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Assessment of Nutritional Value of Caraway-Seed Pulp for Feeding Holstein Dairy Cattle

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Abstract: A study was made to evaluate the nutritional value of the Caraway-Seed Pulp (CSP) in concentrate component of the diet on the performance and blood metabolite of lactating Holstein cattle. Eight Holstein cattle (mean 40 days after calving) were allocated in 4 treatments based on Latin square design experiment. The treatments offered to animals were different levels of CSP, which substituted by Wheat Bran (WB) in concentrate by the following order: 0.0% CSP(100% WB-0.0% CSP as a control group); 33.3% CSP (66.7% WB, 33.3% CSP); 66.6% CSP (33.3% CSP+66.6% WB) and 100% CSP (0.0% WB+100% CSP). Nutrient composition in CSP based of DM were DM-37.6%, Protein-15.2%, fat-6%, NDF-55%, ADF-51% and Ash-14.5%. Overall feed intake was not statistically differ between treatments, however numerical improvement was observed in treatment 100% CSP compared to others although, the differences was not significant ($p>0.05$). The milk production and its composition results for all treatment was not significantly different ($p>0.05$). However, trend was to improve in milk fat by increasing CSP levels in diet with higher rate for treatment 100% CSP. Results obtained from blood metabolite analysis indicated that concentration of glucose was higher in treatment 0.0% CSP (control) compared to others, also, serum concentrate of SGOT and SGPT trended to increase by substitution of CSP in diet ($p<0.05$). Rumen N-NH_3 and pH was not affected by any treatments. Obtain data from this study indicated that substitution of WB by CSP had not adverse effects on dairy cattle health and performance.

Key words: Caraway seed pulp, dairy cattle, SGOT, SGPT, milk

INTRODUCTION

Factors hinder animal production in Middle East, as well as other countries are many and critical. Among of them unstable price and scarcity of some of the conventional feed sources. Caraway (*Bunium persicum* (Boiss)) is an edible plant with longstanding uses as a dietary herbal supplement (Valizadeh *et al*., 2007). Caraway Seed Pulp (CSP) is an agro-industrial by-product from extract spice and herb industry. It is estimated that >6000 tons Caraway produced in IR of Iran each year. At this present, after extracting its juice in spice and herb industry, 93% of its will converted to CSP. Due to shortage of feedstuff in one hand and desirable nutrient content of CSP, it is appear this agro-industrial by product can be use as a good sources of feed ingredient in ruminant nutrition. High yielding dairy cows require an energy dense ration; however, high concentrate and low fiber diets may contribute to metabolic acidosis and reduced milk yield and its fat content (NRC, 2001). The CSP are high in protein and fat with reported Ether Extract (EE) of 6%, CP of 15.2%, ADF of 51% and NDF of 55%.

Because of the high protein, fat and fiber content in caraway seed pulp, it is appear that CSP to be a desirable feed ingredient in early stages of lactation of dairy cattle. Unfortunately, there is no data available on the nutritional value of CSP, especially in dairy cattle. However, an acceptable amount to include CSP in lactating cow rations should be determined.

The main objectives of present experiment were to evaluate the effects substitution of CSP with wheat bran on feed intake, milk yield and its composition and some blood metabolites of lactating dairy cattle.

MATERIALS AND METHODS

The present experiment study was conducted during the period from February 25th to May 20th, 2008 at the Ferdowsi University Dairy Cattle Research Unit (FUDCRU) Mashhad-Iran. Eight lactating mutiparous lactating Holstein cows averaging 50 (±10) days of postpartum and 600 (±45) kg weight were selected for this study. Cows were kept individually in fixed stalls. Cows were adapted to the experimental area and training to use gate feeder for 7 days prior to start the experiment. Dairy

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Table 1: Chemical composition of wheat bran and CSP as to dry matter basis[1]

	Chemical composition[2] (%)						
Items	DM	CP	Fat	NDF	ADF	ASH	Tannin
WB	890.±2.00	17.1±0.4	4.4±0.5	51.0±1.3	15.57±2.06	15.0±2.04	-
CSP	94.6±2.05	15.1±0.5	6.0±0.6	55.0±1.2	50.57±2.06	14.0±0.20	1.1

[1]Number of samples analyzed for each items = 5, [2]WB: Wheat Bran; CSP: Caraway Seed Pulp; DM: Dry Matter; CP: Crude Protein; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre

cows were randomly allocated to the 4 treatments based daily milk production (based on 10 days before start of experiment) in a 4×4 Latin square design.

Four dietary treatments offered to animals were different levels of CSP, which substituted for Wheat Bran (WB) in ration and were: 0.0% CSP (100% WB-0.0% CSP as a control group); 33.3% CSP (66.7% WB,33.3% CSP); 66.6% CSP (33.3% CSP+66.6% WB) and 100% CSP (0.0%WB+100%CSP). Diets were formulated bases on (NRC, 2001). Nutrient requirement of dairy cattle. Cows were offered a TMR to approximately 10% excess and had a free access to water. Ration ingredients and their composition are shown in Table 1. Feed offered was adjusted base on previous week consumption. Each experimental period was 21 days including 14 days adaptation period and 7 days for collection of samples. Feed intake and milk yield were measured daily during collection periods. Samples of CSP and feed ingredients and TMR were taken once during the collection periods, dried in a forced air oven at 60°C to a constant weight.

Milk samples in 3 sequential days during collection periods were taken from the milking times (3 times a day) and were analyzed using milk analyzer to estimate percentage of fat, protein, lactose, Total Solid (TS) and Solid Non Fat (SNF). Blood samples were collected from all animal on the last day of each experimental period.

Ten milliliter of blood was collected from the jugular vein into evacuated tubes at about 3-4 h post feeding and allowed to coagulate and serum was harvested and kept frozen at -20. Meanwhile serum samples were analysis for glucose, BUN, cholesterol, albumin, SGPT (Serum Glutamic Pyruvate Transaminase) and SGOT (Serum Glutamic Oxalate Transaminase) concentrating. Cows were weighted 3 times during last week of each period immediately following the pm milking before cows access to feed and water.

All data were subjected to standard analysis of variance using General Linear Model (GLM) of SAS (9.1). Significance between individual means was identified using Tukey's multiple range test. Mean differences were considered significant at $p<0.05$. Standard errors of means were calculated from the residual mean square in the analysis of variance.

RESULTS AND DISCUSSION

The chemical compositions of CSP and wheat bran are shown in Table 1. As it is shown in Table 1, there was

Table 2: Ingredient and chemical composition of experimental diets

	CSP subsituated with WB[1] (%)			
Items	0	33.3	66.6	100
Dietary ingredient				
Alafalfa hay	17.50	17.50	17.50	17.50
Corn silage	23.75	23.75	23.75	23.75
Ground corn	22.50	22.50	22.50	22.50
Barly	5.00	5.00	5.00	5.00
Soybean meal	8.25	8.25	8.25	8.25
Canola meal	5.00	5.00	5.00	5.00
Wheat bran	10.00	6.70	3.30	0.00
CSP	0.00	3.30	6.70	10.00
Sugar beet pulp	7.50	7.50	7.50	7.50
Dicalcium phosphate	0.35	0.35	0.35	0.35
Mineral premix	0.25	0.25	0.25	0.25
Salt	0.10	0.10	0.10	0.10
Chemical composition				
DM (%)	61.60	61.80	70.10	71.15
NE_l (Mcal kg^{-1})	1.58	1.60	1.62	1.67
CP (%)	16.90	16.70	16.20	16.00
NFC (%)	42.80	43.50	40.80	41.60
EE (%)	4.20	4.50	5.00	5.20
NDF (%)	30.40	30.80	31.70	32.00
ADF (%)	16.60	17.90	18.30	20.90
Ca (%)	0.90	0.90	1.00	1.00
Ph. (%)	0.50	0.50	0.50	0.50

[1]Dry matter basis

no considerable variation between these two feed sources. Cell wall content (NDF and ADF), which represented the most important fraction of dry matter ranged from 51.0-55.0, 15.57-50.57, respectively. However, the CP content of WB was considerable higher than CSP.

Rising CSP from 0-10% in TMR increased EE in the ration from 4.2-5.2% of DM and also ADF from 16.6-20.9% (Table 2). However, DM, NE_l and NDF also a little increased, although, CP was sufficient for the milk yield encountered in this study (NRC, 2001). Offered ration composition are given in Table 2.

The voluntary feed intake, milk yield and its composition shown in Table 3. The dry matter feed intake during different periods of study was not significantly affected by CSP content in diets. Intake of DM changed slightly as dietary CSP increased and was greatest for cows consumed 100% CSP and lowest for cows fed control diet (0.0% CSP). However, the differences were not statistically significant. The results were consisted with those of Frutos *et al.* (2004). Makkar (2003) reported that drying roughage, containing tannin increased intake due to polymerisation of tannin and reduction of

Table 3: Effect of CSP on DMI, Milk yield, milk composition and body weight

	CSP subituated with WB[1] (%)					
Factors	0	33.3	66.6	100	SE	p-value
DMI (kg day^{-1})	22.22	22.93	22.33	23.53	0.17	0.28
DMI (kg/100 kg)	3.32	3.70	3.90	4.01	1.01	0.11
Milk yield (kg day^{-1})	36.28	37.24	36.30	37.00	0.03	0.81
4% FCM[2] (kg day^{-1})	29.96	31.24	31.17	32.20	1.80	0.70
Milk/DMI (kg kg^{-1})	1.63	1.62	1.62	1.57	1.50	0.90
4% FCM/DMI (kg kg^{-1})	1.34	1.36	1.39	1.36	1.01	0.70
Milk fat (%)	2.84	2.94	3.06	3.15	0.06	0.58
Fat yield (kg day^{-1})	1.03	1.09	1.11	1.16	0.01	0.61
Milk protein (%)	2.67	2.63	2.59	2.61	0.02	0.92
Protein yield kg day^{-1}	0.96	0.97	0.94	0.96	0.03	0.95
Lactose (%)	4.54	4.54	4.44	4.52	0.02	0.57
Lactose yield (kg day^{-1})	1.64	1.69	1.61	1.67	0.01	0.84
SNF (%)	7.80	7.90	7.74	7.87	0.02	0.59
TS (%)	10.69	10.85	10.92	10.99	0.08	0.80

[1]Means with different letters at the same variable within the same row are significantly different ($p<0.05$), [2]4% FCM = (0.4×kg milk) + (15×kg fat)

hydroxyls group to react with protein. One of explanation for decrease feed intake in this study may be due to higher tannin EE in diets containing 100% CSP than control diet as indicated in (Table 2).

The effect of different level of CSP on milk yield and its composition are shown Table 3. There was a increase in milk fat content when the concentration of CSP in the diet increased, although, this trend was not statistically significant. Milk fat percentage increased with addition of CSP to the diet. Milk protein percentage declined linearly with increasing dietary CSP (Table 3). Coppock and Wilks (1991) summarized in which supplemental fat was added to studies dairy diets and reported that in many instances, fat addition reduced milk protein percentage. In this experiment, the EE content of diets was greater as CSP increased (Table 2) and EE addition of content apparently was related to the degree of milk protein depression (Table 3).

Khorasani *et al.* (1991) reported a linear decline in milk protein percentage when increasing amounts of canola seed were added to dairy diets so that EE increased incrementally from 2.2-6.7% of dietary DM. However, milk protein percentage could have been affected by the reduced protein availability caused by the protein binding effects of tannins.

Data analysis (Table 4) revealed that blood glucose level of control group were higher ($p<0.05$) than other treatments. Such significant increase in blood glucose level may be attributed to a significant in ruminal propionate production due to lower level of tannin. propionate is passed from rumen to liver where it is transform to glucose via gluconeogenesis (Young *et al*., 1974; Sastradipradja, 1998).

In this study Tukey's test show non significantly differences in serum urea nitrogen. Blood urea levels have often been related to degradable protein intake (O'Mara *et al*., 2000). Concentration of glucose urea nitrogen and serum albumin were related to sufficiency of energy and crud protein intake. There were no significant changes in serum albumin however, effect of treatments on serum cholesterol was significant. Cholesterol increased toward to increasing dietary CSP and was greatest for cows offered the 100% CSP diets. One of explanation for increasing cholesterol in serum in this experiment may be due to the greater fat in serum, which is indicated in milk fat. This finding is agreed with experimental data of Kazemi *et al.* (2009).

In the present study SGOT and SGPT were measured to determine the effect of CSP on liver function. Table 4 reveals that SGOT and SPT concentration was increase toward substitution of CSP in diets and the differences was statistically significant ($p<0.05$). Concentration of these enzyme indicated of variation in liver function, which might occur with feeding of CSP. Plasma concentration of SGPT and SGOT are resemble as a factors of liver health and performance. It has been supposed that the elevation of SGPT and SGOT might indicated an accretion of some abnormal metabolites transferred from blood stream to hepatocytes (Xu *et al*., 1998). However, the differences between treatment were significant but these concentration were in the safe range in animal. However, there has not been enough information on study regarding the effect of CSP on hepatic enzyme in animals, especially for ruminants.

Ruminal pH and Ammonia N concentration are shown in Table 5. Mean ruminal pH was no affected by altering the amount of CSP in diets. There was a non significant trend to lower NH_3-N for higher ratios of CSP. In a review, Frutos *et al.* (2004) reported that tannins react with proteins to form protein-tannin complexes, inhibiting

Table 4: Blood metabolite concentrations of cows fed the different experimental diets

	CSP substituted with WB[1] (%)					
Concentrations	0	33.3	66.6	100	SE	p-value
Serum glucose (mg dL^{-1})	56.88^{a}	44.76^{ab}	42.86^{b}	46.81^{ab}	1.45	0.06
Serum urea N (mg dL^{-1})	21.20	20.30	18.10	19.70	0.24	0.70
Serum albumin (g dL^{-1})	4.55	4.62	4.44	4.33	0.05	0.40
Serum cholestrol dL^{-1}	143.23^{b}	166.66^{ab}	170.39^{a}	186.68^{a}	2.82	0.01
SGOT[1] (U L^{-1})	60.50^{c}	81.75^{b}	86.62^{b}	97.12^{a}	0.58	0.01
SGPT[2] (U L^{-1})	22.12^{c}	25.00^{b}	25.62^{b}	26.32^{a}	0.29	0.01

[1]Means with different letters at the same variable within the same row are significantly different ($p<0.05$), [2]Glutamic-Pyruvic Transaminase, [3]Glutamic-Oxalacetic Transaminase

Table 5: Effect of CSP on ruminal pH and NH3 in dairy cattle

	CSP subituated with WB[1] (%)					
Effects	0	33.3	66.6	100	SE	p-value
pH	6.27	6.46	6.51	6.31	0.03	0.20
NH3 (mg/100 mL)	16.80	17.04	15.70	16.55	0.35	0.82

ruminal proteolysis from creation of tannin-protein complexes. Inhibiting ruminal proteolysis and microbial synthesis with no effect on ammonia production in some case or failing ammonia release with no effect on cellulose digestibility in others.

CONCLUSION

The obtain result indicated that substitution of wheat bran by CSP led to higher level of milk fat content. Milk fat content is an economical factor for some dairy cattle farming. The substitution of CSP at 100% level with wheat bran (dry mater basis) to the dairy cow ration will decrease the cost of milk production without any adverse effect on animals health and performance. This by-product can be regarded as a source of effective fibre for ruminant animal. However, more experiments are needed for confirmation of these finding and suggestion.

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