# INFLUENCE OF DIETARY ENERGY AND PROTEIN SOURCES ON DIGESTIBILITY, RUMEN PARAMETERS AND WEIGHT GAIN OF MALE GOATS

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#### ABSTRACT

This work was carried out to study the effect of dietary energy and protein sources on digestibility, nutritive values, rumen parameters and weight gain. Twelve male goats, average body weight 20 kg were used in this experiment, which divided into four equal groups, fed on concentrate feed mixtures (CFM) and wheat straw ad libitum. The concentrate feed mixtures of tested rations were:

Ration 1: 70% corn + 29% cotton seed meal + 1% additives (CFM1).

Ration 2:23% corn + 29% cotton seed + 47% SBP + 1% additives (CFM2).

Ration 3:70% corn + 29% broken horse bean + 1% additives (CFM3).

Ration 4: 23% corn + 29% broken horse bean + 47% SBP + 1% additives (CFM4).

The CFM was offered the give goat requirements while wheat straw offered ad libitum.

The results of two energy sources showed that sugar beet pulp (SBP) has crude fiber (CF), crude protein (CP) and ash contents higher than corn grains content. While nitrogen free extract (NFE) and ether extract (EE) were less than corn grains. Cotton seed meal (CSM) has higher CF, EE and ash content and lower CP and NFE in comparison with broken horse bean (HB).

Using of SBP instead of corn (CFM2) decreased (P<0.05) the digestibility of CP, EE and NFE while the total digestible nutrients (TDN) and digestible crude protein (DCP)% did not significantly affected. Broken horse bean (HB) caused significantly (P<0.05) increase in DM, OM, CF, NFE digestibility and TDN and DCP% in comparison with (CSM). The interaction between energy and protein sources had significant (P<0.05) effect on all nutrient digestibilities and nutritive values (%). The daily body weight gain did not affect by energy sources. It was high (P<0.05) for goats fed HB in comparison with which fed CSM. Generally, most results indicate that the best rations were contained CFM4 followed by CFM3 followed by CFM1 then CFM2.

Results of rumen parameters showed that, the pH value, ammonia nitrogen and total volatile fatty acids (TVFA's) concentrations not significantly (P<0.05) affected by energy source. On the other hand, the ammonia nitrogen and TVFA's significantly (P<0.05) affected by protein sources. The interaction between energy and protein sources was significant. The lowest pH and highest TVFA's were found in rumen liquor of goats fed CFM1 in comparison with fed others (CFM)s. The CSM increased (P < 0.05) ammonia nitrogen concentration in comparison with HB.

Results of the study indicate that, replacing 67% of corn of CFM1 by SBP had deleterious effect on the digestibility, nutritive values and weight gain of goat when CSM was the protein source (CFM2). On the other hand, replacing of corn by SBP with using HB as protein source (CFM4) give the best results. All results indicate that HB was better than CSM meal.

**Key words:** Dietary energy, protein sources, digestibility, rumen parameters and weight gain, male goats

#### **INTRODUCTION**

Incorporation of cheap untraditional feedstuffs such as the agro industrial by products in the animal ration may be participate in solving the problem of feed shortage in Egypt. Sugar beet pulp (SBP) is the remaining residue after sugar extraction from sugar beet tubers (Talha *et al.*, 2002). The quantity of dried SBP in Egypt was 173326 ton, could supply 155993 ton of dry matter, 113150 ton of TDN and 6708 tons of DCP (Agriculture Economics, 2000). The SBP are fed in a significant amounts instead of corn (Graham *et al.*, 1986; Garcia *et al.*, 1992; El-Ashry *et al.*, 2000; Saleh *et al.*, 2001; Talha *et al.*,2002 & 2005 and Zaza, 2005). Broken horse bean (HB) is small particles of normal horse bean mixed with high amount of its hulls and used in feeding of animals.

The results of replacing corn by SBP were differed. These differences are due to substitution level; concentrate and type of energy and nitrogen (ingredients used); or synchrony of nitrogen degradation rate with carbohydrate degradation rate, percentage of concentrate in the ration, method of feeding or animal species (Casper *et al.*, 1990; Sinclair *et al.*, 1995 and Schmidely *et al.*, 1999).

Therefore, this work was aimed to study the effect of replacing 67% of corn in CFM by SBP with using two sources of protein (CSM and HB) on digestibility, nutritive values, rumen parameters and weight gain of male goats.

#### **MATERIALS AND METHODS**

The experimental work on goats were carried out in Faculty of Veterinary Med. and the analysis of samples were carried out in Animal Production Dept., Faculty of Agric., Zagazig University. Factorial design (2x2) were used to study the effect of 2 energy sources (corn and SBP) and 2 protein sources (CSM and HB) on the digestibility, nutritive values, rumen parameters and weight gain of male goats (Table 1).

Twelve castrated male 20 kg Baladi goats were randomly assigned to four groups (3 male goats/ each group) (Table 1). Goats were fed on concentrate feed mixture (CFM) and wheat straw. Animals of  $1^{st}$  group was fed on CFM consists of 70% corn + 29% cotton seed meal + 1% additives (CFM1);  $2^{nd}$  group was fed on 23%

Items	Concentrate feed mixture							
	CFM1	CFM2	CFM3	CFM4				
Ingredient %:								
Yellow corn	70.0	23.0	70.0	23.0				
Sugar beet pulp (SBP)	0.0	47.0	0.0	47.0				
Cottonseed meal undecorticated	29.0	29.0	0.0	0.0				
Broken horse bean	0.0	0.0	29.0	29.0				
Dicalcium phosphate	0.70	0.70	0.70	0.70				
Vitamin and mineral premix*	<u>0.30</u>	<u>0.30</u>	<u>0.30</u>	<u>0.30</u>				
Total	100	100	100	100				
Calculated nutritive values(%)**:								
TDN	73.47	68.30	80.72	75.55				
DCP	10.12	9.18	12.44	11.50				
*Fach and kilogram of vitaming a	nd minoral	nromin con	toing. 200000	O III Vit A				

Table (1): Formulation of concentrate feed mixtures (CFMs).

**\*Each one kilogram of vitamins and minerals premix contains:** 2000000 IU Vit. A; 150000 IU Vit. D3; 8.33 g Vit. E; 0.33 g Vit. K; 0.33 g Vit. B1; 1.0 g Vit. B2; 0.33 g Vit. B5; 1.70 g Vit. B6; 0.38 g Vit. B12; 3.33 g Pantothenic acid; 33 mg Biotine; 0.83 g Folic acid; 200 g Choline chloride; 11.79 Zn; 12.50 g Fe; 0.50 g Cu; 16.6 Se; 5.0 g Mn and Mg 66.70 g. \*\*TDN and DCP% of corn, SBP, cottonseed, bean and wheat straw were calculated 83 and 7; 72 and 5; 53 and 18; 78 and 26; 42.5 and 0.0 respectively. The above nutritive values of SBP according to (Crawshew, 1990)

corn + 47% SBP horse bean (HB) + 1% additives (CFM3) while  $4^{\text{th}}$  group fed on 23% corn + 47% SBP + 29% HB + 1% additives (CFM4). The CFM was offered the give goat requirements while wheat straw offered *ad libitum*.

Animals were housed individually under shaded pens and same managerial, hygienic and environmental condition. The goats fed the CFM(s) individually 2 times/ day at 8 am and 4 pm and water was offered three times daily while wheat straw was offered *ad labtium* (Table 2). The CFM(s) were offered to give the theoretical requirements (maintenance, medium activity and 50 g weight gain / day) of goats according to (NRC, 1981).

The experiment period was 31 days (21 days as a preliminary period, 7 days as a collection period and 3 days for rumen parameters). Animals were weighted at first and last day of experiment. Acid insoluble ash (AIA) was used as a natural marker for nutrient digestibility determination (Van Keulen and Young, 1977). The rumen fluid samples were taken at last 3 consecutive days after 3 hours post-feeding by using rubber stomach tubes. Rumen pH was immediately measured using pH meter. The rumen liquor were filtered through two layers of surgical gauze. Ammonia-N was determined by Con-Way method (1962). Total VFA's was determined by steam distillation method as described by Warner (1964).

Proximate analysis of ingredients, CFM(s) and rations (Table 3) and feces were determined according to A.O.A.C. (1990). The results were statistically analyzed by the ANOVA as described by Snedecor and Cochran (1982), as 2x2 factorial treatment arrangement. Means were tested for differences using Duncan, s multiple range test (Duncan, 1955).

#### **RESULTS AND DISCUSSION**

#### Effect of energy & protein sources and their interaction: 1- Chemical composition of CFM(s) and experimental rations:

Results presented in Table (2) showed that SBP has higher CF, CP and ash contents than corn grains. Nitrogen free extract (NFE) and EE of corn grains were higher than SBP. These results agreed with those reported by Eweedah *et al.* (1999) and El-Ashry *et al.* (2000). Cotton seed meal (CSM) had higher content of CF, EE and ash but its CP and NFE was low comparing with broken horse bean (HB). Replacing high amount of corn (67%) by SBP increased the CP, CF and ash in CFM2 and CFM4 but the EE and NFE content decreased. Using of HB increased the organic matter (OM), CP and NFE in CFM3 and CFM4 but the CF, EE and ash content decreased (Table 2) in comparison with CFM1 and CFM2 (contained CSM).

#### 2- Feed intake of goats:

The quantity of CFM (s) which offered to goats (Table 3) was calculated according to their nutritive values (Table 1) to give same quantity of TDN and DCP. Generally, the goats fed all rations (FCM + wheat straw) toke their requirements for maintenance plus medium activity and 50 g weight gain/ day according to NRC (1981).

#### **3-** Digestibility of nutrients:

Using of SBP instead of corn decreased (P<0.05) the digestibility of CP, EE and NFE (Table 4). These results agreed with those reported by Saleh *et al.* (2001) who reported that the digestibility of protein significantly declined by increasing SBP level in diet. On the other hand, Talha *et al.* (2005) reported that no significant effect on digestibility of DM, OM, NFE and CF were obtained by replacing of 40 or 60% of corn by SBP in CFM of lactating buffaloes. Also, Schmidely *et al.* (1999) reported that digestibility of nitrogen by goats fed SBP plus slowly degraded nitrogen (coconut meal) and other fed starch plus rapidly degraded nitrogen (horse bean) not differed. The difference between results may be due to: percentage of SBP in rations; source of ingredients; source of protein source and the animal species. SBP increased (P<0.05) the digestibility of CF. These results are due its lignin content is low (El-Ashry *et al.*, 2000).

Broken horse bean caused significantly (P<0.05) increase in DM, OM, CF and NFE digestibility. These results may be due to differed amino acid content between HB and cottonseed meal. Also, Schmidely (1999) reported that the nutritive values of extracted materials often less than non extracted.

The interaction between energy and protein sources had significant (P<0.05) effect on all nutrient digestibility (DM, OM, CP, CF, EE and NFE).

*Generally*, most results indicate that the best CFM(s) was CFM4 and the lowest one was CFM2.

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Tuble (2): I ced marke of gould fed tested futions.							
Items	Ration	Ration	Ration	Ration			
	1	2	3	4			
Number of animals	3	3	3	3			
Initial live body weight (kg)	20	20	20	20			
Dry matter intake (g):							
CFM1	600						
CFM2		660					
CFM3			525				
CFM4				575			
Wheat straw	95	60	110	75			
Total dry matter intake (g)	695	720	635	650			
Dry matter intake as % of live body weight	3.48	3.60	3.18	3.25			
Calculated TDN intake of FCM (g)	441	451	424	434			
Calculated DCP intake of FCM (g)	61	61	65	66			

 Table (2): Feed intake of goats fed tested rations.

 Table (3): Chemical composition of experimental ingredients and calculated chemical composition of concentrate feed mixtures. & tested rations.

Items	Chemical composition on dry matter basis (%)							
	DM	OM	СР	CF	EE	NFE	Ash	
Yellow corn	94.15	98.33	9.44	2.78	4.44	81.67	1.67	
SBP	95.60	94.98	10.12	20.84	0.94	63.08	5.02	
Cottonseed unde.	92.00	93.27	23.28	23.98	14.56	31.45	6.73	
Broken horse bean	93.50	94.42	37.28	13.97	5.48	37.69	5.58	
Wheat straw	94.00	82.14	3.31	34.29	1.98	42.5	17.86	
<b>Calculated chemical</b>	composit	tion ( % ):						
CFM1	92.59	95.88	13.36	8.90	7.33	66.29	3.12	
CFM2	93.27	94.31	13.68	17.39	5.69	57.55	4.69	
CFM3	93.02	96.21	17.42	6.00	4.70	68.10	2.79	
CFM4	93.70	94.74	17.74	14.49	3.05	59.36	4.36	
Ration1	92.78	94.01	11.99	12.37	6.60	63.05	5.13	
Ration2	93.37	93.30	12.82	18.80	5.38	56.30	5.79	
Ration3	93.15	93.77	14.98	10.90	4.23	63.84	5.40	
Ration4	93.78	93.29	16.08	16.77	2.93	57.49	5.92	

#### 4- Nutritive values:

The nutritive values as TDN and DCP% (Table 5) did not significantly differ between goats fed different energy sources (SBP or corn). On the other hand, protein sources had significantly (P<0.05) effect (HB increased TDN and DCP% in comparison with CSM). The TDN and DCP% of ration contained CFM2 were significantly (P<0.05) lower in comparison with other rations. Generally, the highest DCP% in group fed on diet contained CFM4 followed by CFM3, CFM1 and CFM2 respectively. Abd El-Rahman, (2005) reported that no significant effect of protein sources (sunflower seed meal, soybean meal and cotton seed meal) on DCP in sheep,

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but the nitrogen balance differed may be due to difference in amino acid composition of protein sources and its digestibility.

The TDN and DCP intake did not affected by replacing of corn by SBP. Also, TDN intake not affected by protein source. The intake of DCP increased (P<0.05) by HB in comparison with CSM (Table 5).

The interaction between energy and protein sources was significant. The TDN intake not differ significantly between goats fed CFM1, CFM3 and CFM4. The TDN of CFM2 was the lowest one (P<0.05). The DCP intakes of goats fed CFM4> CFM3> CFM1> CFM1.

#### 5- Rumen parameters:

The pH value not affected (P<0.05) by energy and protein sources. The interaction was significant which the lowest pH and highest TVFA's were in goats fed CFM1 in comparison with fed other rations. These results may be due to higher microbial activity by rumen microorganisms as indicated by total VFA's production which took place on the soluble carbohydrate very soon producing more propionate decreasing pH values. While fermentation of the structural carbohydrates need more time producing more acetate delaying the decreased pH value (Andrighetto *et al.*, 1993 and Nagah, 2002). Similer results were obtained by Schmidely *et al.* (1999) in lactating goats. Who found that the pH was low in goat fed diet contain starch plus rapidly degraded protein (20% wheat, 17% barley, 10% oats, 25% horse bean, 20% pea, 5% molasses and 3% minerals) in comparison with fed fiber plus slowly degraded protein (5% corn gluten feed, 35% soybean hulls, 20% coconut meal, 5% molasses and 3% minerals).

Ammonia nitrogen concentration did not significantly (P<0.05) affected by energy sources. On the other hand, CSM increased (P<0.05) ammonia concentration in comparison with HB. These results agreed with *in sacco* degradation that obtained by Schmidely *et al.* (1999). Increasing of ammonia in rumen liquor suggest inefficient use of ruminal NH3 for ruminal proteosynthesis, even when rapidly degraded starch was available for ruminal microorganisms (Sinclair *et al.*, 1995). Also, may be due to the maximum proteolytic and deaminase activities (Rai *et al.*, 1972). On the other hand, the ammonia decreased (P<0.05) in rumen liquor of goats fed horse bean. Lowering of ammonia may be due to absorption and / or utilization of NH3-N in the synthesis activity of rumen (McDonald, 1952).

Goats fed the SBP as energy source compared with goats fed corn had insignificant higher TVFA's concentration. These results agreed with those reported by Schmidely *et al.* (1999) on lactating goats. The HB decreased (P<0.05) TVFA's in rumen liquor of goats in comparison with those fed CSM. Decreasing the VFA's by horse bean may be due to absorption and utilization of its in the synthesis activity of rumen like ammonia. The highest TVFA's were for goats fed corn + cotton seed; SBP + cotton seed; SBP + horse bean then corn + horse bean. The increase of VFA might be due to increasing the activity of microflora on the fermentable carbohydrates (Akin and Borneman, 1989 and Wali, 1994).

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#### 6- Daily body weight gain:

Replacing 66% of corn by SBP had no effect on daily body gain. These results may be attributed to that TDN and DCP intake did not affected according to these energy sources (Table 5). On the other hand, the HB increased (P<0.05) daily weight gain which was 57.79 g in comparison with 51.19 for goats fed CSM. These results are correlated to increasing of DCP intake by HB. The interaction between treatments was significant (P<0.05). The daily gain of goats fed CFM1, CFM3 and CFM4 not significantly differed. But daily gain of these treatments was higher (P<0.05) with goats fed CFM2.

*Conclusively*, replacing 67% of corn by SBP (CFM2) decreased (P<0.05) the digestibilities of CP, EE, NFE and daily body weight gain when cottonseed was used as a source of protein. Broken horse bean (HB) increased (P<0.05) the digestibility of DM, OM, CP, CF, NFE and daily body gain with all sources of protein. Most results indicated that the best CFM was CFM4 (SBP plus HB) and the lowest one CFM2 (SBP and CSM).

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## تأثير مصادر الطاقة وبروتين العليقه على الهضم، قياسات الكرش و الزيادة الوزنية في ذكور الماعز

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تأثير مصدرين للطاقة ( الذرة و تفل بنجر السكر) و مصدرين للبروتين( كسب القطن و كسر الفول) على الهضم، القيم الغذائية، قياسات الكرش و الزيادة الوزنية تم در استه باستخدام ١٢ ذكر ماعز تم استخدام ٤ تركيبات من العلف المركز و هي:

المركز الأول : ٧٠% ذرة + ٢٩% كسب قطن + ١% إضافات.

المركز الثاني: ٢٣%ذره + ٤٧% تفل بنجر سكر (SBP) + ٢٩% كسب بذرة قطن + ١% إضافات.

المركز الثالث: ٧٠% ذرة + ٢٩% كسر فول + ١% إضافات.

المركز الرابع: ٢٣%ذره + ٤٧% SBP + ٢٩% كسر فول + ١% إضافات.

تم تقديم العلف المركز للماعز بحيث يغطى احتياجاتها الغذائية بينما تبن القمح تم إضافته للشبع.

أظهرت النتائج أن تفل بنجر السكر (SBP) يحتوى على ألياف خام ، بروتين خام و رماد أعلى من الذرة. المستخلص الخالي من النيتروجين و مستخلص الأثير في SBP كان اقل من الذرة. بالنسبة لمصادر البروتين احتوى كسب القطن على ألياف خام، مستخلص أثير و رماد أعلى من كسر الفول بينما كان محتواه من البروتين الخام والمستخلص الخالي من النيتروجين اقلٍ من كسر الفول.

انخفض هضم البروتين الخام ، مستخلص الأثير و المستخلص الخالي من النيتروجين معنويا باستخدام (SBP) بدلا من الذرة بينما مجموع المركبات الغذائية المهضومة (TDN%) والبروتين الخام المهضوم (DCP%)لم تتأثر معنويا. زاد هضم المادة الجافة ، المادة العضوية، الألياف الخام و الكربو هيدرات الذائبة المهضومة، TDN% و DCP% بكسر الفول بالمقارنة بكسب القطن. التداخل بين مصادر الطاقة و البروتين كان له اثر معنوي على معاملات هضم كل المركبات الغذائية و القيم الغائية. عائد الوزن اليومي لم يتأثر بمصادر الطاقة. لكنه زاد معنويا في الماعز المغذاة كسر فول مقارنة بكسب المعن المنائية.

نتائج قياسات الكرش أوضحت أن قيمة رقم الحموضة، تركيز الامونيا و الأحماض الدهنية الطيارة لم تتأثر معنوي بمصادر الطاقة. على الجانب الآخر الامونيا و الأحماض الدهنية الطيارة تأثرت معنويا بمصادر البروتين. التداخل بين مصادر الطاقة والبروتين كان معنويا. أقل رقم حموضة وأعلى أحماض دهنية طيارة وجدت في سائل كرش الماعز المغذاة المركز الأول بالمقارنة بالمغذاة المركزات الباقية. زاد تركيز الامونيا في وجود كسب القطن بالمقارنة بكسر الفول.

التوصية: إحلال ٦٧% من ذرة المركز الأول بالبنجر SBP (المركز الثاني) كان له تأثيرات ضارة على الهضم و القيمة الغذائية لعلائق الماعز. كسر الفول زاد هضم كل المركبات الغذائية ماعدا مستخلص الاثير مقارنة بكسب القطن مع أو بدون البنجر. معظم النتائج أشارت أن أفضل مركز هو المركز الرابع وأقل مركز هو المركز الثاني.