EFFECT OF FEEDING DIFFERENT LEVELS OF CORN GLUTEN FEED ON DIGESTION COEFFICIENTS, FEED INTAKE, SOME BLOOD AND RUMEN PARAMETERS IN FRIESIAN DAIRY COWS RATIONS

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SUMMARY

Twelve lactating Friesian cows with the average body weight of 435-570 kg were used in this study. All animals in this study were in the 2nd to 4th lactation season were randomly distributed into four similar groups (three cows for each group). All groups were individually fed according to NRC (2001) recommendations. The four experimental rations were formulated as follows: control: 52% concentrate feed mixture (CFM) (40% corn grain, 30% wheat bran, 23% undecorticated cottonseed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20% corn silage (CS) + 28% rice straw (RS), experimental ration 1 (Exp.1): 52% CFM (35% corn grain, 30% wheat bran, 10% corn gluten feed (CG), 18% undecorticated cottonseed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20% CS + 28% RS, experimental ration 2 (Exp.2): 52% CFM (32.5% corn grain, 30% wheat bran, 15% CG, 15.5% undecorticated cottonseed meal, 5% molass, 0.5% salt and 1.5% limestone) + 20% CS + 28% RS and experimental ration 3 (Exp.3): 52% CFM (30% corn grain, 30% wheat bran, 20% CG, 13% undecorticated cottonseed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20% CS + 28% RS. Four digestibility trials were conducted to determine nutrients digestibility coefficients and nutritive values of the experimental rations. Each digestibility trial consisted of 15 days preliminary period followed by 7 days collected period. Results showed that the dry matter intakes (% body weight) were higher with feeding on Exp.1 or Exp.2 (3.38 and 3.51, respectively) than feeding on control or Exp.3 (3.25 and 3.26, respectively). The apparent digestibility of CP was significantly (P<0.05) higher with feeding on control (74.60%) than feeding on Exp.1, Exp.2, and Exp.3 (67.88, 62.12 and 64.57% respectively). The TDN% values were 72.74, 70.18, 66.45 and 68.8% with feeding on control; Exp.1, Exp.2 and Exp.3 ,respectively, and the same trends were also with ME (Mcal/ kg), ME (Mj/ kg) and NE_L (Mcal/kg). Total tract digestibility (%) of starch was lower for the low starch diets, but ruminal digestion (%) of starch was not affected by starch concentration. The pH values were ranged from 6.16 to 7.59 with different treatments and at all measuring times. The mean value was higher (P<0.05) with feeding on control (6.97) and lower with feeding on Exp.1 (6.51), while there were no significant differences when feeding on Exp.2 (6.73) and Exp.3 (6.73) or among Exp.1 and Exp.2 or Exp.3. The mean values showed that the TVFA's concentration was significantly (P<0.05) higher in control group (4.43 ml eq. /100 ml RL) than feeding on Exp.1 or Exp.2 or Exp.3 (4.08, 4.01 and 4.18 ml eq. /100 ml RL, respectively), but there was no significant effect among Exp.1, Exp.2 and Exp.3. Ruminal NH_3-N concentration was higher (P<0.05) with feeding on the control or Exp.1 (10.50 and 10.25 mg /100 ml, respectively) than feeding on Exp.2 (8.42), but there was no significant effect with feeding on Exp.3 (9.58 mg /100 ml) or control or Exp.1 or Exp.2. The effective neutral detergent fiber (eNDF) values ranged from 25.58 to 36.63%, the eNDF was higher (P<0.05) with feeding on control (36.63%) than feeding on Exp.1 or Exp.2 or Exp.3 (25.58, 30.92 and 30.78 % respectively). The mean value of fibrolytic bacteria was higher (P<0.05) with feeding on Exp.2 (14.7x 10^5 CFU/ml) than feeding on control or Exp.1 or Exp.3 (7.75, 8.12 and 9.65x 10^5 CFU/ ml, respectively). On the other hand, the amylolytic bacteria count was ranged from 1.93 to 8.47x 10^5 CFU/ ml with different treatments. The mean value was the highest (P<0.05) with feeding on the control (6.25 x 10^5 CFU/ ml) than feeding on Exp.1 or Exp.2 or Exp.3 (3.93, 2.89 and 4.11x 10^5 CFU/ ml respectively). The insulin concentration was higher (P<0.05) with feeding on Exp.3 (0.25 ng/ ml) than feeding on control or Exp.1 or Exp.2 which were have similar concentration (0.23 ng/ ml). The triglycerides concentrations were ranged from 106.06 to 343.73 mg /100ml with different treatments at all times, the mean values were higher (P<0.05) with feeding on control and Exp.1 (246.44 and 231.39 mg/ 100ml, respectively) than feeding on Exp.2 and Exp.3 (196.21 and 209.13 mg/ 100ml, respectively). The total protein concentrations were ranged from 4.19 to 8.01 g/ 100ml with feeding on the experimental rations at all times. The urea concentrations

were increased with Exp.1 or Exp.2 or Exp.3 than feeding on control at all times. The mean values were higher (P<0.05) with feeding on Exp.2 or Exp.3 (21.68 and 23.24 g/ 100ml, respectively) than feeding on control or Exp.1 (16.6 and 18.67 g/ 100ml respectively). Corn grain and undecorticated cottonseed meal can be replaced by 15% corn gluten feed are often considered providing the proper amounts of ruminally fermentable carbohydrates.

Keywords: lactating Friesian cows, corn silage, corn gluten feed, some rumen liquor parameters, fibrolytic bacteria, amylolytic bacteria and some blood parameters.

INTRODUCTION

There is a deficiency in animal feeds (27% of calculated requirements) in the northern countries of Africa (Egypt, Algeria, Libya, Morocco and Tunisia). Over the whole year, Usage of the available feed quantities is not at a constant rate. During the winter (rainfall) season, the more nutritious 65% of available feeds are consumed. While in summer season, animals suffer from severe feed insufficiency due to lack of minerals, nitrogen, vitamin A precursors and soluble carbohydrates at the same time. The northern countries of Africa have considerable amounts of crop residues and agro-industrial by-products which are underutilized. Also, in milk production a diet based on chopped and supplemented by-products resulted in a similar level of milk yield as that obtained on a 1:1 concentrate to green roughage diet (on DM basis), (Kossila, 1981). Removal of starch content of new material is done in most cases. After concentrating the remaining material, the raw product from which they originate is lower in protein, fiber and fat. Despite removing the rapidly-digested starch from the feed, fiber in the form of cellulose remains and is highly digestible by ruminants such as cattle and sheep. Consequently, the energy (TDN) content of these feeds is not very different from the TDN of the whole grain from which these by-products originate (Wahlberg, 2009). Corn by-products continue to be economical sources of nutrients. Maintaining energy levels and decreasing feed costs can be achieved by using wheat midds, corn gluten feed and soy hulls. Dairy managers and nutritionists must monitor corn by-products as ethanol producers continue to market corn nutrients in by products (Hutjens, 2010), to capture value-added feed markets. Simply, acetic acid is produced by fermentation of fiber (cellulose and hemicellulose), then acetic acid is used for energy by the cow and as a primary precursor of fat in milk. In contrast, propionic acid is produced from digestion of sugars and starches, and then in the liver of the cow propionic acid is changed into glucose and used for energy (Grant, 1997). Corn gluten feed is a by-product of corn syrup manufacturing. This feed has protein that is mostly degradable in the rumen and is not considered a source of rumen resistant protein, while energy is similar to some grains. Corn gluten feed is often an economical feed to use in rations. The precedent part of the present study was to evaluate the replacement of amounts of corn grain and cottonseed meal in the concentrate feed mixture in lactating cows rations by 15% corn gluten feed are often considered for enhancing production of milk, persistency and economic efficiency (Maklad Eman *et al.,* 2017).

The objective of this study was to evaluate the effect of partially substituting of corn and undecorticated cottonseed meal by corn gluten feed on feed intake, nutrients digestibility, some rumen liquor parameters, fibrolytic bacteria, amylolytic bacteria and some blood parameters of lactating Friesian cows.

MATERIALS AND METHODS

The present study was conducted at El-Karada Animal Production Research Station, Animal Production Research Institute, Agricultural Research Centre, Ministry of Agriculture. In this study, the weights of the twelve cows were ranging from 435-570 kg. The animals in this study were in the 2nd to 4th lactation season. According to NRC (2001) recommendations all groups were fed individually. The four experimental rations were formulated as follows: control: 52% concentrate feed mixture (CFM) (40% corn grain, 30% wheat bran, 23% undecorticated cottonseed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20% corn silage (CS) + 28% rice straw (RS), experimental ration 1 (Exp.1): 52% CFM (35% corn grain, 30% wheat bran, 10% corn gluten feed (CG), 18% undecorticated cottonseed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20% CS + 28% RS, experimental ration 2 (Exp.2):

52% CFM (32.5% corn grain, 30% wheat bran, 15% CG, 15.5% undecorticated cottonseed meal, 5% molass, 0.5% salt and 1.5% limestone) + 20% CS + 28% RS and experimental ration 3 (Exp.3): 52% CFM (30% corn grain, 30% wheat bran, 20% CG, 13% undecorticated cottonseed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20% CS + 28% RS.

Four digestibility trials were conducted using three cows from each group to determine nutrients digestibility coefficients and nutritive values of the experimental rations. Each digestibility trial consisted of 15 days preliminary period followed by 7 days collected period. During the digestion trials, cows were fed their allowances according to the experimental assignment of each group. Acid insoluble ash (AIA) was used as a natural marker (Van keulen and Young, 1977). Nutrients digestibility was calculated from the equations stated by Schneider and Flatt (1975). Samples of concentrate mixture, corn silage and rice straw were taken at the beginning, middle and at the end of each trial. At the end of the collection period composite samples were dried in a forced air oven at 65°C for 48 hours, then ground and kept for chemical analysis. Faces samples were taken from the rectum of each cow twice daily with 12 hours interval during the collection period of each trial and dried in a forced air oven at 65°C for 48 hours. Dried samples were composted for each cow and representative samples were taken, ground and kept for chemical analysis. Chemical analysis of samples of concentrate mixture, corn silage, and rice straw were carried out to determine dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), ash and fiber fractions (NDF,ADF ADL, Hemi. and Cell.) according to the methods of AOAC (1990).

At the end of the collection period ruminal fluid samples were taken using stomach tube before feeding and at 2, 4 and 8 hrs post-feeding from three animals of each treatment. The collected rumen fluid samples were filtered through three layers of gauze without squeezing for the determination of pH, ammonia-N and total volatile fatty acids (TVFA᾿s). Ruminal pH was estimated by pH meter (Orion Research, model 201 digital pH meter). Ruminal ammonia-N was determined according to Conway (1957). The TVFA᾿s were determined by the steam distillation method as described by Warner (1964). Fibrolytic bacteria (included Fibrobacter succinogenes) counting medium, the Hungate anaerobic culture method as described by Varel and Jung (1986) was used, the composition of the cellulose and xylan agar plate medium per 100ml. Amylolytic bacteria (included Streptococcus bovis) counting medium, Azide dextrose agar was used for counting S. bovis by Abshire (1977).

Blood samples were taken after the end of the collection period from the jugular vein of dairy cows before feeding and at 2, 4 and 8hrs post- feeding from three animals of each treatment. Blood samples were separated by centrifugation at 4000 r.p.m for 10 minutes. The serum samples were frozen at -20°C until analysis for Leptin, Insulin, FFA, Glucose, Cholesterol, Triglycerides, Total protein, urea and NEFA (None esterified fatty acids). Different items of the blood picture tested in this experiment were carried out according to the corresponding references illustrated in the following illustration using commercial Kits,

References used for the blood profile analyses were as follows:

Criteria	References
Leptin	Ahima and Flier (2000)
Insulin	Cohen *et al*. (1996)
FFA	Zollner and Kirsch (1962)
Glucose	Trinder (1969)
Cholesterol	Allain *et al*. (1974)
Triglycerides	Fossati and Prencipe (1982)
Total Protein	Gornall *et al*. (1949)
Urea	Faweett and Scott (1960)
NEFA (Non esterified fatty acids)	Cunningham (1992)

Data were statistically analyzed by variance test method according to Snedecor and Cochran (1982) while the differences among means were tested using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition of the ingredients and experimental rations were as shown in Table (1). The CP% was higher for CG 10%, CG 15% and CG20% of CFM and lower in CF, ADF and ADL%

compared with CG 0% of CFM. However, the CFM with or without CG were contained similar values of NFE, Ash, NDF, hemicellulose and NFC %. The chemical compositions of the experimental rations were contained similar of all nutrients. The CP% values ranged from 10.32 to 11.85, ADF% values were from 34.56 to 35.41 and NFC% values were ranged from 26.00 to 26.35. The average daily dry matter intake of each experimental ration was shown in Table (2). The dry matter intake (% body weight) was higher with feeding on Exp.1 or Exp.2 than feeding on control or Exp.3. The NRC (1989) recommended that diets for lactations dairy cows should contain minimum of 25% to 28% of the total DM as NDF, and it is suggested that 75 % of that NDF should be from a forage source. For providing highly digestible neutral detergent fiber (NDF) and non-fiber carbohydrates, utilization of more by-product feeds and high-quality forage was suggested as a strategy for lactating cow diets with high corn prices (Shaver, 2008).

As shown in Table (3), the apparent digestibility of CP was significantly ($P<0.05$) higher with feeding on control than feeding on Exp.1, Exp.2, and Exp.3, but there was no significant effect among the experimental diets Exp.1, Exp.2 and Exp.3. The NFC digestibility was higher with feeding on control than feeding on Exp.2, but without significant effects with feeding on Exp.1 or with Exp.3, also there was no significant effect among Exp.1, Exp.2 and Exp.3. The same trend was observed with the TDN%. The TDN% values were 72.74, 70.18, 66.45 and 68.8% with feeding on control, Exp.1, Exp.2 and Exp.3 respectively, the same trends were also, with ME (Mcal/kg), ME (Mj/kg) and NE_L (Mcal/kg), there were no significant differences among other nutrients digestibility. The effect of feeding more grain or increasing rumen starch digestion on milk yield varies. Increases milk yield is often observed with increased grain feeding or increased ruminal degradation of starch, but if too rapid ruminal starch digestion causes acidosis, milk yield may decrease (Grummer, 1995). Total tract digestibility (%) of starch was lower for the low starch diets, but ruminal digestion (%) of starch was not affected by starch concentration. However, the corn grain treatment did not affect the productivity of cows fed the low starch diets. Oba and Allen (2003) gusted that the optimal ruminal starch digestibility is dependent on the starch content and fermentabililty of the diets.

As shown in Table (4) the pH values were ranged from 6.16 to 7.59 with different treatments and at all measuring times. The pH values decreased with advancing time (0, 2 and 4 hrs), then increased once again at 8 hrs post-feeding. The mean value was higher ($P<0.05$) with feeding on control and lower with feeding on Exp.1, while there were no significant differences when feeding on Exp.2 and Exp.3 or between Exp.1 and Exp.2 or Exp.3. Ruminal pH is high before the morning feeding because extensive rumination and limited feed intake occur at night. After feeding the pH drops and the extent of this decline depends upon the size and fermentability of the meal (Russell and Wilson, 1996). The by-products of grains that contain more fiber and less starch. In most instances the fiber of these by-products such as corn gluten feed, are highly digestible by rumen microbes. Exceptions of this include cottonseed hulls and rice hulls which are not readily digestible. In addition to containing digestible fiber many by-products contain a greater level of protein as compared to corn (Weinder and Grant, 1994).

A higher pH typically favors the cellulolytic microoragnisms (Fibrobacter succinogenes, Ruminococcus flavefaciens and Ruminococcus albus) that yield a higher proportion of acetic and butyric acids. On the other hand a lower pH tends to favor the amylolytic microorganisms that yield a higher proportion of propionic acid. Kinetics of cellulose digestion is first order and cellulose digestion is limited by availability of substrate, not by cellulolytic capabilities of the resident microflora (Weimer, 1998). Therefore availability of fiber, the total amount and surface accessible for digestion, plays an important role in production performance. Ruminal pH increased linearly from 6.28 to 6.55 as ADF intake increased (Lu *et al.*, 2008). As shown in Table (4), the mean values showed that the TVFA's concentration was significantly ($P<0.05$) higher in control group than feeding on Exp.1 or Exp.2 or Exp.3, but there was no significant effect among Exp.1, Exp.2 and Exp.3, Volatile fatty acids are the end products of microbial fermentations in the rumen. These products are absorbed across the rumen wall and utilized for biochemical synthesis, further producing products that can be served as energy sources, deposited as body fat, or synthesized into milk fat (Lu *et al.,* 2008). Feeding more grain, or feeding grains with higher ruminal starch digestibility, generally provides the cow with more energy. Starch is fermented in the rumen to VFA (acetate, propionate and butyrate) which ate then absorbed and serve as the main sources of energy for the cow. Additionally, propionate is the primary precursor for synthesis of glucose by the liver. The amount of organic matter, particularly starch, fermented in the rumen is commonly viewed as the driver of microbial protein synthesis. Understanding starch digestion is the key to optimizing protein and energy supply to the cow, and to improving the efficiency and effectiveness of high grain diets.

Table (1): The chemical composition of the ingredients and experimental rations.

Item	DM	Chemical composition (% as DM)														
		OM	CP	EE	CF	NFE	Ash	NDF	ADF	Hemi.	Cell.	ADL	NFC*	UNDF[1]	ANDF[2]	NDS[3]
Ingredients																
$CFM_{0\%}$	92.33	92.25	13.69	2.29	12.29	63.98	7.75	39.91	23.01	16.9	14.01	9.00	36.36	8.62	31.29	60.09
$CFM_{10\%}$	91.20	92.39	15.2	2.16	11.74	63.29	7.61	39.11	22.27	16.84	13.81	8.46	35.92	7.94	31.17	60.89
$CFM_{15\%}$	91.08	92.45	15.97	1.93	11.36	63.19	7.55	38.5	21.59	16.91	13.83	7.76	36.05	7.17	31.33	61.5
$CFM_{20\%}$	91.32	92.42	16.69	1.81	11.03	62.89	7.58	37.83	21.16	16.67	13.63	7.53	36.09	6.84	30.99	62.17
Corn silage	31.60	89.96	10.67	3.31	30.62	45.36	10.04	44.34	33.02	11.32	27.67	5.35	31.64	5.69	38.65	55.66
Corn gluten feed	95.48	95.37	30.17	2.74	8.53	53.93	4.63	35.13	12.09	23.04	10.1	1.99	27.33	1.68	33.45	64.87
Rice straw	92.36	83.69	3.87	1.56	35.48	42.78	16.31	74.47	59.84	14.63	43.24	16.60	3.79	29.67	44.80	25.53
Experimental rations																
Control	67.47	89.37	10.32	2.28	22.39	54.38	10.63	50.6	35.41	15.19	24.94	10.47	26.17	12.71	37.89	49.40
Exp.1	66.46	89.54	11.22	2.23	21.95	54.14	10.46	49.74	34.60	15.14	24.55	10.05	26.35	12.00	37.74	50.26
Exp.2	67.10	89.47	11.50	2.09	21.93	53.95	10.53	49.88	34.69	15.19	24.87	9.82	26.00	11.76	38.12	50.12
Exp.3	67.34	89.44	11.85	2.02	21.82	53.75	10.56	49.52	34.56	14.96	24.83	9.73	26.05	11.56	37.96	50.48

Corn silage = CS, Corn gluten feed = CGF, Rice straw = RS.

Non fibrous carbohydrates%= OM% - (CP%+NDF%+EE %), Calsamiglia et al., 1995.

(1)UNDF: Unavailable NDF = NDF x 0.01 x ADL x 2.4 (Fox et al., 2000).

2) ANDF: Available NDF = NDF – UNDF.

(3) NDS: Neutral detergent solubles = 100 – NDF.

(Control): 52 % $CFM_{0\%}$ (40% corn grain, 30% wheat bran, 0% CGF, 23% undecorticated cotton seed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20 % CS + 28 % RS, Exp.1: 52 % $CFM_{10\%}$ (35% corn grain, 30% wheat bran, 10% CGF, 18% undecorticated cotton seed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20 % CS + 28 % RS, Exp.2: 52 % $CFM_{15\%}$ (32.5% corn grain, 30% wheat bran, 15% CGF, 15.5% undecorticated cotton seed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20 % CS + 28 % RS and (Exp.3): 52 % $CFM_{20\%}$ (30% corn grain, 30% wheat bran, 20% CGF, 13% undecorticated cotton seed meal, 5% molasses, 0.5% salt and 1.5% limestone) + 20 % CS + 28 % RS.

Table (2): Average daily dry matter intake of concentrate feed mixture, corn silage and rice straw by dairy cows.

Item	Control	Exp.1	Exp.2	Exp.3
Average body weight (kg)	535	485.7	491.7	510
Kg w$^{0.75}$	111.2	103.4	104.4	107.3
Concentrate : Roughage	52.4 : 47.6	52.8 : 47.2	52.3 : 47.7	52.3 : 47.7
Intake of dry matter: Concentrate feed mixture (CFM)				
Kg/h/d	9.08	8.66	9.03	8.68
% BW	1.70	1.79	1.84	1.71
Intake of dry matter: Corn silage (CS)				
Kg/h/d	3.32	3.27	3.32	3.16
% BW	0.62	0.68	0.67	0.62
Intake of dry matter: Rice straw (RS)				
Kg/h/d	4.93	4.46	4.93	4.77
% BW	0.92	0.92	1.00	0.94
Total dry matter intake (DMI)				
Kg/h/d	17.32	16.39	17.28	16.61
% BW	3.24	3.38	3.51	3.26

Table (3): Effect of the experimental rations on the digestion coefficients and feeding values by dairy cows.

Item	Control	Exp.1	Exp.2	Exp.3	SEM
Nutrient digestibility (%):					
DM	76.20	74.15	70.53	72.46	1.847
OM	78.64	75.74	72.04	74.72	1.960
CP	74.60^a	67.88^b	62.12^b	64.57^b	1.916
EE	86.21	84.68	76.54	78.00	1.745
CF	64.76	68.37	57.10	58.21	4.478
NFE	84.81	79.97	80.05	83.46	3.046
NDF	71.23	69.96	69.79	69.21	2.526
ADF	69.62	71.91	70.70	68.63	2.640
Hemi.	74.97	65.33	67.71	70.77	6.449
Cell.	76.88	73.17	73.87	75.93	2.714
ADL	52.34^{bc}	68.81^a	62.67^{ab}	49.99^c	3.574
NFC	93.88^a	89.20^{ab}	80.40^b	89.52^{ab}	3.248
Feeding value:					
TDN%	72.74^a	70.18^{ab}	66.45^b	68.80^{ab}	1.798
DCP%	7.70	7.62	7.14	7.65	0.261
ME (Mcal/kg)	2.59^a	2.50^{ab}	2.37^b	2.45^{ab}	0.064
ME (Mj/kg)	10.83^a	10.45^{ab}	9.89^b	10.24^{ab}	0.268
NE$_L$ (Mcal/kg) *	1.66^a	1.60^{ab}	1.51^b	1.57^{ab}	0.044
DDM% **	61.51^a	59.02^{ab}	56.44^b	58.14^{ab}	1.415
RFV***	154.63	154.81	153.55	147.40	6.911

a, b and c: Means within the same row with different superscripts are significantly different (p<0.05).

* *NE$_L$ (Mcal / kg) = (TDN% x 0.0245) – 0.12 (NRC, 2001).*

***DDM% of DM = 88.9 – 0.779 x (ADF% of DM) (Schroeder, 1996).*

****RFV = DMI x DDM / 1.29 (Schroeder, 1996).*

Table (4): Effect of feeding experimental rations on some rumen liquor parameters at different times of sampling.

Item	Hours	Control	Exp.1	Exp.2	Exp.3	SEM
pH-Values	0	7.59	7.29	7.36	7.49	0.123
	2	6.67	6.16	6.63	6.30	0.196
	4	6.78	6.37	6.37	6.53	0.212
	8	6.86[a]	6.21[b]	6.57[a]	6.58[a]	0.099
	Means	6.97[a]	6.51[b]	6.73[ab]	6.73[ab]	0.082
Total VFA's (ml eq /100ml)	0	3.23[ab]	2.83[b]	3.60[a]	3.30[ab]	0.162
	2	5.73[a]	4.93[b]	4.17[c]	5.20[ab]	0.210
	4	4.30	4.27	4.33	4.47	0.076
	8	4.47[a]	4.30[a]	3.93[ab]	3.73[b]	0.161
	Means	4.43[a]	4.08[b]	4.01[b]	4.18[b]	0.080
NH_3-N (mg/100ml)	0	16.33	16.33	14.00	14.67	1.00
	2	8.33	8.33	6.67	9.33	0.782
	4	11.33[a]	5.67[b]	6.33[b]	7.33[b]	0.601
	8	6.00[b]	10.67[a]	6.67[b]	7.00[b]	1.027
	Means	10.50[a]	10.25[a]	8.42[b]	9.58[ab]	0.435
%eNDF*		36.63[a]	25.58[c]	30.92[b]	30.78[b]	1.512

a, b and c : Means within the same raw with different superscripts are significantly different (p<0.05).

* % eNDF = (pH - 5.425) / 0.04229 (Fox et al., 2000).

Data presented in Table (4), showed that ruminal NH_3-N concentrations at 0, 2, 4 and 8 hrs post-feeding was ranged from 5.67 to 16.33 mg /ml rumen liquor with different treatments. The optimal concentration of ruminal NH_3-N required to maximize microbial protein synthesis are controversial, bur 5 mg /dl of NH_3-N maximized microbial protein synthesis (Satter and Slyter, 1974). Under in vitro conditions, NH_3-N started to accumulate when dietary N concentrations equivalent to 11-14 % CP (DM basis) were added to fermenters (Satter and Slyter, 1974). Karsli and Russell (2002) have indicated that concentrations of 11 to 13 % CP in diets were adequate to contain optimal microbial protein synthesis. Several studies have reported increased utilization of ruminal NH_3-N for microbial protein synthesis when diets contained readily digestible carbohydrate rather than starch in high fiber diets (Karsli and Russell, 2002). Microbial N synthesis was highest when highly ruminally available nonstructural carbohydrates (NSC) were combined with highly ruminally available protein, and lowest when highly ruminally available NSC were combined with poorly ruminally available protein. As shown in Table (4), the effective neutral detergent fiber (eNDF) values ranged from 25.58 to 36.63%. The eNDF was higher (P<0.05) with feeding on control than feeding on Exp.1 or Exp.2 or Exp.3. Effective NDF (eNDF) is the percentage of the NDF effective in stimulating chewing and salivation, rumination and rumen motility (Russell *et al.,* 1992). Effective NDF was calculated to estimate adjustments in ruminal pH useful when eNDF was below 30%. Fiber digestion is at normal levels (pH about 6.2 optimal) when eNDF is at least 20%. As forage NDF is replaced by non forage NDF total NDF digestibility seems to decrease as a result of increasing negative associative effects (Firkins, 1997). Similarly, as the ratio of forage NDF to ruminal degradable starch (RDS) decreases below 1:1, Poor *et al.* (1993) suggested that ruminal function was comprised by excessive acidity in the rumen. The by-product of starch digestion is the production of stronger acids as compared to weaker acids produced during fiber digestion. The production of stronger acids as a result of starch digestion causes a reduction in rumen pH. As the pH begins to decline, the rumen environment reaches a point where it is no longer suitable for the fiber digesting bacteria to digest fiber efficiency. This change in rumen environment results in a reduction in how fast fiber is digested. When balancing rations that require greater than 0.5% body weight as supplemental high starch grains such as corn, supplementation adjustments should be made because of the expectations for a reduction in forage intake. In general, to maximize the fermentation of forage fiber and NSC (sugars and starches) in the rumen, while maintaining rumen pH above 6.2. This requires an understanding to the nutritional needs of the rumen bacteria. The fiber-digesting bacteria require a constant supply of NH_3 to grow and manufacture microbial protein. Ammonia in the rumen comes from the fermentation-soluble and degradable protein plus recycled NH_3 from the saliva.

Data presented in Table (5) showed the ruminal fibrolytic bacteria count was almost higher (P<0.05) with feeding on Exp.1, Exp.2 and Exp.3 than feeding on control by advancing time post-feeding to record the highest (P<0.05) values at 4 hrs. post-feeding value of fibrolytic bacteria was higher (P<0.05) with feeding on Exp.2 than feeding on control or Exp.1 or Exp.3.

Table (5): Effect of feeding experimental rations on some microbial count in the rumen liquor.

Item	Hours	Control	Exp.1	Exp.2	Exp.3	SEM
Fibrolytic	0	5.00 [b]	7.17 [a]	6.57 [ab]	8.47 [a]	0.580
bacteria	2	8.00 [b]	9.00 [b]	16.00 [a]	6.83 [b]	1.530
(Microbial	4	7.33 [b]	5.67 [b]	22.17 [a]	11.00 [b]	1.652
count x 100000	8	10.67	10.67	14.33	12.33	2.088
CFU/ml)	Means	7.750 [b]	8.125 [b]	14.767 [a]	9.658 [b]	0.781
Amylolytic	0	4.17	4.10	3.67	3.67	0.708
bacteria	2	6.73 [a]	3.13 [ab]	1.93 [b]	3.20 [ab]	1.273
(Microbial	4	5.67 [a]	4.73 [ab]	2.97 [b]	2.90 [b]	0.703
count x 100000	8	8.47 [a]	3.78 [ab]	3.00 [b]	6.70 [ab]	1.386
CFU/ml)	Means	6.258 [a]	3.938 [b]	2.892 [b]	4.117 [b]	0.533
Microbial protein production (Ng/day)						
DM intake (Kg/h/day)		17.323	16.393	17.276	16.608	0.830
NE_L (Mcal/kg diet)		1.662 [a]	1.600 [ab]	1.508 [b]	1.565 [ab]	0.044
NE_L Intake (Mcal/day)		28.777	26.180	25.913	25.980	1.229
MCP N g/day[*]		219.333	200.667	198.667	199.000	8.865

a, b and c : Means within the same row with different superscripts are significantly different (p<0.05).

[*]MCP N g/day= -6.24 + (8.54xNE_L intake Mcal/day) – (0.024xNEI_L^2), (Oldick et al, 1999).

On the other hand, the ruminal amylolytic bacteria count was almost higher (P<0.05) with feeding on control at 2 hr up to 8 hrs post-feeding than feeding on Exp.2, while there was no differences among control or Exp.1 or Exp.3. The mean value was the highest (P<0.05) with feeding on the control than feeding on Exp.1 or Exp.2 or Exp.3.

As shown in Table (5), the calculated microbial protein production (g/day) was similar with feeding on the different experimental rations. Many mammals are herbivorous and consume plant material high in cellulose. Consequently these animals have evolved a close symbiotic relationship with the microorganisms which reside in their gut which aid the digestion of highly fibrous plant material for the host. A high fiber diet provides not only substrates that favor the growth of cellulolytic microbes, but also increase salivation through eating and ruminating. Salivation through its buffering capacity further increases ruminal pH that favors the growth of cellulolytic microbes (Lu *et al.,* 2008). Consideration of the nutrients required to support microbial growth indicates that major source of energy used by ruminal microorganisms is the mono saccharides, which are derived from the ruminal catabolism of ingested soluble and structural carbohydrates (Beever and Cattrill, 1994). A fermentable carbohydrate that releases energy at the same rate as N is released from dietary N source is also required for the most efficient utilization of nutrients by rumen microbes (Sinclair *et al.,* 1995). It seems that diets containing a mixture of structural and non-structural carbohydrate sources increase microbial protein synthesis and the efficiency of microbial protein synthesis because of an improved ruminal environment for more divers ruminal bacteria species and increased amount and type of substrates, available for microbial protein synthesis. In cows fed a high forage diet, the microbial population consists of a low number of lactate producers (starch digesters) and lactate users (convert lactate to acetate and propionate), and a large number of cellulolytic bacteria (Dann *et al.,* 1999).

As shown in Table (6) the leptin concentration was increased with advancing time from 0 up to 2 hrs. post feeding then decreased at 4 hrs and increased again at 8 hrs. post-feeding. The mean value was increased significantly (P<0.05) with feeding on Exp.1, Exp.2 and Exp.3 than feeding the control. The insulin concentrations were having the same trend with advancing times as shown in Table (6).

Table (6): Effect of experimental rations on some blood parameters.

Item	Hours	Control	Exp.1	Exp.2	Exp.3	SEM
Non-estrified fatty acids (NEFA), ml Eq/L	0	0.20	0.25	0.23	0.26	
	2	0.26	0.19	0.24	0.23	
	4	0.22	0.25	0.46	0.36	
	8	0.85	0.87	0.90	0.96	
	Mean	0.38	0.39	0.46	0.45	0.049
Leptin, ng/ml	0	0.90	1.00	1.47	2.10	
	2	3.37	3.43	3.73	3.93	
	4	3.63	3.40	3.37	3.87	
	8	3.17	4.13	3.90	3.90	
	Mean	2.77 [c]	2.99 [bc]	3.12 [b]	3.45 [a]	0.084
Insulin, ng/ml	0	0.19	0.19	0.22	0.23	
	2	0.24	0.23	0.28	0.27	
	4	0.23	0.20	0.19	0.24	
	8	0.24	0.27	0.25	0.28	
	Mean	0.23 [b]	0.23 [b]	0.23 [b]	0.25 [a]	0.006
Free fatty acids (FFA), mg%	0	5.81	5.92	6.42	6.14	
	2	8.30	8.96	8.45	9.79	
	4	10.96	11.21	11.15	11.18	
	8	11.18	11.34	10.92	10.93	
	Mean	9.06 [b]	9.36 [ab]	9.23 [ab]	9.51 [a]	0.105
Glucose, mg%	0	117.85	155.52	138.49	149.78	
	2	123.44	117.63	132.38	151.82	
	4	122.44	114.90	151.27	142.71	
	8	184.93	185.53	180.92	166.94	
	Mean	137.17	143.40	150.77	152.81	5.811
Cholestrol, mg%	0	71.32	65.96	69.11	67.19	
	2	57.32	65.23	43.74	40.68	
	4	46.35	46.51	43.97	40.55	
	8	33.28	31.82	48.91	46.86	
	Mean	52.07	52.38	51.43	48.82	2.316
Triglycerides, mg%	0	328.95	343.73	327.84	308.26	
	2	291.76	218.82	208.36	287.44	
	4	204.91	169.38	106.06	110.15	
	8	160.13	193.64	142.58	130.67	
	Mean	246.44 [a]	231.39 [a]	196.21 [b]	209.13 [b]	7.279
Total protein (T.P), g%	0	5.69	4.37	4.19	4.32	
	2	6.47	6.27	5.77	4.26	
	4	4.23	5.41	4.91	7.58	
	8	5.29	8.01	6.18	6.12	
	Mean	5.42 [b]	6.01 [a]	5.26 [c]	5.57 [b]	0.054
Urea, mg%	0	5.32	6.59	9.15	9.09	
	2	13.09	11.60	14.32	17.23	
	4	17.53	18.68	23.39	25.10	
	8	30.48	37.83	39.85	41.52	
	Mean	16.60 [c]	18.67 [b]	21.68 [a]	23.24 [a]	0.653

a, b and c : Means within the same row with different superscripts are significantly different ($p < 0.05$).

The free fatty acids (FFA's) concentrations were increased with advancing time from 0 to 8 hrs post feeding as shown in Table (6). The mean value was higher (P<0.05) with feeding on Ex.3 than feeding on control, but there were no significant differences when feeding control or Exp.1 and Exp.2. In the reversal situs, triglycerides concentrations were decreased with advancing time from 0 to 8 hrs. post feeding as shown in Table (6). The mean values were higher (P<0.05) with feeding on control and Exp.1 than feeding on Exp.2 and Exp.3 as shown in Table (6). There were no significant effects on the mean values of cholesterol concentrations with feeding the experimental rations. The total protein concentrations were ranged from 4.19 to 8.01 g/100ml with feeding on the experimental rations at all times, as shown in Table 6. The mean value was higher (P<0.05) with feeding on Exp.1 than feeding on control, Exp.2 and

Exp.3.The urea concentrations were increased with Exp.1 or Exp.2 or Exp.3 than feeding on control at all times, as shown in Table (6).There was no significant effect with feeding experimental rations on glucose or non-esterified fatty acids (NEFA) concentrations. The results in Table (6) shown that, the highest concentration of glucose, insulin and leptin were observed with feeding on Exp.2 and Exp.3 compared with feeding on control or Exp.1, while the highest concentrations of total protein and triglycerides and lowest concentrations of urea and NEFA were with feeding on control and Exp.1 compared with feeding on Exp.2 and Exp.3. Ruminant animals maintain low blood glucose concentration (<70 mg/dl) compared to non-ruminant animals (>0.85 mg/dl). Low blood glucose is the result of microbial fermentation of dietary sugars and starches to the VFA propionate, with minimal glucose being presented to the small intestine for absorption. In contrast, ruminants maintain higher blood glucose concentrations more similar to that of non-ruminant animals. Hyperglycemic response (blood glucose concentrations >200 mg/dl) in response to even minimal stress situations. Elevated blood glucose can be somewhat explained by studies showing a sluggish insulin response and moderate insulin resistance, somewhat similar to diabetes condition (Cebra *et al.*, 2001). Insulin was positively correlated with glucose and total protein, but negatively correlated with total cholesterol. Insulin regulates the use of glucose and therefore glucose uptake by cells depends on the hormone insulin (Wettemann *et al.*, 2003). In early lactation, when cows are in negative energy balance, they may develop ketosis and experience depressed insulin and glucose levels, with elevated ketones, free fatty acids, and cholesterol in the blood. There is a positive relationship between nutrient intake and concentration of leptin in plasma of cattle, as increased plane of nutrition is associated with increased circulating leptin concentrations (Leon *et al.,* 2004). Glucose is utilized by all animal cells to produce energy (Richards *et al.*, 1995), glucose concentration was significant and positively correlated with total protein but negatively correlated to urea. Total cholesterol was positively correlated with urea. Due to poor nutritional status and body condition score (BCS) of the experimental cows, relatively less fat was available to be metabolized to provide energy. Thus more protein was metabolized to meet the energy requirements and this elevated the urea and creatinine concentrations (Damptey *et al.,* 2013). In most circumstances glucose requirement can be predicted reasonably well from ME intake (Reynolds, 1995), or on the basis of milk yield (milk lactose yield/ 0.7). On the other hand, the concentration of plasma insulin decreases dramatically as calving approaches and remains low in the first week postpartum. The concentration of plasma somatotropin increases dramatically and rapidly postpartum. This decrease in insulin combined with a decrease in sensitively of adipose tissue to insulin and the increase in somatotropin results in a decrease in the synthesis of triglycerides in adipose and favors their mobilization (Lanna and Bauman, 1990). Therefore, there is a resulting increase in plasma NEFA at calving. The somatotropin, in concert with elevated cortisol, stimulates the liver to produce more glucose.

The present study suggested that corn grain and undecorticated cottonseed meal can be replaced by 15% corn gluten feed are often considered providing the proper amounts of ruminally fermentable carbohydrates are critical to optimizing ruminal fermentation and generating volatile fatty acids and microbial protein for energy and amino acid use by the lactating Friesian cows.

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تأثير التغذية على مستويات مختلفة من الجلوتوفيد على معاملات الهضم ، المأكول ، بعض قياسـات الـدم وبعض مقاييس الكرش فى علائق الأبقار الفريزيان الحلابة.

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تهدف هذه الدراسة إلى تقييم الإستبدال الجزئي لكل من مستخلص كسب القطن غير المقشور والأذرة الصفراء بجلوتوفيد الأذرة ، وتأثير ذلك على معاملات الهضم والقيمة الغذائية ومقاييس سائل الكرش وبعض قياسات الدم في أبقار الفريزيان الحلابة ، وقد تم إجراء هذه الدراسة بمحطة بحوث الإنتاج الحيواني بالقرضا، التابعة لمعهد بحوث الإنتاج الحيواني، مركز البحوث الزراعية، وزارة الزراعة، مصر بالتعاون مع قسم الإنتاج الحيواني – كلية الزراعة – جامعة المنصورة.

وقد إشتملت الدراسة على أربعة مجموعات تحتوي كل مجموعة على ثلاث أبقار فريزيان حلابة في المواسم من الثاني إلى الرابع و بمتوسط وزن ٤٣٥ – ٥٧٠ كجم.

وتم تكوين أربعة أنواع من العلف المُركز كما يلي:-

١- علف مُصنع (مقارنه) وهو يتكون من: ٤٠٪ أذرة + ٣٠٪ نخالة + ٢٣٪ مستخلص كسب قطن غير مقشور + ٥٪ مولاس + ٠,٥٪ ملح + ١,٥٪ حجر جيري.

٢- علف مُصنع (يحتوي على ١٠٪ جلوتوفيد الأذرة) وهو يتكون من: ٣٥٪ أذرة + ٣٠٪ نخالة + ١٠٪ جلوتوفيد + ١٨٪ مستخلص كسب قطن غير مقشور + ٥٪ مولاس + ٠,٥٪ ملح + ١,٥٪ حجر جيري.

٣- علف مُصنع (يحتوي على١٥٪ جلوتوفيد الأذرة) وهو يتكون من: ٣٢,٥٪ أذرة + ٣٠٪ نخالة + ١٥٪ جلوتوفيد + ١٥,٥٪ مستخلص كسب قطن غير مقشور + ٥٪ مولاس + ٠,٥٪ ملح + ١,٥٪ حجر جيري.

٤- علف مُصنع (يحتوي على٢٠٪ جلوتوفيد الأذرة) وهو يتكون من: ٣٠٪ أذرة + ٣٠٪ نخالة + ٢٠٪ جلوتوفيد +١٣٪ كسب قطن غير مقشور + ٥٪ مولاس + ٠,٥٪ ملح + ١,٥٪ حجر جيري.

وباستخدام المواد العلفية الخشنة تم تكوين العلائق التجريبية الأربعة كما يلي:-

١- عليقة المقارنه: ٥٢٪ علف مُصنع (خالي من جلوتوفيد الأذرة) + ٢٠٪ سيلاج أذرة + ٢٨٪ قش أرز.
٢- عليقة تجريبية أولى: ٥٢٪ علف مُصنع (يحتوي على ١٠٪ جلوتوفيد الأذرة) + ٢٠٪سيلاج أذرة + ٢٨٪ قش أرز.
٣- عليقة تجريبية ثانية: ٥٢٪ علف مُصنع (يحتوي على١٥٪ جلوتوفيد الأذرة)+ ٢٠٪ سيلاج أذرة + ٢٨٪ قش أرز.
٤- عليقة تجريبية ثالثة: ٥٢٪ علف مُصنع (يحتوي على٢٠٪ جلوتوفيد الأذرة) + ٢٠٪ سيلاج أذرة + ٢٨٪ قش أرز.

وقد تم تكوين العلائق حتى تكون متماثلة تقريباً فى محتواها من البروتين الخام والطاقة.

تم تغذية حيوانات التجربة فردياً وتم إجراء تجارب الهضم بطريقة مستخلص الرماد غير الذائب فى الحامض.

وكانت أهم النتائج المتحصل عليها كما يلى:

- زادت كمية المأكول عند التغذية على العليقة التجريبية الأولى و الثانية (٣,٣٨ و ٣,٥١ ٪ من وزن الجسم الحى على التوالي) مقارنة بعليقة المقارنة أو العليقة التجريبية الثالثة (٣,٢٥ ، ٣,٢٦٪ من الجسم الحى على التوالي).

- زاد معامل هضم البروتين الخام معنوياً مع عليقة المقارنة (٧٤,٦٠٪) مقارنة بالعلائق التجريبية الأولى والثانية والثالثة (٦٧,٨٨ و ٦٢,١٢ و ٦٤,٥٧٪) على الترتيب، ولم توجد فروق معنوية على مستوى (٠,٠٥) بين العلائق التجريبية الثلاثة. بينما كانت قيم المركبات الغذائية الكلية المهضومة عند التغذية على العلائق الأربعة ٧٢,٧٤ و ٧٠,١٨ و ٦٦,٤٥ و ٦٨,٨٠٪ عند التغذية على عليقة المقارنة والعلائق التجريبية الأولى والثانية والثالثة على التوالى.

- تراوحت درجة حموضة سائل الكرش بين ٦,١٦ إلى ٧,٥٩ عند التغذية على العلائق الأربعة وكان متوسط درجة الحموضة عالية (٦,٩٧) معنويا على مستوى (٠,٠٥) عند التغذية على عليقة المقارنة مقارنة بالتغذية على العليقة التجريبية الأولى (٦,٥١).

- كانت قيم تركيزات الأحماض الدهنية الكلية الطيارة بسائل الكرش تتراوح ما بين ٢,٨٣ إلى ٥,٧٣ (مللي مكافئ / ١٠٠مللي لتر) ، بينما زاد تركيز الأحماض الدهنية الكلية الطيارة بسائل الكرش معنوياً مع عليقة المقارنة بالعلائق التجريبية الثلاثة والتى لم توجد فروق معنوية بينهم ، وقد كانت قيم تركيزات نيتروجين الأمونيا بسائل الكرش تتراوح ما بين ٥,٦٧ إلى ١٦,٣٣ (مللي جرام / ١٠٠مللي لتر) عند التغذية على العلائق الأربعة.

- زاد متوسط أعداد البكتيريا المحللة للألياف معنويا على مستوى (٠,٠٥) عند التغذية على العليقة التجريبية الثانية (١٤,٧ × ١٠⁹ خلية / مللى) مقارنة بالتغذية على العليقة الكنترول أو العليقة التجريبية الأولى أو الثالثة (٧,٧٥ , ٨,١٢ , ٩,٦٥ × ١٠⁹ خلية / مللى على

الترتيب) بينما زادت أعداد البكتريا المحللة للنشا معنويا على مستوى (٠,٠٥) عند التغذية على العليقة الكنترول (٦,٢٥ × ١٠ ° خلية / مللى) مقارنة بالتغذية على العلائق التجريبية الأولى والثانية والثالثة (٣,٩٣ ٬ ٢,٨٩ ٬ ٤,١١ × ١٠ ° خلية / مللى على الترتيب).

- زاد تركيز الأنسولين معنويا على مستوى (٠,٠٥) بالتغذية على العليقة التجريبية الثالثة (٠,٢٥ نانو جرام /مللى) مقارنة بالتغذية على العليقة الكنترول أو العلائق التجريبية الأولى أو الثانية (٠,٢٣ نانو جرام/مللى).

- زاد تركيز الجلسريدات الثلاثية معنويا على مستوى (٠,٠٥) بالتغذية على العليقة الكنترول والعليقة التجريبية الأولى (٢٤٦,٤٤ ٬ ٢٣١,٣٩ملليجرام/١٠٠ مللى على الترتيب) مقارنة بالتغذية على العليقة الثانية أو الثالثة (١٩٦,٢ ٬ ٢٠٩,١٣ مللليجرام/١٠٠ مللى على الترتيب).

- زاد تركيز اليوريا معنويا على مستوى (٠,٠٥) بالتغذية على العليقة التجريبية الثانية أو الثالثة (٢١,٦٨ ٬ ٢٣,٢٤ مللليجرام/١٠٠ مللى على الترتيب) مقارنة بالتغذية على العليقة الكنترول أو العليقة التجريبية الأولى (١٦,٦ ٬ ١٨,٦٧ مللليجرام/١٠٠ مللى على الترتيب).

ونستخلص من هذه الدراسة أن إحلال نسبة من حبوب الأذرة وكسب القطن غير المقشور بما لايزيد عن ١٥% بجلوتوفيد الأذرة فى مخلوط العلف المصنع (على أساس المادة الجافة) تكون مناسبة لزيادة أعداد البكتريا المحللة للألياف لمعظمة تخمرات الكرش وإنتاج أحماض دهنية طيارة وتكوين بروتين ميكروبي مما يؤدى الى زيادة الإستفادة من الطاقة والأحماض الأمينية فى علائق الأبقار الفريزيان الحلابة.