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Effects of Crude Protein Degradability on Some Blood Parameters of Ruminants

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Abstract

The experiment was investigated the effects of degradability crude protein on some blood parameters of ruminants, two experiments were conducted for three sources dietary crude protein: Soya, whey protein and urea. First experiment, soya was replaced with whey protein, while second experiment, soya was replaced with urea. Fifteen male lambs were used for each experiment and randomly distributed to five treatments T1, T2, T3, T4 and T5. Concentrated was fed at 3% of body weight as DM basis, while alfalfa was fed ad-libitum. Jugular blood was sampled from lambs after 90 days of experiment before feeding morning. Results of replacing soya with whey protein showed decreased blood protein and cholesterol, while, blood urea was increased and blood glucose had a linear increase with increasing whey protein intake, 45.75, 48.5, 52.5, 66.0 and 89.75 mg/ dl for T1, T2, T3, T4 and T5. In second experiment, the results of replacing soya with urea showed decreased blood glucose and cholesterol for 2% urea in contrast with control, while blood urea was increased for 2% urea 36.11 mg/dl in contrast with 22.73mg/dl for control. In concluded, feeding high soluble crude proteins, decreased cholesterol and increased blood urea nitrogen.

Keywords: Whey, Soya protein, Urea, Ruminants, Blood traits.

1. Introduction

The increase of population and prosperity is offset by an increase in quantity and quality of food demand, which is accompanied by an increase in industrial and agricultural pollution, global warming and their problems for environment, this interconnection between producers and consumers requires reducing contradictions and creating a symbiotic environment between them. Dairy industry is widespread in both developing and developed countries with liquid wastes remains after formation of curds, called whey or dairy serum, it's rich in milk proteins like beta-lacto globulin, alpha lactalbumin, bovine serum albumin, and immunoglobulin's, or it's a by-product of casein coagulating by enzymes or acids during cheese manufacturing processes, it was often massively discarded as effluent in sewage and rivers. Casein proportions different between mammilla with superiority of ruminant compared to other types. Whey protein containing sulfur-amino acids or phosphoproteins, work as antioxidants, with high solubility over a wide pH range [1] and high content of soluble lactose [2], widely used to produce commercial milk replacer for ruminant, as a source of protein [3, 4]. There are several forms in which whey is used in feedstuffs for ruminants like, feeding as liquid with adaptation period [5] or as concentrated whey especially with molasses for palatability, and feeding of dried whey. Uneconomical to transport high water content of whey (93-94% water), leads to feeding as dried with high positive significance on: daily gain [6] and feed efficiency [7]. Researchers found 60.5% β -Lactoglobulin or lipocalin protein of whey powder [8], that means can bind and transport hydrophobic molecules, also able to bind iron via siderophores and enhance immune responses. Casein increases starch digestion rate by affects the activity and secretion of α -amylase in small intestine [9], with refer to the earlier studies, whey protein, enhances rumen protozoa and bacteria [10] as well as increases the total feed efficiency [11]. In contrast, bacteria in the rumen of ruminants break down urea to ammonia and combine with volatile fatty acids to produce microbial protein and hence protein for maintenance and production. Blood urea affected by degradability of dietary crude protein and previous researches focused on the utilization of urea and/or whey protein on rumen characteristics without blood parameters, therefore, the objective of this study was to investigate consuming different sources of crude protein on some blood parameters in ruminants.



2. Materials and Methods

2.1 Experimental animal and management

First experiment: Fifteen Awassi male lambs aged 3-4 months with initial weight $23.15 \pm 0.42\text{kg}$ penned in individual cages $1.5 \times 2\text{m}$., animals were randomized distributed to five levels of whey protein (WP) 0%, 25%, 50%, 75% and 100% replaced with soya protein as T1, T2, T3, T4 and T5. They were provided concentrate, roughage feed and clean water. Animals were given vaccines and kept continuous veterinary supervision all experimental days. Concentrated feed offered to lambs once a day at 7am at 3% of live body weight as DM basis, while roughage or alfalfa offered as ad-libitum with remaining. After 90days of the experiment period, blood samples were collected.

Second experiment: Fifteen Awassi male lambs aged 3-4 months with initial weight $24.67 \pm 0.33\text{kg}$ penned in individual cages $1.5 \times 2\text{m}$., animals were randomized distributed to five levels of urea 0%, 0.5%, 1.0%, 1.5% and 2% replaced with soya protein as T1, T2, T3, T4 and T5. Animals were given vaccines and kept continuous veterinary supervision all experimental days. All animals fed concentrated feeds at 3% of live body weight as DM basis and alfalfa offered as ad-libitum with remaining. After 90days of the experiment period, blood samples were collected.

2.2 Blood sampling

Blood samples were collected from the jugular vein after three months of experimental feeding by using a 5ml syringe needle before feeding morning. All samples analysed in the laboratory by using Biosystem, design BTS-300 Germany origin.

2.3 Chemical analyses

Formulation of concentrated feeds (Table 1.) were sampled with alfalfa for approximate analysis (Table 2) as [12].

Table 1. Formulation of experimental concentrated feeds.

Ingredients (%)	T1	T2	T3	T4	T5
(First experiment)					
soya	10.0	7.5	5.0	2.5	0
whey powder (wp)	0.00	5.5	11	16.5	22.00
barley	40.0	40.0	40.0	40.0	40.0
bran	48.0	45.0	42.0	39.0	36.0
minerals & vit.	2.0	2.0	2.0	2.0	2.0
(Second experiment)					
soya	9.0	6.0	2.5	1.0	0
Urea	0.00	0.5	1	1.5	2.0
barley	49.0	49.0	49.0	49.0	50.0
bran	30.00	32.50	35.50	36.50	36.00
corn	10.0	10.0	10.0	10.0	10.0
minerals & vit.	2.0	2.0	2.0	2.0	2.0

First experiment: T1= 0 % wp; T2= 25% wp; T3= 50% wp; T4= 75% wp; T5= 100% wp.

Second experiment: T1= 0% urea; T2= 0.5% urea; T3= 1.0%; T4= 1.5 urea; T5= 2.0% urea.

2.4 Statistical analysis

Data were statistically analysed using Completely Randomized Design (CRD), One-way ANOVA analysis was performed using statistical program [14] and Duncan's multiple range test was used to determine the significant differences ($p < 0.05$) and ($p < 0.01$) among treatments [15], using following formula $Y_{ij} = \mu + t_i + \delta_{ej}$.

Table 2. Chemical composition of concentrated feeds and alfalfa (% as DM basis) for two experiments.

Approximate analysis	T1	T2	T3	T4	T5	Alfalfa
First experiment						
Dry matter (DM) %	96.07	96.25	96.25	96.21	96.44	27.00
Organic matter (OM) %	92.70	91.58	91.58	91.68	91.85	91.00
Crude protein (CP) %	14.96	14.05	14.05	13.96	13.73	18.00
Ether extract (EE) %	5.56	6.47	6.47	8.14	9.73	3.00
Crude fibre (CF) %	12.95	8.76	8.76	9.75	7.79	27.00
Inorganic matter (ash) %	7.30	8.42	8.42	8.32	8.15	9.00
*Metabolic energy (MJ/kg DM)	12.458	12.853	12.853	13.062	13.537	43.00
Nitrogen free extract (NFE)	59.23	62.31	62.31	59.83	60.60	10.461
pH value	7.35	7.30	7.30	6.90	6.88	6.70
Approximate analysis	T1	T2	T3	T4	T5	Alfalfa
Second experiment						
Dry matter (DM) %	93.80	94.98	93.87	94.74	93.67	
Organic matter (OM) %	93.16	93.11	94.34	94.11	94.66	
Crude protein (CP) %	14.66	14.53	14.75	14.77	15.14	
Ether extract (EE) %	6.04	5.68	5.89	5.72	5.68	
Crude fibre (CF) %	8.42	7.59	8.15	7.78	7.52	
Inorganic matter (ash) %	6.84	6.89	5.66	5.89	5.34	
Nitrogen free extract (NFE)	64.04	65.31	65.55	68.84	66.32	
*Metabolic energy (MJ/kg DM)	13.0182	13.0273	13.1804	13.5722	13.2384	
pH value	7.64	7.65	7.84	7.79	7.83	

*Metabolic energy (MJ/kg DM) = 0.012 × crude protein + 0.031 × ether extract + 0.005 × crude fibre + 0.014 × nitrogen free extract [13].

First experiment: T1= 0 % wp; T2= 25% wp; T3= 50% wp; T4= 75% wp; T5= 100% wp.

Second experiment: T1= 0% urea; T2= 0.5% urea; T3= 1.0%; T4= 1.5 urea; T5= 2.0% urea.

3. Results and Discussion

3.1 Effect of soya vs whey protein on some blood parameters

The main effects of source of crude protein in concentrated feeds, soya or whey on some blood parameters, have been shown in figure 1. There were highly decreases in blood cholesterol ($p < 0.01$) with whey powder and highly increases in blood glucose, while interaction between treatments showed linear increase of blood glucose ($p < 0.01$) with increase of whey protein (Table 3.), they were 45.75, 48.5, 52.5, 66.0, 89.75 mg/dl for T1, T2, T3, T4, T5 respectively, blood cholesterol decreased with increasing whey protein, 64.75, 54.75, 39.25, 34.5, 31.0 mg/dl for T1, T2, T3, T4, T5. Blood total proteins decreased for whey treatments ($p < 0.01$), 8.87, 7.2, 6.52, 5.67, 7.35 g/dl while blood urea increased ($p < 0.01$), 22.5, 15.5, 23.0, 16.5, 26.75 mg/dl for T1, T2, T3, T4, T5 respectively, despite low of feeds protein with increasing whey in treatments (Table 2), that's leads to catabolism amino acids and proteins first from the pool of amino acids or blood and produce urea as end product of protein and amino acid catabolism, so, we found decreases of blood proteins and increases serum urea with increasing whey in feeds, the increasing of blood urea for whey treatment refers to higher protein metabolism [2]. Highly increasing muscle gains when supplemented whey protein compared to other protein supplements like soya protein [16] and increase blood glucose 71.6 mg/dl, when feeding 2.5% liquid whey in contrast 64.0 mg/dl for control [17], that because of increases in activity and secretion of α -amylase in small intestine [9]. The same results in terms of lower cholesterol and increased urea with whey treatments, 55.7 and 12.9 mg/dl compared to control 78.4 and 11.00 mg/dl for cholesterol and urea respectively [7]. Liquid whey will probably be more greatly used when assured regular supplies or animals are located close to where the whey is produced, climatic conditions would affect whey protein use, because of highly fermentable. Milk sugar (lactose) is broken down and fermented rapidly by rumen microorganisms into lactate and butyric acid, very little amount of lactate absorbed into the blood in normal feeding, but if the animals are small and don't mature, large quantities of lactose leads to inability of the rumen microorganisms to convert most of the lactate into volatile fatty acids and its accumulation in the rumen, and may cause severe fermentation problems throw penetrates the wall of rumen and may cause acidosis, so, it's prefer to submit whey protein after mature animals.

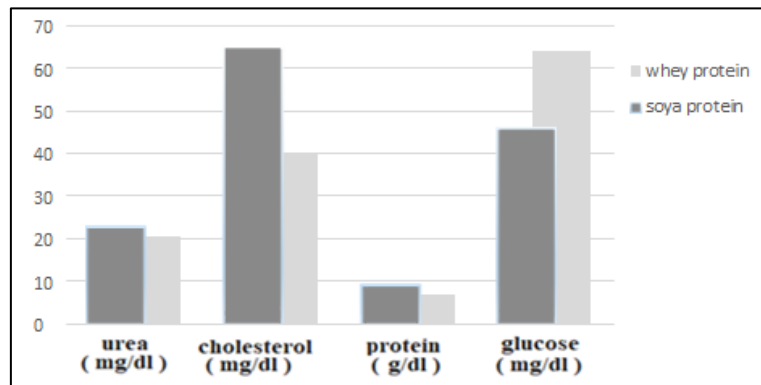


Figure 1. Main effect of soya and whey protein on some blood parameters.

Table 3. Effect of soya and whey protein on some blood parameters \pm Standard error.

Treatments	blood glucose mg/dl	blood protein g/dl	blood cholesterol mg/dl	blood urea mg/dl
T1	45.75 \pm 1.10d	8.87 \pm 0.17a	64.75 \pm 1.10a	22.50 \pm 1.04 b
T2	48.50 \pm 0.64d	7.20 \pm 0.19b	54.75 \pm 0.85b	15.50 \pm 0.86c
T3	52.50 \pm 0.64c	6.52 \pm 0.13c	39.25 \pm 1.31c	23.00 \pm 1.08 b
T4	66.00 \pm 1.29b	5.67 \pm 0.13d	34.50 \pm 0.64d	16.50 \pm 0.64c
T5	89.75 \pm 1.37a	7.35 \pm 0.15b	31.00 \pm 0.40e	26.75 \pm 1.49a
Significant	**	**	**	**

Different litters in same column means significant differences; ** Significant differences at level 0.01

First experiment: T1= 0 % wp; T2= 25% wp; T3= 50% wp; T4= 75% wp; T5= 100% wp.

3.2 Effect of soya vs urea on some blood parameters

The main effects of urea nitrogen and soya crude protein in concentrated feeds on some blood parameters have been shown in figure 2. Soya protein treatment decreased blood urea ($p < 0.05$) in contrast with urea treatments, and increases blood cholesterol, while interaction between treatments showed significant decrease of blood glucose ($p < 0.05$) with 2% of urea comparison to 1% (Table 4.), they were 62.02 mg/dl and 78.16 mg/dl respectively. Blood cholesterol decreased with increasing urea nitrogen, 53.64, 47.58, 47.33, 44.5, 41.0 mg/dl for T1, T2, T3, T4, T5. The increasing of urea levels in feeds led to increase blood urea and decreased blood glucose cholesterol. Utilization of dietary protein depends on types of rumen degradable protein (RDP) intake to optimize the requirement of rumen microbes [18], Urea can be used to supplemental protein to meet the ruminant protein requirement [19]. Urea hydrolysis to ammonia is very rapid and override its utilization by ruminal microorganisms, that leads to increase blood urea nitrogen (BUN) may due to increased ruminal ammonia concentration. Wanapat and Pimpa [20] reported linear increase in BUN with increasing ruminal $\text{NH}_3\text{-N}$ concentrations, same results for Chumpawadee et al. [21] and Paengkoum et al. [22] who reported that an increase in ruminal $\text{NH}_3\text{-N}$ leads to increased BUN concentration.

Table 4. Effect of soya protein and urea nitrogen on some blood parameters \pm Standard error.

Treatments	blood glucose mg/dl	blood protein g/dl	blood cholesterol mg/dl	blood urea mg/dl
T1	78.01 \pm 5.54 a	5.61 \pm 0.22 a	53.64 \pm 2.23a	22.73 \pm 3.76 c
T2	73.06 \pm 6.34 ab	5.69 \pm 0.20 a	47.58 \pm 1.98ab	24.87 \pm 5.85 bc
T3	74.16 \pm 9.16 ab	5.49 \pm 0.11 a	47.33 \pm 2.43ab	32.10 \pm 2.91 ab
T4	74.05 \pm 4.09 ab	5.64 \pm 0.14 a	44.50 \pm 1.77bc	33.80 \pm 3.21 ab
T5	62.02 \pm 7.84 b	5.68 \pm 0.24 a	41.00 \pm 1.53c	36.11 \pm 3.71 ab
Significant	*	ns	*	*

Different litters in same column means significant differences; * Significant differences at level 0.05

Second experiment: T1= 0% urea; T2= 0.5% urea; T3= 1.0%; T4= 1.5 urea; T5= 2.0% urea.

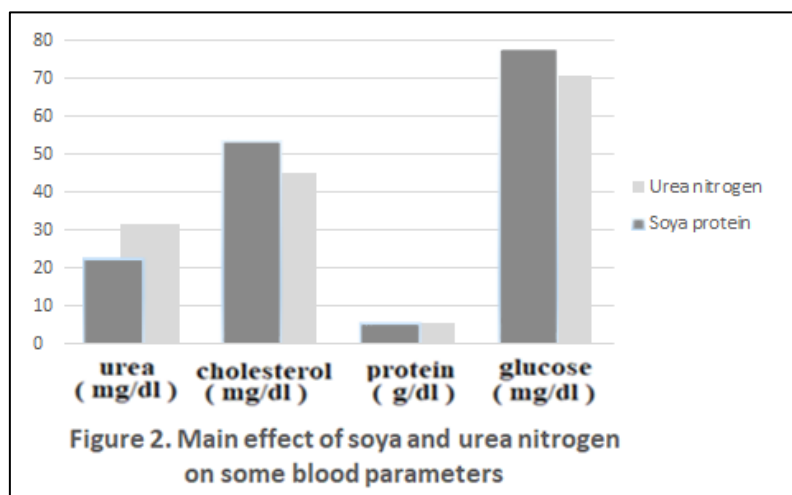


Figure 2. Main effect of soya and urea nitrogen on some blood parameters.

Conclusions

The results of water soluble or rapidly degraded protein urea or whey protein, in contrast with soya protein, showed decreased cholesterol and increased blood urea nitrogen and the possibility of using it as a source of protein to produce cheap ruminant feeds, less pollution, and possibility to use it with molasses. However, more trials involving ruminal characteristics are suggested prior to have final recommendations.

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