluten (low RDP). The diets (Table 1) consisted of:

1. Low RDNSC and high RDP. 2. High RDNSC and high RDP.
3. Low RDNSC and low RDP. 4. High RDNSC and low RDP.

The tested materials were ground together and mixed with other ingredients to make pellets (6 mm) of concentrate feed mixture (CFM). The experimental diets were formulated to exceed or equal the NRC (1989) recommendations. All animals were fed on the tested diets containing 60% : 40% concentrate : roughage ratio which were hand-mixed just before feeding once daily.

Table 1. Formulation of the experimental diets (% of DM)

Ingredients	High RDP		Low RDP	
	Low RDNSC (Diet 1)	High RDNSC (Diet 2)	Low RDNSC (Diet 3)	High RDNSC (Diet 4)
Whole corn silage, WCS	60	60	60	60
Corn gluten meal, CGM	-	-	14	14
Barley grain, BG	-	18	-	24
Corn grain, CG	18	-	24	-
Soybean meal, SBM	20	20	-	-
Limestone	1.1	1.1	1.1	1.1
Salt	0.5	0.5	0.5	0.5
Di-calcium phosphate	0.2	0.2	0.2	0.2
Minerals and vitamins mixture*	0.2	0.2	0.2	0.2

*** Each Kg contained P, 40 g, Ca, 50 g, Mg. 50 g, Mn, 4.5 g, S, 12 g, Fe, 7 g, Cu, 2 g, Se, 12 mg, Co, 50 mg, vitamin A, 2000000 IU, vitamin D, 20000 IU and vitamin E, 20 mg (Biomix 33, Produced by Biochema, A.R.E., Cairo).**

Samples of the four tested diets (Table 2) were analyzed for dry matter, ash, crude fiber, crude protein and ether extract according to AOAC (1990). The NDF % was analysed according to Robertson and Van Soest (1981) and the NSC % was calculated according to Calsemiglia *et al.* (1995).

Metabolism trials were carried out at the end of the feeding experiment using 3 random animals from each group to determine the digestion coefficients and nutritive values of the tested diets used in the feeding trial. Fecal samples were gripped from the rectum of each animal twice daily during the collection period (5 days). Acid insoluble ash (AIA) was used as a natural marker (Van Keulen and Young, 1977).

Animals were hand milked twice daily and milk yield of individual animals was recorded at each milking. Milk was sampled biweekly form two consecutive milkings, and composited according to milk yield. Composite milk samples were analyzed for contents of total solids (TS), ash, fat, total nitrogen (TN), non-casein nitrogen (NCN), and non-protein nitrogen (NPN).

Total solids in milk were determined by drying at 105°C for 4 hours to a constant weight, milk fat was analyzed following the Gerber method (British Standard Institution's Method, 1955), and protein was analyzed using the Kjeldahl method (N x 6.38). Lactose was determined by difference after ashing in a muffle furnace (Model RHF, 1200, England) at 750°C for 4 hours. Solids-not fat (SNF) were calculated as the difference between TS and fat. Non-casein nitrogen (NCN) was determined by Kjeldahl analysis of the filtrate by using Whatman paper No. 42 after precipitation with 10% acetic acid and 1 N sodium acetate (Ling, 1963). Non-protein nitrogen (NPN) was determined by Kjeldahl analysis of the filtrate by using Whatman paper No. 42 after precipitation with 15% trichloroacetic acid, TCA (Ling, 1963).

Casein-N was calculated as the difference between TN and NCN, true protein-N was calculated as the difference between TN and NPN. Whey N was calculated as the difference between true protein-N and casein-N.

Methyl esters of fatty acids of milk lipids were analyzed according to the method described by Chouinard *et al.* (1997).

During the last week of the experimental period, blood samples were collected in heparinized test tubes from the jugular vein from three animals of each group before morning feeding, 2 and 4 hours post-feeding. Blood samples were centrifuged immediately at 3500 revolution per minute (rpm) for 15 minutes to separate blood plasma and stored at -20°C until further analysis. Blood plasma was analyzed for urea-N (Patton and Crouch, 1977), total protein (Peters, 1968), and albumin (Webster, 1974). Globulin concentration was calculated by difference (total protein-albumin).

Data were subjected to statistical analysis by the computer program of SAS (1996) using the General Linear Model (GLM). The data of digestibility coefficient and milk yield and its components were subjected to analysis of variance for examing of effects of treatments ($diet_1$, $diet_2$, $diet_3$ and $diet_4$) and high and low (rumen degradable protein, RDP and rumen degradable non structural carbohydrates, RDNSC) and their interaction according to the following model:

$Y_{ijk}= U+P_i+D_j+PD_{ij}+eijk$.

where: Y_{ijk}= observed traits, U= overall mean, P_i= effect of RDP and RDNSC 1-4 (1= high RDP, 2= low RDP, 3= high RDNSC, 4= low RDNSC), D_j= effect of experimental diets 1-4 (1=$diet_1$, 2= $diet_2$, 3= $diet_3$, 4= $diet_4$), PD_{ij}= interaction, eijk= Random error.

The data of blood metabolites was subjected to analysis of variance for examing of effects of treatments ($diet_1$, $diet_2$, $diet_3$ and $diet_4$) and high and low (RDP and RDNSC) and time of samping (0,2 and 4 hours) and their interaction according to the following model:

$Y_{ijkl}= U+ P_i+ D_j+T_k+PD_{ij}+PT_{ik}+DT_{jk}+ PDT_{ijk}+e_{ijkl}$

where: Y_{ijkl} = observed traits, U= overall mean, P_i= effect of RDP and RDNSC 1-4 (1= high RDP, 2= low RDP, 3= high RDNSC and 4= low RDNSC),D_j=

effect of experimental diets 1-4, T_k= time of sampling, PD_{ij}= interaction RDP and RDNSC X experimental diets, PT_{ik}= interaction RDP and RDNSC X time of sampling, DT_{jk}= interaction experimental diets X time of sampling, PDT_{ijk}= interaction RDP and RDNSC X experimental diets X time of sampling, e_{ijkl}= Random error. Means were compared according to Duncan's Multiple Range Test at 0.05 level (Duncan, 1955). It was found that the interactions not significant, the main effects will by only presented in the results and discussion.

RESULTS AND DISCUSSION

The results presented in Table 2 show that the chemical analysis of different ingredient used in this study were within the normal range of similar materials as discussed and reviewed previously by (Mehrez, 1992; Mabjeesh *et al,* 1997; El-Badawi *et al.* 2001; El-Shabrawy, 2000 and El-Shabrawy and El-Fadaly, 2006). The calculated chemical composition of the tested formulated diets using these ingredients seemed similar in all nutrients, except for NSC which was higher in diet 3 and was lower in diet 2 and this could be attributed to its variable content in both corn grain (74.63) and barley grain (66.37).

Regarding the dry matter intake (DMI), organic matter intake (OMI) and crude protein intake (CPI), data in Table 3 showed that there were similar in the four tested groups with averages of 1567, 1450 and 233 g/h/d. However, the RDP as % of CPI decreased when gluten replaced SBM in diets 3 and 4 since the degradability of corn gluten meal CP is lower than that of SBM (Mabjeesh *et al.*, 1997 and Casper *et al.*, 1999).

Table 2. Chemical composition of the tested ingredients and the experimental diets

Ingredients	DM (%)	Chemical composition on DM basis (%)							
		OM	CP	EE	CF	NFE	Ash	NDF	NSC*
WCS	26.04	92.92	8.23	2.30	25.70	56.69	7.08	45.40	36.99
CGM	91.21	97.98	53.36	1.90	2.80	39.92	2.02	14.15	28.57
BG	89.43	97.52	9.30	1.85	7.10	79.27	2.48	20.00	66.37
CG	87.50	98.10	9.11	2.35	2.70	83.94	1.90	12.01	74.63
SBM	89.92	93.20	42.48	3.40	6.21	41.11	6.80	14.25	33.07
Calculated chemical composition of the tested diets									
1	49.35	92.05	15.07	2.48	17.15	57.35	7.95	32.25	42.23
2	49.69	91.94	15.10	2.39	17.94	56.51	8.06	33.69	40.75
3	49.39	93.01	14.60	2.21	16.46	59.74	6.99	32.10	44.10
4	50.85	92.87	14.64	2.29	17.51	58.43	7.13	34.02	42.12

*** NSC % = 100 – (NDF% + CP% + Fat% + Ash%). Calsemiglia *et al.* (1995)**

Moreover, the calculated RDNSC was higher in diets 2 and 4, while recorded lower values in diets 1 and 3. This could be referred back to the higher content of barley grain which its starch may be more rapidly fermented in the rumen than is corn starch (McCarthy *et al.,* 1989; Herrera-Saldana *et al.*, 1990 and Mabjeesh *et al.*, 1997).

Table 3. Intake and rumen degradability for some elements of the experimental diets.

Items	Experimental diets			
	1	2	3	4
Total DM intake, g/head/day	1550	1570	1560	1590
Total OM intake, g/head/day	1427	1443	1451	1477
Total CP intake, g/head/day	234	237	228	233
RDP intake, g/head/day	150	158	101	110
RDP% from DM intake	9.68	10.06	6.47	6.92
RDP* % from CP intake	64.10	66.67	44.29	47.21
Total NSC intake, g/head/day	655	640	688	670
RDNSC intake, g/head/day	473	558	457	572
RDNSC% from DM intake	30.52	35.54	29.29	35.97
RDNSC* % from NSC intake	72.21	87.19	66.42	85.37

*** Rumen degradable protein (RDP) and non-structural carbohydrate (RDNSC) calculated according to Mabjeesh *et al.* (1997).**

Regardless the NSC content of the tested diets, data in Table 4 revealed that the digestibility coefficients of DM, OM, CP and NFE significantly ($P<0.05$) increased for goats fed low rumen degradable protein, low RDP compared to those fed high rumen degradable protein, high RDP. The feeding values expressed as TDN and DCP followed the same trend of digestibility coefficients. The DCP values were higher ($P<0.05$) in diets low in RDP than diets high in RDP. The higher DCP was probably because of higher CP digestibility. Meanwhile, no significant ($P<0.05$) effect on EE and CF digestibilities for goats fed diets with low RDP or those fed diets with high RDP. The diets contained low RDP was higher by about 3.96% for CP digestibility than diets contained high RDP. The obtained results in this study were close to the previous findings reported by El-Shabrawy *et al.* (2004) who found that feeding goats on diet containing formaldehyde treated alfalfa silage (low RDP) increased CP digestibility by 4.19% compared to those fed the diet contained untreated alfalfa silage (high RDP). On the other hand, no significant effect ($P<0.05$) on EE and CF digestibility for goats received low or high RDNSC.

Regarding the effect of RDNSC, data in Table 4 revealed that digestibility coefficients of nutrients in terms of DM, OM, CP and NFE increased significantly ($P<0.05$) for goats given high RDNSC compared to those fed low RDNSC. Within the same context, the TDN and DCP showed to be significantly ($P<0.05$) affected with high RDNSC sources of the tested diets more than the low RDNSC sources, since it gave the highest values (67.79 and 11.09) with high RDNSC *Vs.* the lowest values (66.70 and 10.76) with low RDNSC.

The diet contained high RDNSC was higher by about 2.63% for CP digestibility than the diet contained high RDP. The obtained results in the present study were close to the previous findings reported by Rotger *et al.* (2006). These results are also on line with those obtained by Surber and Bowman (1998) who reported greater total tract DM and OM digestibility for barley than corn based diets fed to steers. However, Khorasani *et al.* (2001) did not observe any differences in the apparent total tract digestibility of corn compared with barley.

Table 4. Effect of protein and carbohydrate sources and their formulated diets on digestion coefficients (%) and nutritive values by Zaraibi goats

Item	Experimental diets				SEM	RDP*		RDNSC**		SEM
	1	2	3	4		High	Low	High	Low	
DM	64.10	66.51	69.07	69.42	0.47	65.31[b]	69.25[a]	67.97[a]	66.59[b]	0.33
OM	66.28	68.41	71.09	71.42	0.37	67.35[b]	71.25[a]	69.91[a]	68.69[b]	0.26
CP	70.65	73.17	74.51	77.24	0.32	71.91[b]	75.87[a]	75.21[a]	72.58[b]	0.23
EE	66.31	66.43	66.61	65.73	0.45	66.37	66.17	66.08	66.46	0.32
CF	65.48	66.37	65.10	65.70	0.56	65.93	65.40	66.04	65.29	0.39
NFE	69.47	70.65	72.03	73.46	0.54	70.06[b]	72.75[a]	72.05[a]	70.75[b]	0.38
TDN	65.46	66.45	67.94	69.12	0.31	65.96[b]	68.53[a]	67.79[a]	66.70[b]	0.22
DCP	10.65	11.05	10.88	11.31	0.05	10.85[b]	11.09[a]	11.18[a]	10.76[b]	0.03

*** RDP = Rumen degradable protein ** RDNSC = Rumen degradable non structural carbohydrate**

a, b means within the same row within each category having different superscripts are significantly different at P<0.05.

Although there were higher response in DM, OM, CP and NFE for goats given diets contained high RDNSC than those given diets contained low RDNSC, El-Badawi *et al.* (2001) reported that feeding lambs on diets containing barley decreased OM, CP and NFE than those fed on diets containing corn. The reverse was true for TDN% and DCP% since they were higher in case of high RDNSC containing diets. This could be explained by the increase in the favourable N source for rumen microbes beside the higher available carbohydrates which may lead to more fermentation so that it increased the efficiency of microbial protein synthesis. These results are in harmony with the findings of Rotger *et al.* (2006).

The above mentioned results clearly indicated that the digestibility coefficients of different nutrients are varying according to the extent and degree of availability of nitrogen sources and carbohydrate together in the rumen of animals. In this concern, El-Shabrawy (2000) reported that reducing protein solubility and degradability in the rumen could provide more dietary protein for digestion and absorption in the small intestine. Moreover, although greater intake compensate for lower digestibility, nutrients apparent digestibility along the whole alimentary tract is reflection of fermentation in the rumen in terms of N-availability for rumen microbes as a result of RUP and the synergy between NSC and RDP contents in the diet (Thomson *et al.*, 1991). Also, El-Deeb *et al.* (2005) concluded that increasing in the diet NSC content with low RDP enhanced fermentation in the rumen and improving feed utilization compared to that contained high RDP.

The effect of experimental diets and effects of RDP and RDNSC and sampling times on some blood constituents are presented in Table 5. Regarding the effect of RDP, a significant (P<0.05) reduction in plasma urea-N concentration was obtained with goats fed low RDP diets (23.87 mg/100 ml) than those in goats fed high RDP diets (35.87 mg/100 ml). The results obtained in the present investigation are similar to the previous findings reported by El-Shabrawy (2006) who found that feeding goats on diet contained formaldehyde treated-SBM (low RDP) reduced plasma urea compared to those fed the diet contained untreated-SBM (high RDP).

The reduction in blood urea-N concentration for goats given diets contained low RDP may be due to the decrease in RDP, consequently decreased NH_3-N concentrations in the rumen liquor (El-Shabrawy, 2006 and El-Deeb *et al.*, 2010). Plasma urea-N concentration in the present study followed a pattern similar to that of milk NPN concentration (Table 6), whereas higher (P<0.05) values of total protein and its fractions (albumin and globulin) were recorded for goats given low RDP diets than those given high RDP diets. The results obtained in this study were close to the previous findings reported by El-Shabrawy (2000) and El-Shabrawy (2006) who found significantly higher level of protein in plasma of animals fed protected protein. This may be due to lower RDP, which consequently may increased amino acids supply in the small intestine.

Table 5. Effect of protein and carbohydrate sources and their formulated diets on some blood constituents of Zaraibi goats.

Item	Experimental diets				SEM	RDP		RDNSC		SEM	Time Effect
	1	2	3	4		High	Low	High	Low		
Urea nitrogen:											
0 hr	39.75	39.00	29.50	28.25	0.77	39.37	28.87	33.63	34.63	0.55	34.13^{a}
2 hr	34.25	36.00	19.50	18.00		35.13	18.75	27.00	26.88		26.94^{c}
4 hr	36.50	29.75	24.50	23.50		33.13	24.00	26.63	30.50		28.56^{b}
Treatment Effect	36.83^{a}	34.92^{a}	24.50^{b}	23.25^{b}	1.18	35.87^{a}	23.87^{b}	29.08^{b}	30.67^{a}	0.32	
Total protein:											
0 hr	6.56	6.55	7.48	7.49	0.05	6.56	7.48	7.02	7.02	0.03	7.02^{ab}
2 hr	6.59	6.55	7.51	7.39		6.57	7.45	6.67	7.05		7.01^{b}
4 hr	6.53	6.64	7.56	7.52		6.63	7.54	7.08	7.09		7.08^{a}
Treatment Effect	6.59^{b}	6.58^{b}	7.51^{a}	7.47^{a}	0.03	6.59^{b}	7.49^{a}	7.02	7.05	0.02	
Albumin:											
0 hr	3.51	3.53	3.09	4.09	0.03	3.52	4.09	3.81	3.80	0.02	3.81
2 hr	3.53	3.54	4.10	4.07		3.53	4.09	3.81	3.81		3.81
4 hr	3.53	3.59	4.13	4.09		3.56	4.11	3.84	3.80		3.83
Treatment Effect	3.52^{b}	3.55^{b}	4.11^{a}	4.09^{a}	0.02	3.54^{b}	4.09^{a}	3.82	3.81	0.01	
Globulin:											
0 hr	3.05	3.03	3.38	3.39	0.05	3.04	3.39	3.21	3.22	0.03	3.21
2 hr	3.06	3.01	3.41	3.32		3.04	3.37	3.17	3.24		3.20
4 hr	3.10	3.05	3.43	3.42		3.08	3.42	3.24	3.26		3.25
Treatment Effect	3.07^{b}	3.03^{b}	3.41^{a}	3.37^{a}	0.03	3.05^{b}	3.39^{a}	3.20	3.24	0.02	

a, b means within the same row and column within each parameter category having different superscripts are significantly different at P<0.05.

Concerning the effect of RDNSC, lower significant (P<0.05) values of urea-N were recorded for goats given diets contained high RDNSC than those given diets contained low RDNSC. On the other hand, no significant effect was found on total protein and its fractions of goats received diets with high or low RDNSC. The reduction in blood urea-N for goats given diets contained high RDNSC (barley) compared to those given diets contained low RDNSC (corn) may be due to the improvement in ruminal fermentation with diets contained barley (high RDNSC) compared to those contained corn (low RDNSC), consequently decreased NH_3-N concentration in the rumen (Rotger *et al.*, 2006). The present results came on line with those reported by

Mabjeesh *et al.* (1997) and El-Shabrawy *et al.* (2004) who found a close positive relationship between blood urea-N level and ruminal NH_3-N concentration.

Although the data in Table 6 showed that the experimental animals were within the same range of initial live body weight (without significant differences) and finished the experimental period without significant difference in their final live body weights, there was significant (P<0.05) positive change by about 3.8 Kg for goats in the fourth group which was receiving low RDP with high RDNSC compared to the other two first groups which was receiving high RDP either with low RDNSC or high RDNSC. The noticed change in live body weight for the fourth group could be attributed to the availability for high level of RDNSC, but not for protein degradability, since the other three groups which received different sources of degradable nitrogen did not show any significant differences among them. These results could be supported by findings of Bruckental *et al*. (1996) who noticed a decreases in body weight and body condition score (P<0.05) for dairy cows fed low RUP than those fed high RUP in early lactation. They suggested that the additional supply of RUP in their study might be responsible for the earlier recovery of body condition score of the cows fed HRUP as compared with the cows fed LRUP.

Table 6. Effect of protein and carbohydrate sources and their formulated diets on body weight change, milk yield and milk components of Zaraibi goats.

Item	Experimental diets				SEM	RDP		RDNSC		SEM
	1	2	3	4		High	Low	High	Low	
B W change (Kg/head)	1.80	2.00	2.80	3.80	0.52	1.92	3.29	2.92	2.29	0.39
Milk yield (g/day)	1001	963	1121	1250	70.3	982[b]	1185[a]	1106	1061	49.7
FCM (g/day)	984	950	1104	1123	64.0	967[b]	1162[a]	1086	1043	45.2
Fat										
%	3.77	3.80	3.84	3.79	0.15	3.79	3.81	3.79	3.81	0.11
g/day	37.89	36.65	42.55	47.20	2.59	37.27[b]	44.87[a]	41.92	40.22	1.83
Protein										
%	3.58	3.59	3.70	3.65	0.06	3.59	3.68	3.62	3.64	0.04
g/day	35.84	34.64	41.41	45.64	2.04	35.24[b]	43.52[a]	40.14	38.62	1.87
Lactose										
%	4.77	5.04	4.88	4.70	0.12	4.91	4.79	4.87	4.83	0.09
g/day	47.81	48.57	54.94	58.81	3.83	48.19[b]	56.88[a]	53.69	51.37	2.71
Solids not fat (SNF)										
%	9.03	9.36	9.30	9.02	0.12	9.19	9.16	9.19	9.17	0.08
g/day	90.84	90.10	104.35	112.69	6.72	90.32[b]	108.52[a]	101.43	97.42	4.75
Total solids (TS)										
%	12.80	13.17	13.15	12.80	0.21	12.98	12.97	12.98	12.97	0.15
g/day	128.37	126.81	146.89	159.89	8.98	127.59[b]	153.39[a]	143.35	137.63	6.35
Ash										
%	0.68	0.72	0.72	0.66	0.03	0.70	0.69	0.69	0.70	0.02
g/day	6.84	6.96	8.00	8.24	0.49	6.89[b]	8.12[a]	7.60	7.42	0.34

a, b means within the same row for each effect having different superscripts are significantly different at P<0.05.

Higher response in daily milk yield (Table 6), estimated by 250, 290 and 130 g/d, were recorded for goats fed diet 4 than those fed diets 1, 2 and 3, respectively. The 4% fat corrected milk (FCM) took the same trend of milk yield. Concerning the effect of RDP on milk and 4% FCM yields, there were significant (P<0.05) improving effect with goats fed low RDP than those fed high RDP being 1185 and 1162 g/d *Vs.* 982 and 967 g/d, respectively.

On the same flock of Zaraibi goats, El-Shabrawy (2006) showed that milk yield and 4% FCM were improved by 14% and 11.5% for goats fed soybean meal treated with formaldehyde than those fed untreated one. Similarly, Abo-Donia *et al.* (2003) and El-Shabrawy *et al.* (2004) noticed an increase in milk production in lactating animals fed the heated soybean seeds or formaldehyde treated alfalfa silage as compared to those fed the untreated ones. These results are also in agreement with the previous results of El-Shabrawy and El-Fadaly (2006) who found an increase in milk yield and 4% FCM in dairy animals fed low RDP than those fed high RDP.Concerning the effect of RDNSC on milk yield and 4% FCM, there were increments by 45 and 43 g/d without significant differences for goats fed high RDNSC and those fed low RDNSC, respectively. These results are in good agreement with Chanjula *et al.* (2004) who showed that milk yield and 3.5% FCM were higher for lactating cows fed diet of *Cassava*-based concentrate (high RDNSC) than those fed diet of *Corn*-based concentrate (low RDNSC). Moreover, the results obtained herein are in agreement with the previous results of Grings *et al.* (1992) since they found no differences in milk production between cows fed diets based on corn or barley. On the other hand, the studies of Casper and Schingothe (1989); Casper *et al.* (1990) and Casper *et al.* (1999) showed greater milk production from cows fed corn than others fed barley.

The results in Figure 1 indicated that milk yield for goats fed diet 4 was increased and maintained higher through the whole experimental period compared to those fed diets 3, 1 and 2, respectively.

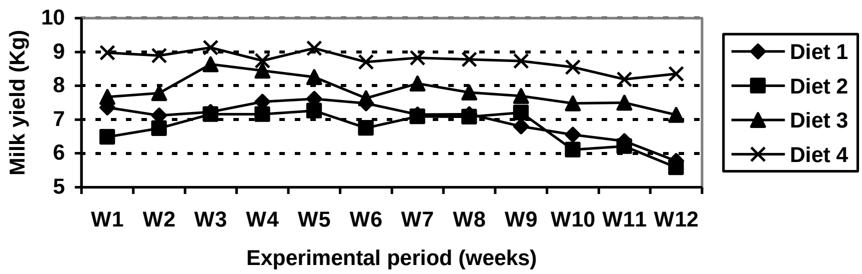

Figure 1. Milk yield during the experimental period of Zaraibi goats fed the tested diets.

The highest milk yield recorded for diet 4 (low RDP and high RDNSC) and the lowest milk yield recorded for diet 2 (high RDP and high RDNSC) could be referred back to the increase of RUP in diet 4 compared to that in diet 2. These results could be explained by the results achieved in the first part of this study by (El-Deeb *et al.*, 2010) who found that RFV, DE, ME and NE_L values were higher in diets contained high RDNSC (barley) than those with low RDNSC (corn) and with low RDP (corn gluten meal) than those with high RDP (SBM). In this concern, Garvin *et al.* (1997) and El-Shabrawy (2000) found more persistency for milk yield in cows fed high RDP than those fed low RUP.

There were no significant effects on milk composition percentage for goats fed high or low RDP or RDNSC. On the other hand, yields of fat, protein, lactose, SNF and TS milk were greater (P<0.05) for goats fed low RDP than those fed high RDP. These results are in good agreement with Casper *et al.* (1999) and El-Shabrawy (2004) since they reported that milk components yield increased when lactating animals were fed low RDP.

There were no significant differences in milk components yields when goats were fed high or low RDNSC. These results are in agreement with the previous results obtained by McCarthy *et al*. (1989) and Grings *et al.* (1992) who reported similar milk protein, lactose and SNF concentrations among cows fed diets based on corn (low RDNSC) or barley (high RDNSC). In the present study, the increase in RUP improved the yield of milk and its components and this was probably because of higher flow of N and essential amino acids to the intestine (Mabjeesh *et al.*, 1997).

Table 7 presents the effect of feeding the experimental diets and sources of protein and carbohydrate on milk nitrogen fractions. Milk total-N, true protein-N, non-casein-N, casein-N and whey-N were significantly increased (P<0.05) for goats received diets contained low RDP than those received diets contained high RDP. On the other hand, using low RDP diets decreased (P<0.05) NPN content in milk, which reflects dietary differences in RDP (El-Shabrawy *et al.*, 2004 and El-Shabrawy, 2006).

The increase in milk protein content (Table 6) corresponded to an increase in true protein-N content as the casein-N, NCN and whey-N contents in milk increased. These results are in agreement with those obtained by El-Shabrawy *et al.* (2004) and El-Shabrawy (2006).

Table 7. Effect of protein and carbohydrate sources and their formulated diets on milk nitrogen fractions of Zaraibi goats.

Item	Experimental diets				SEM	RDP		RDNSC		SEM
	1	2	3	4		High	Low	High	Low	
Total - N										
%	0.560	0.563	0.580	0.572	0.009	0.562^{b}	0.576^{a}	0.568	0.570	0.007
g/day	5.62	5.43	6.49	7.15	0.41	5.52	6.82	6.29	6.05	0.29
True protein - N										
%	0.529	0.533	0.554	0.547	0.009	0.531^{b}	0.551^{a}	0.539^{b}	0.541^{a}	0.007
g/day	5.29	5.13	6.19	6.84	0.39	5.21	6.52	5.98	5.75	0.28
Non-protein - N										
%	0.031	0.031	0.026	0.025	0.0002	0.031^{a}	0.026^{b}	0.028^{b}	0.029^{a}	0.0002
g/day	0.318	0.298	0.293	0.317	0.02	0.308	0.305	0.307	0.306	0.01
Non-casein – N										
%	0.088	0.087	0.087	0.085	0.001	0.087	0.086	0.086	0.088	0.001
g/day	0.882	0.834	0.976	1.058	0.06	0.86^{b}	1.02^{a}	0.946	0.929	0.04
Casein – N										
%	0.472	0.477	0.493	0.488	0.008	0.47	0.49	0.482	0.483	0.006
g/day	4.73	4.59	5.62	6.09	0.35	4.66^{b}	5.81^{a}	5.34	5.13	0.25
Whey – N										
%	0.056	0.056	0.061	0.059	0.001	0.056^{b}	0.060^{a}	0.058	0.059	0.001
g/day	0.565	0.537	0.681	0.741	0.04	0.55^{b}	0.71^{a}	0.639	0.623	0.03

a, b means within the same row within each category having different superscripts are significantly different at P<0.05.

Milk NPN concentration has been used as an indicator of relative protein to energy intake and efficiency of ruminal N capture (Oltner and Wiktorsson, 1983). Milk NPN concentration in the present study followed a similar pattern of plasma urea-N concentration (Table 5). In this concern, El-Shabrawy *et al.* (2004) found that milk NPN content was lower by 22.0% for goats fed diets contained formaldehyde treated alfalfa silage than those fed on diet containing untreated alfalfa silage. Also, El-Shabrawy (2006) found that milk NPN content decreased by 18.5% in F-SBM diet and by 38.0% in H-SBS diet compared with U-SBM diet.

Decreasing NPN and increasing casein-N of goat's milk as a result of feeding diets containing protected protein (either by formaldehyde or heat) would improve the yield and properties of cheese made from it. Milk containing high casein ratio produces suitable firm curd and so cheese with good body and texture and raise the yield, while increasing of NPN content in milk retard the rennet action and made weak curd and the resultant chesses has low yield and bad properties (Davis, 1965).

No significant effects ($P<0.05$) on TN, true protein-N, NPN, NCN, CN and whey-N contents were found among goats fed low or high RDNSC, but true protein-N % and NPN% were significantly higher with goats fed low RDNSC than those fed diets with high RDNSC.

Generally, the increase in milk true protein-N and casein-N content were associated with decrease in milk NPN for goats fed diets contained low RDP, thus increased the availability of amino acids in the small intestine and improved protein status of the host animal (Chanjula *et al.*, 2004).

Data in Table 8 shows the effect of formulated diets and protein and carbohydrate sources on fatty acids (FA) profile of experimental goats' milk. It is clear that goats given low RDP gave lower ($P<0.05$) saturated FA % than that obtained from goats received diets high in RDP, while the vice versa took place with the % of unsaturated FA with significant ($P<0.05$) differences. These changes in milk FA are similar to those formed by Abo-Donia *et al.* (2003) and El-Shabrawy (2006) when they fed formaldehyde or heated soybean seeds to dairy cows.

The decrease of short and medium chain FA and saturated FA indicated lower *de novo* FA synthesis within the mammary gland (Chouinard *et al.*, 1997). Depressed proportions of short and medium chain FA and saturated FA because of the decrease in *de novo* FA synthesis has been attributed to a direct inhibition of mammary acetyl-coenzyme-A carboxylase activity (Palmquist and Jenkins, 1980). This inhibition may be the result of formulation of *trans* isomers, which is a result from biohydrogenation of long chain and unsaturated FA in the rumen (Griinari *et al.*, 1998) and increased mammary uptake of long chain and unsaturated FA from plasma triacylglycerols (Storry, 1988).

The unsaturated FA increased especially myrisoleic (C14:1) and oleic (C18:1) fatty acids which showed the highest response, whereas the saturated FA were decreased especially myristic (C14) for goats received diet with low RDP. In this concern, Abo-Donia *et al.* (2003) stated that the increase of unsaturated lipids could be through protection from microbial hydrogenation in the rumen.

Table 8. Effect of protein and carbohydrate sources and their formulated diets on milk fatty acids composition.

Item	Experimental diets				SEM	RDP		RDNSC		SEM
	1	2	3	4		High	Low	High	Low	
Butyric (c_4)	0.81	0.76	1.18	0.56	0.12	0.78	0.87	0.66^{b}	0.99^{a}	0.09
Caproic (c_6)	3.03	3.28	3.29	1.64	0.56	3.16	2.47	2.46	3.16	0.39
Caprylic (c_8)	4.71	3.82	4.45	2.47	0.53	4.27	3.46	3.14^{b}	4.58^{a}	0.38
Capric (c_{10})	15.50	14.18	15.78	12.32	1.05	14.84	14.05	13.25	15.64	0.74
Lauric (c_{12})	6.44	6.67	6.79	8.37	0.50	6.56	7.58	7.52	6.61	0.36
Myristic (c_{14})	12.29	11.90	13.01	12.54	0.30	12.09	12.77	12.22	12.65	0.21
Pentadecamic (c_{15})	1.11	1.19	2.14	1.14	0.32	1.15	1.64	1.17	1.62	0.23
Palmitic (c_{16})	31.45	31.15	27.79	33.38	1.64	31.30	30.58	32.27	29.62	1.16
(c_{17})	0.69	0.64	1.00	0.75	0.27	0.66	0.87	0.70	0.84	0.19
Stearic (c_{18})	6.16	6.02	5.12	5.63	0.70	6.09	5.38	5.83	5.64	0.49
Myrisoleic ($c_{14:1}$)	0.39	0.53	0.68	1.02	0.11	0.46^{b}	0.85^{a}	0.78	0.54	0.07
Palmitoleic ($c_{16:1}$)	1.29	1.19	1.13	1.36	0.17	1.24	1.24	1.27	1.21	0.12
Oleic ($c_{18:1}$)	16.14	18.67	17.65	18.82	0.26	17.41^{b}	18.24^{a}	18.75^{a}	16.79^{b}	0.19
Saturated fatty acids, %	82.18	79.61	80.54	78.99	0.36	80.89^{a}	79.76^{b}	79.30^{b}	81.36^{a}	0.26
Un-saturated fatty acids, %	17.82	20.39	19.46	21.20	0.34	19.11^{b}	20.33^{a}	20.79^{a}	18.64^{b}	0.42
Short-chain (c_4-c_{12})	30.14	28.70	31.49	25.36	1.85	29.42	28.43	27.03	30.81	1.31
Medium-chain (c_{14}-c_{16})	44.84	44.24	42.93	47.06	1.51	44.54	44.99	45.65	43.89	1.07
Long-chain (c_{17}-c_{18})	24.70	27.05	25.58	27.59	1.04	25.88	26.58	27.32	25.14	0.73

Means within the same row within each category having different superscripts are significantly different (P< 0.05).

Regarding the effect of RDNSC, the percentage of saturated FA were increased (P<0.05) when goats were given diets based on corn (low RDNSC) than those given diets based on barley (high RDNSC), especially butyric (C4) and caprylic (C8) fatty acids. On the other hand, the percentages of unsaturated FA were decreased for goats received diets based on corn than those received diets based on barley, except oleic fatty acid (C18:1) which showed a significant (P<0.05) increase with diets low in RDNSC.

Jenkins and McGuire (2006) documented that grain feeding typically reduces the proportions of milk fatty acids having 6 to 16 carbons, and increases the proportion of 18-carbon unsaturated fatty acids. On line with our results, Mir *et al.* (1999) found that there are increases in the levels of C18:0 and C18:1 fatty acids of goats' milk which was similar to the observations by Aldrich *et al.* (1997), who reported increases in C18:0 levels from 87.7 in the control to 158.6 $mg.g^{-1}$ of fat and C18:1 from 201.3 in the control to 336.0 $mg.g^{-1}$ of fat, when crushed canola seed was fed to dairy cows. Bonanome and Grundy (1988) have suggested that the sum of the C18:0 and C18:1 concentrations relative to the concentration of C16:0 may be a better indicator of the cholesterolemic tendency of a fat source than the saturated versus unsaturated fatty acid comparison. A higher ratio of C18:0 C18:1 to C16:0 is deemed to be nutritionally better than a lower ratio. Although their study does not report all of the C16 fatty acids separately, the ratio of the C18:0 & C18:1 fatty acids to the C16 fatty acids increased from 0.41 in the control treatment to 0.74 in the 6.0% canola oil treatment, thereby enhancing the nutritionally beneficial fatty acid profile in goat milk.

Moreover, Khorasani *et al.* (2001) found that FA composition of milk was not affected by dietary treatments with the exception that C18:3 tended ($P<0.08$) to increase and total C20:1 increased ($P<0.05$) as the proportion of corn in the diets increased. They reported also that the biohydrogenation pathway for the saturation of 18-carbon polyunsaturated FA can be perturbed, with a resultant increase in C18:1 trans-FA. Some of these trans-FA have been shown to be potent inhibitors of milk fat synthesis (Griinari *et al.*, 1998).

Generally, the changes occurred in milk fatty acid profile should be of great focused areas in future work since Jenkins and McGuire (2006) stated that an important discovery within the last few years was the observation that the Δ–desaturase was the predominant source of the cis-9, trans-11 conjugated linoleic acid (CLA) isomer in milk, which has a number of benefits to human health (including anticarcinogenic properties). Trans-11 arising from biohydrogenation in the rumen is transferred to the mammary tissue and desaturated to cis-9, trans-11 CLA via the Δ-desaturase. This has shifted attention to manipulating ruminal biohydrogenation to enhance the yield of the trans-11 isomer.

On the light of the above mentioned results the present study recommended the use of corn gluten meal with barley grain in formulating rations containing 60 concentrate:40 roughage ratio for Zaraibi goats during milk production, while, it is no recommended to use barley with soybean under this experimental conditions. In similar experimental circumstances, the nutritive value of rations containing soybean meal could be improve by adding corn to the mixed ration fed to goats.

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تأثير البروتين والكربوهيدرات المتكسرين في الكرش على الأداء الإنتاجي للماعز الحلاب:

٢- معاملات الهضم ، بعض مكونات الدم وإنتاج اللبن وتركيبه

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أجريت هذه الدراسة في محطة بحوث الإنتاج الحيواني بالسرو على ٢٤ عنزة زرايبي في منتصف مرحلة الحليب المتوسط ، وقسمت عشوائياً إلى (٤) مجموعات (٦ حيوانات بكل مجموعة) في تصميم عاملي (٢ × ٢) إشتملت على مصدرين من الكربوهيدرات (أذرة صفراء "منخفض التكسر بالكرش" و شعير "عالي التكسر بالكرش") ومصدرين من البروتين (كسب فول صويا "عالي التكسر بالكرش" و جلوتين الأذرة "منخفض التكسر بالكرش"). وقد تم تكوين أربعةو علائق تجريبية من هذه المصادر بهدف معرفة تأثير التغذية على تلك العلائق على معاملات الهضم وبعض مكونات الدم وكلك إنتاج وتركيب اللبن الناتج من الحيوانات التجريبية.

- أظهرت النتائج المتحصل عليها أن معاملات هضم كل من المادة الجافة والمادة العضوية والبروتين الخام ومستخلص خالي الأزوت وكذلك القيمة الغذائية في صورة مواد كلية مهضومة وبروتين مهضوم قد إزدادت (معنوية أقل من٠.٠٥) قيمتها عند التغذية على العليقة التي تحتوي على جلوتين الأذرة وحبوب الشعير مقارنة بتلك العلائق التي إحتوت على كسب فول الصويا وأذرة صفراء.
- إنخفضت (معنوية أقل من ٠.٠٥) تركيزات نتروجين-يوريا الدم في الحيوانات التي كانت تعطى كسب جلوتين الأذرة مع حبوب الشعير، وعلى الجانب الآخر زادت (معنوية أقل من ٠.٠٥) تركيزات البروتينات الكلية والألبيومين والجلوبيولين في العلائق المحتويةعلى كسب جلوتين الأذرة.
- محصول اللبن واللبن معدل الدهن (٤%) ومكونات اللبن كانت عالية عند مستوى معنوية (٠.٠٥) في الحيوانات المغذاة على عليقة محتوية على كسب جلوتين الأذرة ، مقارنة بمثيلاتها المغذاة على علائق محتوية على كسب فول الصويا. وكانت تركيزات المواد الآزوتية غير البروتينيه في اللبن منخفضة في حالة التغذية على العلائق المحتوية على كسب جلوتين الأذرة ، وعلى الجانب الآخر إرتفع محصول نتروجين البروتين الحقيقي والنتروجين الكازيني ونتروجين الشرش والأحماض الدهنية غير المشبعة (عند مستوى معنوية ٠.٠٥).
- وجد أن التفوق في محصول اللبن والمثابرة على إنتاج اللبن كانت أفضلها في الحيوانات المغذاة على كسب جلوتين الأذرة مع حبوب الشعير.

وعلى ضوء ما سبق ذكره من نتائج توصي هذه الدراسة باستخدام كسب جلوتين الأذرة مع حبوب الشعير في علائق الماعز الزرايبي الحلابة لما له من مردود إيجابي على صفات اللبن ولا يوصى باستخدام حبوب الشعير في العلائق المحتوية على كسب فول الصويا تحت ظروف التجربة الحالية ، وقد يمكن تحسين الإستفادة من كسب فول الصويا بإضافة حبوب الأذرة إلى عليقة الحيوانات.

قام بتحكيم البحث

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