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Artigo

The effect of using different levels of whey powder on milk yield and composition in Simmental cows

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Abstract: The present study was conducted to investigate the effect of using different levels of whey powder on milk yield and composition in Simmental cows. For this reason a total of eight Simmental cows (four nulliparous and four multiparous dairy cows) were randomly assigned to the 4 experimental treatments in Latin square design with 4 cows each. The experimental period lasted 56 days. The cows were feed by basal diet as control, 3, 6 and 12 percentages of whey powders in their daily diets respectively. The result indicated that the feed intake (kg/d) was increased by using different levels of whey powder. Data showed that there were no significant effects between treatments about feed intake compared to the control. The result showed that the milk protein percentage was increased none significantly by whey powder compared to the control. Milk fat induced and percentage milk protein improved as a result of whey powder supplementation. Data from current study indicate that the milk lactose, milk non-fat solids and milk total solids values in the treatments are none significantly different. As result revealed milk somatic cell increased when cows were fed by different levels of whey powder and their number increased with increasing consumption of whey powder. The presented results in this study showed that Milk urea nitrogen had decreased by whey powder, but Milk urea had tended to increase significantly ($P \leq 0.05$). It seems that using different levels of whey powder could positive effects on feed intake, milk yield and its composition on Holstein dairy cows.

Key words: Simmental cows, Feed intake, Milk yield, Milk composition, Whey powder.

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Introduction

Milk production and composition is economically important to milk producers and processors and nutritionally important to consumers (Ben Salem and Feraj, 2007). It has been known for years that variations in milk compositions occur; however, the composition of milk marketed nationally has been rather constant over the last 15 years, averaging 3.6 percent fat, 3.2 percent protein, and 4.7 percent lactose (Young et al., 1986). This is probably partly because of the prominence of the Simmental cows and the pricing of milk based on fat concentration. The introduction of milk pricing on a component basis and the perception by consumers that animal fats are unhealthy have created new interest in how milk components can be altered to accommodate these emerging markets (Woods and Burroughs ,1969). Whey is the valuable co-product resulting after the production of cheese, curd cheese or casein from milk (Welch et al., 1974).

The type of whey produced depends on the method of precipitation that is employed to separate the casein. Whey is a slightly acid, yellow-green liquid which is the residue obtained from the coagulation of milk by rennet or by the lowering of its pH (Webb and Whittier, 1948). Whey has been used in liquid form, principally for pigs, when the available quantity was not large and could be used nearby, but for practical reasons of transport and storage this pattern of use has been progressively superseded by drying for animal feed (Ben Salem and Feraj, 2007). This involves increased production costs which limit its use to the feeding of young animals or fattening pigs (Borba et al., 2014).

Whey proteins (lacto albumins and globulins) are of excellent quality; their essential amino acid content is superior to that of egg or casein proteins (Demott, 1972). They are quite rich in lysine and tryptophane and in the sulphur-containing amino acids (methionine and cystine). Whey is also relatively rich in calcium, phosphorus, sodium, potassium and chlorine. Whey in the form of dried solids can also be used by ruminants (Anderson et al., 1974). When introduced in relatively moderate doses (14% of total dry matter) in concentrate feeds, it prevents the lowering of the butterfat content generally observed in dairy cattle when this type of feed is consumed in large quantities (Schingoethe et al, 1973). There is limited data on the whey supplementation in dairy cows. The objective of this study was to investigate the effect of using different levels of whey

powder on milk yield and its composition in Simmental cows.

Material and methods

Treatments and animal management

This experiment was carried out at the Farsan, Iran. A total of eight nulliparous and multiparous Simmental cows (four cows in first calving and four cows in second calving period) were randomly assigned to the 4 experimental treatments in Latin square design with 5 cows each. The feed offered, individual refusals and feces were analyzed for DM, ash, crude protein (CP), crude fiber (CF) and ether extract (EE) according to the AOAC (2000). The cows were feed by basal diet as control, 3, 6 and 12 percentages of whey powders in their daily diets respectively. The cows were fed by experimental diets during 56 days (4 weeks period and 14 days per each). Diets were formulated to meet all the nutritional requirements for calves based on National Research Council (NRC, 2001). Also the diets and water were offered for adlibitum intake during the experimental period (Table 1).

Table 1- Feed ingredients and nutrient composition of dairy cows

Item	**Control**	**2.5% whey**	**5% whey**	**10% whey**
Ingredients (%)				
Corn	48.83	46.63	43.83	38.83
Wheat barn	9.40	9.40	9.40	9.40
Soybean meal	11.02	11.02	11.02	11.02
Cotton seed meal	11.22	11.22	11.22	11.22
Fish meal	4.30	4.30	4.30	4.30
Whey powder	0	2.5	5	10
DCP	0.37	0.37	0.37	0.37
Calcium Carbonate	0.58	0.33	0.33	0.33
Nacl	0.66	0.66	0.66	0.66
Bicarbonate	1.7	1.7	1.7	1.7
Mineral premix	0.49	0.49	0.49	0.49

Vitamin premix	0.49	0.49	0.49	0.49
Nutrient composition				
Dry matter (%)	89.97	89.99	90.01	90.05
Crude protein (%)	21.9	21.9	22	22
ME (Mcal.kg)	1.91	1.91	1.91	1.91
NDF (%)	6.8	6.2	5.7	4.5
Fat (%)	2.85	2.83	2.82	2.80
Ca (%)	0.51	0.53	0.55	0.60
P (%)	0.51	0.53	0.54	0.57

Feed intake

Feed intake was measured daily by measuring the distribution of feed.

Measuring milk production and the composition of milk

Simmental cow's health and the inflammatory breast mastitis infection were observed before each milking. Milk yield of cows during each of 14 weeks of suckling period was estimated by the cows suckling weight differential technique. Cows were milking at clock 8.00, 16.00 and 24.00. This procedure was repeated weekly during the whole suckling periods. Milk samples were taken for chemical analysis on 70 ml package and stored at $4^{\circ c}$ for determine fat , protein and lactose content by MilkoScan(134BNFossElectric,Hillerod,Denmark) device. A generalized additive model (GAM) with smoothed estimates was used to evaluate MUN and lactose. The somatic cell counts from morning and afternoon milking were transformed (SCCT) using Log^2 (cell $mL^{-1}*100^{-1}$) +3, as adapted by Dabdoub and Shook (1984).

Statistical Analysis

Obtained data were analyzed using the general linear models (GLM) procedure of SAS (2001) for an experimental design. All mean comparisons were by the least significant difference method after a significant ($p<0.05$) treatment effect. The significance of effects was designated at $p<0.05$ unless otherwise noted.

Result and Discussion

The results of dietary inclusion different levels of whey powder on

performance in dairy cows are shown in (table 2). The presented results indicate that the feed intake (kg/d) was increased by using different levels of whey powder. Data showed that there were no significant effects between treatments about feed intake compared to the control. Anderson et al. (1974), suggested that dairy cows can use as much as 100 liters per day, which corresponds to over 30% of the total dry matter intake. Morrill and Dayton, (1974) showed that for calves that are being weaned, the introduction of whey at the rate of 10% of the concentrate feeds increases feed intake. The improvement in the milk yield performance as a result of increases total protein in blood may be due to the positive effect of these treatments on the digestibility coefficient of different nutrients and nutritive values as suggested by (Borba et al., 2014). Schingoethe and Rook (1976) showed that the addition of 5% whey to a concentrate feed for dairy cows does not improve absorption or retention of the minerals in the ration. They mentioned that it is important to ascertain whether the use of a higher percentage of whey changes mineral nutrition in ruminants.

Schingoethe,(1976) showed that he addition of a small quantity of whey (2% of the total dry matter content) to grass or maize silage in dried, concentrated or liquid form improves the digestibility of the main constituents of the mixture. Casper and Schingoethe (1986) reported increased feed intake for cows fed urea-dried whey compared with cows fed urea diet in early lactation.

Table 2- The effect of using different levels of whey powder on performance in Simmental cows

Variable	Treatments				P value
	Control	3% whey	6% whey	12% whey	
Feed intake (kg.d)	22.62	23.30	23.30	23.51	n.s**

*Means within a row with no common letter are significantly different (P<0.05). ** n.s= none significant.

The presented results in (Table 3) showed that the milk protein percentage was increased none significantly by whey powder compared to the control. Milk fat induced and percentage milk protein improved as a result of whey powder supplementation. Whey is also relatively rich in calcium, phosphorus, sodium, potassium and chlorine. The concentration of these elements in whey is constant

irrespective of the origin of the product (WIN AND SCHIWGOETHE, 1984). Ben Salem et al.,(2007)noted that yields of milk and 4% fat corrected milk were higher ($P<0.05$) for cows fed the whey supplementation.

Coulon et al, (1979) reported that increase of milk production occurred when mid lactating dairy cows received 37 liters of whey in replacement of 2.25 kg of the concentrate feed. Barba et al, (2014) showed that the use of whey from goat and cow cheese in making creamy ricotta is feasible and does not cause negative impact in the final product. Some researchers found that it is possible to feed whey to high producing dairy cows and maintain similar amounts of fat corrected milk, but it appears to be economical only when the farmer is paid a high premium on milk fat and if the price for this by product is very low (SUTTON,1980; ROGERS et al.,1977). Gou et al, (2016) showed that diet formulation usually would affect milk urea nitrogen equally among all cows at a similar stage of lactation.

Milk lactose, milk non-fat solids and milk total solids values in the treatments are none significantly different.

As result revealed milk somatic cell increased when cows were fed by different levels of whey powder and their number increased with increasing consumption of whey powder. The presented results in this study showed that Milk urea nitrogen had decreased by whey powder, but Milk urea had tended to increase significantly ($P\leq0.05$). In the rumen, whey lactose is broken down quite rapidly by bacteria and protozoa and converted into lactic acid, which is metabolized into volatile fatty acids, principally butyric acid (DE FRAIN et al., 2006).

Under normal feeding conditions very little lactic acid is absorbed into the blood, but if the animals are given large quantities of lactose before the microbial population of the rumen has become adjusted to its use, severe fermentation problems may result. Lactic acid in excess penetrates the wall of the rumen and may cause serious metabolic disorders (acidosis). Lactose is an energy source which makes possible the utilization of none protein nitrogen in the rumen. The ammonia concentration of the rumen fluid is not increased by the addition of urea to the ration (THIVEND AND EHOUINSOU, 1977).

Table 3- The effect of using different levels of whey powder on Milk yield and composition

Variable	Treatments				P value
	Control	3% whey	6% whey	12% whey	
Milk yield (kg.day)	14.43	14.54	14.82	15.05	n.s**
Milk fat (%)	2.9	2.76	2.80	2.73	n.s**
Milk protein (%)	3.09	3.11	3.14	3.12	n.s**
Milk lactose (%)	4.78	4.78	4.72	7.45	n.s**
Milk non-fat solids (%)	7.75	7..78	7.73	7.75	n.s**
Milk total solids (%)	11.12	11.01	11.09	10.93	n.s**
Milk somatic cells (n×1000)	121.72	145.69	166.63	165.84	n.s**
Milk urea nitrogen (m.dl)	14.71	13.32	13.29	13.15	n.s**
Milk urea (m.dl)	0.123^{b}	0.129^{a}	0.126^{ab}	0.128^{a}	**

*Means within a row with no common letter are significantly different (P<0.05). ** n.s= none significant

The synthesis of microbial proteins in the rumen is improved by this lactose / urea ratio (Schingoethe and Beardsley, 1975; Huber, 1967). Windschitl and Schingoethe (1984) reported that dry whey increased nitrogen utilization through stimulation of increased microbial protein synthesis. The digestibility of the nitrogenous matter in whey has been studied only to a very limited extent in adult ruminants. The nitrogen in the whey is converted in the rumen into microbial protein and its apparent digestibility is of the order of 70% (Anderson, 1975). When it is not degraded in the rumen, its digestibility in the intestine is much higher (91% in pre ruminant calves (Toullec et al., 1974 and Susmel et al., 1995). Ben Salem and Feraj (2007) concluded that including whey in dairy diets, in a partial replacement of the concentrate, significantly improved milk fat and protein yields without affecting milk composition. Schingoethe and Skyberg, (1981) indicated that cows fed dried whey often have similar or increased milk fat percentages compared with cows fed diets without whey. This is most probably related to rumen fermentation characteristics of cattle diets containing whey.

Conclusion

We could conclude that supplementation of different levels of whey powder could raise feed intake none significantly by increasing nutrient digestibility and improve milk yield and its composition in experimental nulliparous and multiparous Holstein dairy cows.

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