

The Effects of Feeding Raw Fiber Concentrate on Growth Performance and Blood Metabolites of Suckling Holstein Calves

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Abstract—Sixteen female Holstein calves allocated in three treatments including: 1: control, 2: fed raw fiber concentrate (RFC) for 45 days and 3: fed RFC for 90 days. RFC supplement (Vitacel® 200) was added to milk immediately before feeding (10 g/L milk). Withers height and body weights of calves were measured monthly. Individual dry matter intake was recorded daily. Blood samples were taken monthly. The result showed that calves consumed RFC had significantly greater weaning and final body weight. Treatment effect on dry matter intake was not significant ($p>0.05$). Calves fed RFC had better feed efficiency. Withers height of calves fed RFC were taller than the control group ($p<0.05$). Plasma cholesterol and total proteins concentrations in calves fed RFC were less than control group. We conclude that feeding RFC for 45 or 90 days in suckling period caused to achieve better feed efficiency and higher growth performance in Holstein calves.

Keywords—Holstein calves, raw fiber concentrate, growth, blood metabolites.

I. INTRODUCTION

GASTROINTESTINAL infections and subsequent diarrhea and dehydration description for the common of health problems affecting calves during the preweaning period and are the main reason for death and poor growth in the first 60 d of age [1,5]. In dairy farm, just young calves fed milk replacer still receive antibiotics on a practice and continual basis [3]. Use of antibiotics in animal production may contribute to antibiotic resistance of human pathogens [2]. In recent years use of bacterial probiotic [7] or yeast cultures [10], oligosaccharides [3] and raw fiber concentrate [12] are common practice in attempt to minimize the risk of digestive diseases. Raw fiber concentrate is new sources of fiber concentrate of high biological and functional value, available on the market. Recent studies have demonstrated that raw fiber concentrate (Vitacel® 200) fed at early age have a positive influence on intestinal development, microbiological parameters and immune and health status in piglets [8]. Effects of raw fiber concentrate have examined on the growth of intestinal villi and improve bowel movements in piglets and broiler chickens in a few studies. Vuki Vranjes, et al. [12] demonstrated calves fed fiber concentrate in the liquid feed achieved higher final body weight, daily weight gain and blood parameter and they stated earlier development of gastrointestinal tract in calves triggered by raw fiber concentrate enabled higher feed intake and better feed utilization. The reasons for positive effects of raw fiber concentrate may contribute to improving growth performance through two possible modes of action such as mannan oligosaccharides.

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This composition can bind to cell walls of bacteria preventing the bacteria from attaching to intestinal epithelial cells [11]. Many bacteria possess fimbriae, which are specific surface lectins that bind to the mucosal surface of the intestine to help proliferation of the bacteria [8]. Type I fimbriae specifically bind to glycoproteins that contain carbohydrate on the intestinal cell surface is such a product that has been shown to bind, in vitro, to bacterial cells possessing. Type I fimbriae, including species of *Escherichia coli* and *Salmonella* [11], preventing these pathogens from binding to and proliferating at the mucosal surface of the intestine. Oligosaccharide and non-digestible carbohydrates can bind to the surface lectins and they stand inactive, bacteria and undigested carbohydrates be excreted.

The objective of present research was to evaluate the effects of raw fiber concentrate addition to milk and duration of feeding that on growth performance, blood metabolites and health in suckling female Holstein calves.

II. MATERIAL AND METHODS

A. Calves and diets

The experimental protocols for this research were approved by the University of Tehran Institutional Animal Care and Use Committee. The research was carried out at Sharifabad Qazvin dairy farm, Iran, from January to April 2010. In this study, 60 female Holstein calves until the age of 120 days used in a completely randomized design with three treatments and 20 replications. Holstein female calves were separated from their dams within 2 h after birth, weighed, and moved into individual pens (1.5 × 2.5 m; bedded with wheat straw) where they were fed colostrum at 10% of BW over 2 meal every day for the primary 3 d. Calves were alternately allocate to 1: control, without raw fiber concentrate, 2: fed raw fiber concentrate for 45 days and 3: fed raw fiber concentrate for 90 days. Calves received the same amount of whole milk according to the standard farm feeding system. Calf had free access to starter concentrate (table I) and fresh water from day 7. Raw fiber concentrate supplement (Vitacel® 200, JRS, Germany) were added to milk immediately before feeding at the rate proposed by the manufacturer (10 g/ L milk) in groups 2 and 3. Vitacel® 200 is a raw fiber concentrate containing 74% of crude cellulose, which is 89% NDF and 84% ADF. Average particle length is 200 µm. Feed ingredients and chemical composition of starter is shown in Table I.

TABLE I

FEED INGREDIENTS AND CHEMICAL COMPOSITION OF STARTER DIET

Feed ingredients(% DM)	Chemical composition(% DM)
Corn grain	31.5 DM 88.5
Barley grain	18.05 NEm (Mcal/kg DM) 1.89
Soybean meal	26.16 NEg (Mcal/kg DM) 1.28
Wheat bran	13 CP 21.47
Corn gluten meal	3 EE 2.83
Molasses	3 NDF 17.59
Calcium carbonate	1.5 ADF 7.20
DCP	0.5 NFC 48.80
Sodium bicarbonate	1 Ash 9.71
White salt	0.88 Ca 1.3
Min/vit premix 1	1.21 P 0.7
Toxin binder	0.2

DM: dry matter; EE: ether extract; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; NFC: non-fibrous carbohydrates calculated as 100-(ash+EE+CP+NDF); Chemical composition analyzed in animal nutrition laboratory except NEm and NEg that calculated by NRC, 2001 software. 1 Contained per kilogram of premix: Ca, 180 g; Na, 50 g; P, 70 g; Mg, 30 g; Fe, 4130 mg; Cu, 370 mg; Zn, 3000 mg; Mn, 5000 mg; Co, 20 mg; I, 200 mg; Se, 20 mg. 400,000 IU of vitamin A; 100,000 IU of vitamin

TABLE II
LEAST SQUARE MEANS OF GROWTH PERFORMANCE IN CALVES FED WITH OR WITHOUT RFC DURING SUCKLING PERIOD

Trait	Control	RFC 45 d	RFC 90 d	SEM	P-value
Initial BW (kg)	39.15	41.29	39.64	3.11	0.64
Final BW (kg)	129.15b	137.29a	139.24a	4.4	0.02
Weaning BW (kg)	93.63b	99.41a	102.47 a	3.20	0.05
Average daily gain, (whole period) kg/d	0.75	0.80	0.83	0.025	0.06
DMI, kg/d (whole period)	1.887	1.905	1.916	0.045	0.89
Feed efficiency, (whole period)	0.289b	0.322a	0.338a	0.011	0.008
Feed efficiency, (after weaning)	0.283	0.292	0.294	0.017	0.58
Fecal score	3.29b	3.44ab	3.88a	0.083	0.001
Wither height (cm)	87.52b	89.18a	89.35a	0.51	0.021

a, b : Means with different letter in a row had significant difference ($p < 0.05$)

B. Data and samples collection

To measure growth status and physical structure of calves, the withers height and body weight of calves were measured monthly. Also birth weight recorded. Individual dry matter intake was recorded daily. Blood was sampled in day 90 by puncture of the jugular vein using evacuated tubes containing EDTA for plasma separation. Blood tubes were placed on ice immediately after collection and later centrifuged at $3,000 \times g$ for 15 min in a refrigerated centrifuge for division of plasma and then samples froze at -20°C for later analyses. Cholesterol, glucose, blood urea nitrogen, total protein, beta hydroxy butyrate (BHBA) and triglyceride were measured using enzymatic method and appropriate kits (BHBA: Randox Laboratories Ltd., Crumlin, UK; other metabolites: Pars-

azmon Co., Tehran, Iran) and Clima Plus Analyzer (RAL, Madrid, Spain). Attitude and fecal consistency were scored daily by the research team during the morning milk feeding using a 1 to 5 scale. Fecal consistency was scored as 5 when firm, 4 when soft 3 moderate consistency, 2 when runny or mild diarrhea, and 1 when watery and profuse diarrhea [4]. Weekly averages of attitude and fecal scores were generated for individual calves for statistical analyses. Incidence of health problems were recorded daily for individual calves by method Magalhaes, et al., [5]. Rectal temperature was measured for calves displaying clinical signs of disease such as diarrhea, bloat, coughing, increased respiratory frequency, depression, and lack of appetite. Febrile calves were evaluated for diarrhea, which was characterized by presence of watery feces using fecal score < 2 , and for pneumonia based on incidence of respiratory pain, increased respiratory frequency, and nasal discharge. Total of events of diarrhea, pneumonia and lack of appetite were recorded. Calves with digestive and respiratory problems were treated according to protocols established by the herd veterinarian.

C. Statistical analysis

Variables with repeated measurements (week or month), within the same calf were analyzed using MIXED and variables with a single measurement during the study were analyzed with GLM procedure of SAS software statically (9). Statistical model considered the main effects of period, animal and treatment of the completely random design. Differences among treatments were determined using the LSMEAN option treatments measured by Tukey test. All analysis considered probably 0.05 as the minimum threshold for statistical significance.

III. RESULTS

Calves that consumed raw fiber concentrate in milk for 45 days or 90 days had significantly greater final body weight (8.14 and 10.09 kg respectively) and weaning body weight (8.84 and 5.78 kg respectively) than control group (Table II). Average daily gain in calves fed raw fiber concentrate in whole period tendency increased than the control group ($p = 0.063$).

Results showed that effect of treatments on dry matter intake was not significant.

The results of feed efficiency (gain:feed) in total period showed that calves fed raw fiber concentrate had better feed efficiency than control group. But feed efficiency after weaning wasn't significant between groups. Results of growth and skeletal structures showed that withers height of calves fed raw fiber concentrate were taller than the control group ($p < 0.05$). Statistical comparisons for blood metabolites showed that cholesterol concentrations and blood total proteins concentration in calves fed raw fiber concentrate were less than control group ($p < 0.05$). Other blood metabolites such as beta hydroxy butyrate (BHBA), glucose, triglycerides and urea nitrogen were similar between treatments (Table III). Calves fed with raw fiber concentrate had fecal score better than the control group during entire trial period (Table II).

Incidence of health problems in calves assigned to different treatments did not differ numerically (Table IV).

TABLE III

LEAST SQUARE MEANS OF BLOOD METABOLITES IN CALVES FED WITH OR WITHOUT FIBER CONCENTRATE (RFC) DURING SUCKLING PERIOD

Metabolites	Control	RFC	RFC	SEM	P-value
		45 d	90 d		
Glucose (mg/dl)	110.8	103.4	103.2	4.52	0.410
Cholesterol (mg/dl)	72.85a	57.30b	64.62ab	3.86	0.032
Triglyceride (mg/dl)	9.11	10.50	12.30	2.43	0.201
Total protein (g/dl)	7.28a	6.87ab	6.65b	0.16	0.028
Urea nitrogen (mg/dl)	14.61	13.96	14.30	0.76	0.835
BHBA (mM/dl)	0.303	0.295	0.344	0.029	0.457

a,b : Means with different letter in a row had significant difference ($p < 0.05$)

TABLE IV

INCIDENCE OF HEALTH PROBLEMS IN CALVES FED WITH OR WITHOUT FIBER CONCENTRATE (RFC) DURING SUCKLING PERIOD

Problems	Control	RFC 45 d	RFC90 d
Diarrhea	1	-	1
Respiratory disease	-	-	-
Lack of appetite	1	2	1
Limb problems	2	-	-
Mortality	-	-	-

IV. DISCUSSION

Dry matter intake of calves did not affected by experimental treatments. But final body weight and weaning body weight were higher in calves fed raw fiber concentrate and this indicates that raw fiber concentrate can increase feeding efficiency (gain:feed). Results of feed efficiency confirmed this statement (Table II). Present results were similar to [12] reports. They use raw fiber concentrate in suckling calves and observed feed intake per day was very alike in both groups but calves fed Vitacel® 200 in the liquid feeding part utilized concentrated feed more efficiently compared to control group (1.67 vs. 1.74). But Heinrichs, et al., [3] reported utilization of calf starter increased at a faster growth rate in calves fed Oligosaccharides, and these calves eat more calf starter after weaning [3]. The reason of this difference may be due to use of these carbohydrates in starter but in present experiment use in milk.

In the other hand raw fiber concentrate escape from decomposition and changes in the rumen and was able to cause effects on the intestinal environment.

The results of Rozeboom, et al. [8] that studied the effects of oligosaccharide in infancy ration on performance of piglets confirmed present results.

They observed use of Oligosaccharides causes increased the performance, final weight and feed efficiency in piglets. In this experiment, we observed that raw fiber concentrate cause increased weight gain and feed efficiency, while no significant different in dry matter intake. It should be noted that after weaning feed efficiency (eliminate consumption raw fiber concentrate) wasn't significantly different between treatments. The reason this result may be due to the effects of raw fiber concentrate on intestinal and consequently improving the digestibility of feed composition. These observations agree with Vuki Vranjes, et al. [12] results. They reports that raw fiber concentrate improved feed efficiency during the infancy of Holstein male calves, but after weaning not difference with the control group. Values attain for feed intake and efficiency are like with values statement by Adamovi, et al.[1] and others for calves of comparable genotype, age, diet formulation and weight gain attained [12].

Results of blood parameters showed that most blood parameters were not affected but only the total protein and cholesterol were lower in calves fed with raw fiber concentrate. Vuki Vranjes, et al.[12] showed that level of glucose in the blood was higher in calves fed raw fiber concentrate ($p > 0.05$). They expressed the reason different earlier improvement of gastrointestinal tract in calves started by raw fiber concentrate enabled higher feed intake and better feed consumption. In present study we assume that because of higher growth rate of calves fed raw fiber concentrate, more glucose and protein entering the cell and the protein is significantly lower and glucose also showed a significant tendency. This decrease can be due to differences in growth rate of calves in this treatment because deposition protein tissue reduces blood protein levels. Calves fed 90 days raw fiber concentrate had less blood total protein than calves' fed 45 days (Table III) that confirmed above hypothesis.

The rate of diseases in calves fed with raw fiber concentrate was numerical less than control calves. This phenomenon may be due to the effect of non-digestible non-absorbed carbohydrates in the intestine. This can be essential in diseases in which inflammatory answer intensification the harmful effects of the disease such as in chronic processes or in toxicities associated with gut pathogens like enter toxigenic *E. coli*. These effects are probable to get better gut health and may explain the profit to fecal scores and diarrhea observed in the present study when calves were fed raw fiber concentrate [5]. These compounds may bind to receptors on a variety of protection cells of the gut, which stimulates immune resistance such as phagocytosis [6]. And also might explain the related ability of these compounds to improve fecal scores in calves compared with antibiotics [3].

Calves fed raw fiber concentrate had better fecal score than the control group in the entire experimental period. These observations could be due to the increased role of raw fiber concentrate peristalsis movements' intestine and create a wider contact surface because the capillary network to better function digestive enzymes on digestion the substances in the intestines, follow-on in better digestion and absorption in the

intestine and reduce the passes rate offered material from the gastrointestinal tract.

We concluded that the use of raw fiber concentrate in milk for suckling calves during 45 or 90 days improve weaning and final body weight and wither height. Feed intake did not differ between groups but feed efficiency improved in calves fed raw fiber concentrate. Calves had better fecal score but lower blood total protein and cholesterol concentration in raw fiber concentrate groups. Earlier and better development of gastrointestinal tract in calves fed raw fiber concentrate for 45 or 90 days maybe caused to achieve better feed utilization and higher growth performance in female Holstein calves. In regard to economical aspect, feeding raw fiber concentrate for first 45 days of suckling period preferred.

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