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Effect of Physical Form of the starter on Performance of Holstein Calves

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ABSTRACT

Sixteen pre-weaning Holstein calves were paired based on gender and body weight (BW) and monitored for 7 wk to assess starter intake (sDMI), feed efficiency, growth rate, and weaning age as affected by feeding either a conventional ground or a commercial pelleted starter. Calves were weaned at 60 d of age if a minimum BW of 75 kg was obtained. Growth rate was estimated using a linear regression equation fitting BW against time for each calf. Polynomial equations were used to estimate the age at a daily consumption of 680 g starter and age at 75 kg BW. Weekly and average sDMI and BW, growth rate, and weaning age were not significantly affected by the processing method of the calf starter. Calves on both starters required the same time to attain 75 kg BW. Results supported the hypothesis that the easy-to-access, ground calf starter is as effectual as its more costly, pelleted form in promoting adequate starter intake and growth rate needed for the early weaning of dairy calves.
(**Key words:** starter diet, ground, pelleted, Holstein calf)

***Abbreviation key*: GS =** ground starter, **PS =** pelleted starter, **sDMI =** daily intake of starter dry matter.

INTRODUCTION

Early transition of neonate rumen to a functioning fermentor necessitates an adequate furnish of volatile fatty acids (VFA), which may not be achieved until after calves consume a vital quantity of dry feed (e.g., 680 g/d; NRC, 2001). Physical properties of the calf starter are considered to be influential in promoting the histological shifts in the papillae and muscular maturity of the rumen. This cascade is sustained by a capacious absorption and modification of the VFA across the rumen that in turn supports their subsequent metabolism in the hepatocytes and periphery (Baldwin et al., 2004).

It has been shown that early access to water and calf starter as contrasted by the intake of only milk leads to a greater butyrate production, earlier expansion of the ruminal digestion, and a reduced weaning age (Anderson et al., 1987). However, a controversy still continues to exist over the optimal particle size or the abrasiveness of the starter diet. Offering rolled and whole grains as compared to a finely ground starter improved feed efficiency, growth, and body weight (BW) of dairy calves in a most recent study (Coverdale et al., 2004). Franklin et al. (2003) have

recently reported that the commercial textured and traditional ground starters were equally effective in enhancing grain intake and reducing weaning age over a pelleted starter.

Paucity of data in the literature and on-going disagreement over the optimum physical form of the calf starter with no major forage fiber led us to conduct this study. We hypothesized that the conventional, easy-to-perform, affordable grinding is as effective as the commercial, pelleting of the calf starter in stimulating dry feed intake and growth of dairy calves. This study aimed to monitor the key on-farm criteria for the assessment of calf well-being i.e., starter DM intake (**sDMI**), feed efficiency, growth rate and weaning age, as affected by offering either 1) a finely ground or 2) a pelleted form of the same starter concentrate.

Materials and Methods

Sixteen Holstein calves with 45.5 ± 2.3 (mean ± SE) kg BW were monitored for 7 wk in Calf Housing Facilities of Lavark Research Station (Isfahan University of Technology, Iran). Calves were grouped by sex (8 males and 8 females), paired based on BW and assigned randomly to each of two treatments. The treatments included offering either 1) the conventional finely ground (**GS**), or 2) the commercial pelleted (**PS**) form of the same starter diet (Table 1). The initial age of claves assigned to either of treatments was 20 ± 3 (mean ± SE). Calves were housed in individual hutches and received milk by 10% of BW twice daily at 0800 h and 1500 h until 7 wk of age. At wk 8, the daily offer of milk was reduced to 8% of BW and calves were weaned at 60 d of age if they had obtained a minimum of 75 kg BW, otherwise remained on milk + starter. This was to assess how physical form of the starter would influence calf growth and weaning age. Calves were weighed Twice daily and were offered *ad libitum* the starter and clean fresh water for the entire experiment. Performance criteria were measured repeatedly for each calf on a weekly basis. Starter intake was measured daily.

A mixed model of repeated measures (Wang and Goonewardene, 2004) was used to analyze the data with Restricted Maximum Likelihood (REML) estimation method in MIXED Procedure of SAS (1999) to evaluate the time-trend effect of treatments on calf performance. Significance levels were declared at $P < 0.05$.

Results and Discussion

To the authors' knowledge, this is the first study that compared GS and PS with no confounding from the use of different types and inclusion rates of dietary ingredients (Table 1). In the only to date study on comparing GS and PS for young calves, Franklin et al. (2003) used entirely different cereal choices and protein supplements to formulate the two diets. As a result, the respective dietary levels of CP, NDF, Ca, K and Na were considerably different for GS and PS, which may have affected the calf response to the physical form of the starter in their study.

No significant effects ($P > 0.05$) of treatments on weekly sDMI were observed (Figure 1A) in the present study. Franklin et al. (2003) reported a greater grain intake for calves on GS than for those fed PS that disagrees with the equal sDMI of calves on PS and GS in our study. This discrepancy between two studies could be attributed to the dissimilar types and inclusion rates of the dietary ingredients used to formulate PS and GS in their study as opposed to the use of the exactly same diet for both treatments in the current investigation. Also, the probable differences in the particle size, firmness, and palatability of the pellets between two studies should not be ignored. Nonetheless, as no information was provided by Franklin et al. (2003)

regarding the pelleting process, pellet size or the degree of grinding, such aspects may not be compared between two studies. As pointed out by Beharka et al. (1997), grinding provides more surface area for microbial adhesion that may elevate the rate of VFA production in the rumen. This could induce an inhibitory effect on feed intake (Allen et al., 2000). However, the magnitude of such effect may have not been large enough to significantly depress sDMI of calves fed GS in the current study. Furthermore, subjecting the starter to both cold and warm physical modifications during pelleting was expected to enhance the ruminal fermentability of the slowly degradable corn starch (Zinn et al., 2002). This may have in part compensated for the more accessible surface area of GS narrowing the gap in starch fermentability of GS and PS thus a less different regulatory impact of their fermentation products on sDMI in the current study.

The treatments did not significantly affect ($P > 0.05$) the average weekly BW, mean BW and average daily gain (**ADG**) across the experimental weeks (Table 2, Figure 1B, 1C). In agreement with our results, no differences in BW of calves fed either GS or PS were noticed by Franklin et al. (2003). Similarly, Coverdale et al. (2004) reported no effects of offering rolled and whole grains as compared to finely ground grains on preweaning BW and ADG of dairy calves. However, GS with mean particle size of 1 mm as compared to unground starter containing chopped hay and rolled grains tended to enhance BW of 10-wk-old bull calves in the study of Beharka et al. (1998). As already mentioned, the increased ruminal and post-ruminal availability of the starter as a result of steam-processing (e.g., pelleting) may have, at least partly, filled the gap in the fermentability of finely GS and coarsely PS in the present trial. In contrast, coarse, unground starter was expected to be much less exposable to the rapid digestion as compared to finely GS in the study of Beharka et al. (1998). Such probable between-treatment discrepancies might have, in consequence, contributed to the dissimilar magnitude of BW responses between two studies.

In conclusion, the conventional ground starter seemed to be as efficacious as the commercial, more-costly, pelleted starter in promoting dry feed intake by young dairy calves. This was ultimately supported by the similar growth performance, BW, weaning age and age at 75 kg BW between two groups. The large between-calf variability of performance criteria warrants further research using larger sample sizes. A more limited offer of milk is suggested for a more specific attribution of calf performance to the physical and chemical properties of the starter during calf transition from milk to dry feed.

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Table 1. Feed ingredients and chemical composition of the calf starter concentrate (DM basis).*

Ingredients	% of dietary DM
Corn grain	34.5
Barley grain	18.0
Soybean meal	34.0
Wheat bran	6.0
Sugarcane molasses	2.0
Alfalfa hay	2.0
Zeolite®	1.5
Dicalcium phosphate	1.5
Minerals and vitamins supplement[1]	0.5
DM, %	89.0
NEm (Mcal/kg) [2]	2.34
NEg (Mcla/g) [2]	1.78
CP, %	21.8
NDF, %	18.3
ADF, %	7.7
Ether extract, %	4.9
Ca, %	0.5
P, %	0.75

* NDF and ADF were analyzed according to Van Soest et al. (1991), and CP, ash, and EE according to AOAC (1990).
[1] Contained 250000 IU vit. A, 50000 IU vit. D, 1500 IU vit E, 2.25 g Mn, 7.7 g Zn, 20 g P, 20.5 g Mg, 186 g Na, 1.25 F, 3 g S, 14 mg Co, 1.25 g Cu, 56 mg I, and 10 mg Se per kg supplement.
[2] Calculated from NRC (2001).

Table 2. Effect of offering ground (GS) or pelleted (PS) starters on body weight (BW), starter DMI (sDMI), average daily gain (ADG), feed efficiency, and weaning age of Holstein calves.

Item	Starter diet (Trt)			Effects, *P*		
	GS	PS	SEM	Trt	Week	Trt × Week
Initial BW[1], kg	45.7	45.4	2.3	NS		
Final BW, kg	78.6	80.9	1.5	NS		
Mean BW, kg	57.3	59.2	0.9	NS	<.0001	NS
ADG[2], g	744.4	806.2	53.9	NS	<.0001	0.007
sDMI[4], g/d	742.7	860.9	88.1	NS	<.0001	NS
ADG:sDMI[4]	1.73	1.72	0.29	NS	<.0001	NS
Weaning age[5], d	50.8	47.6	2.5	NS		
Age at 75 kg BW[6], d	64.5	64.0	3.5	NS		

[1]Modeled as a covariate for the analysis of weekly BW measurements.

[2]Calculated as weekly ADG for each calf and analyzed as a repeated measures design.

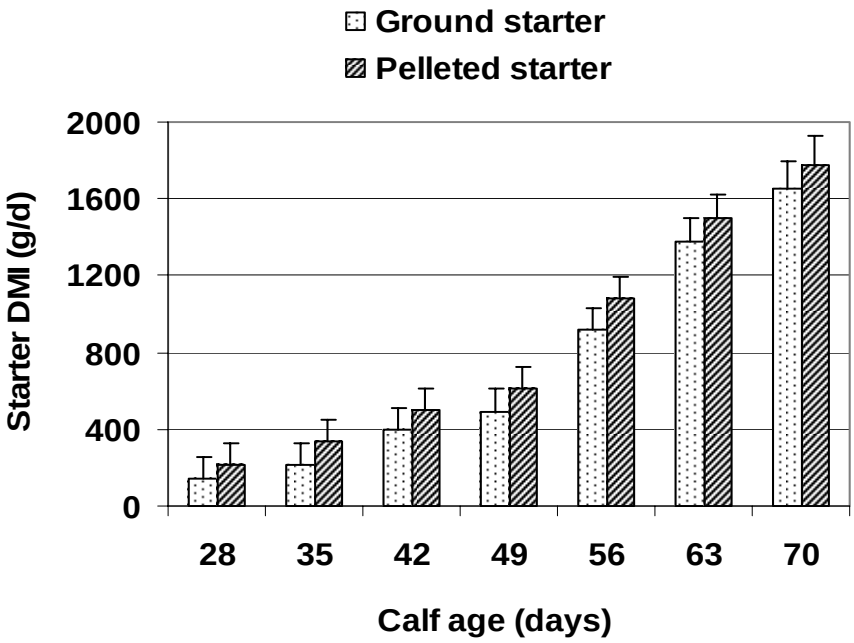
[3]Estimated by regressing weekly BW against time for individual calves and subjecting the slopes to ANOVA as a completely randomized design.

[4]Average daily intake of starter DM across the experimental weeks. Feed efficiency is based on weekly measurements of starter intake and ADG.

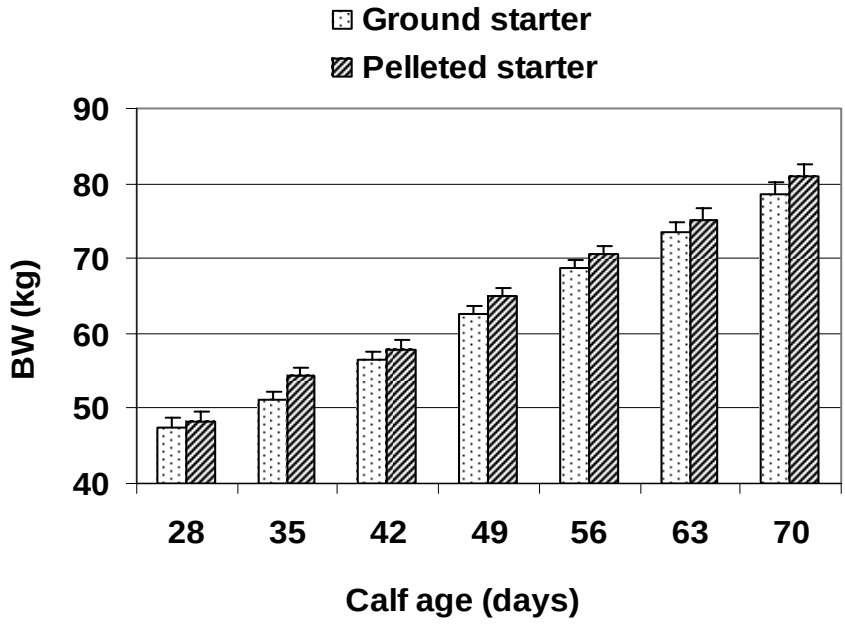
[5]Age at daily intake of 680 g starter DM (NRC, 2001) estimated using polynomial equations fitting sDMI to the age of individual calves.

[6]Estimated using polynomial equations regressing weekly sDMI to BW for individual calves.

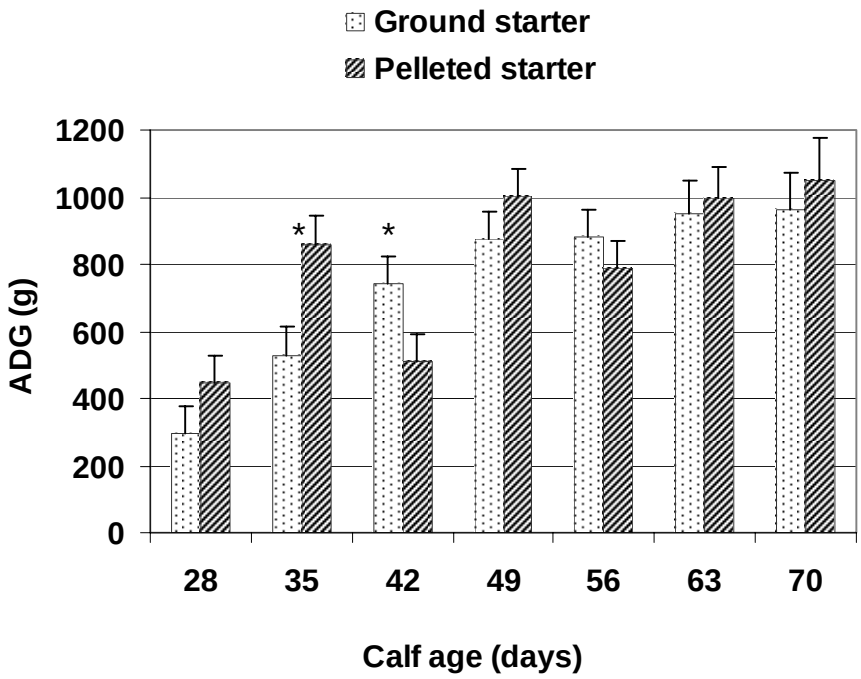
NS = not significant, $P>0.10$. SEM = standard error for treatment least square means.


Ground starter
Pelleted starter
Starter DMI (g/d)
2000
1600
1200
800
400
0
28
35
42
49
56
63
70
Calf age (days)

(A)


Ground starter
Pelleted starter
BW (kg)
90
80
70
60
50
40
28
35
42
49
56
63
70
Calf age (days)

(B)



(C)

Figure 1. Time trend effect of offering either conventional ground starter or commercial pelleted starter on starter DMI **(A)**, body weight (BW) **(B)**, and average daily gain (ADG) **(C)** of Holstein calves. Calves were weaned at 60 d of age only after their BW was 75 kg. * = $P < 0.05$.