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Comparison of Traditional Ground and Commercial Pelleted Starters for Pre-Weaning Holstein Calves

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Abstract: Debate exists as to the optimal processing method or abrasiveness of the starter diet for young calves. Eight male and eight female neonatal Holstein calves were grouped by gender, age and Body Weight (BW) and assigned to either the traditional Ground (GS) or the Commercial Pelleted (PS) forms of the same starter concentrate. The objective was to evaluate starter intake, feed efficiency, growth rate and Weaning Criterion (WC), as affected by offering differently processed starters. Milk offer ended at 60 days of age with a minimum BW of 75 kg, otherwise continued until calves reached 75 kg BW. The WC, or the age at a daily consumption of 680 g starter and age at 75 kg BW were estimated using polynomial regression equations. Weekly starter intake and BW, growth rate and WC were not significantly affected by the treatments. The average daily starter intake, however, tended to be greater in calves fed the PS than in calves fed the GS. The two groups required the same time-period to attain 75 kg BW. In conclusion, GS appeared as effective in promoting adequate starter intake and growth rate for early weaning of dairy calves as PS.

Key words: Ground starter, pelleted starter, growth, pre-weaning, Holstein calf

INTRODUCTION

Early transition of the neonate rumen to a functioning fermentor requires sufficient supply of Volatile Fatty Acids (VFA) for papillae development. Adequate consumption of dry feed (e.g., 680 g day^{-1}; NRC, 2001) by growing calf is imperative for the papillae development to occur. Physical properties of the calf starter are considered influential in promoting such histological shifts and maturity of the rumen papillae. This cascade is sustained by a capacious absorption and modification of VFA across the rumen to fuel the intermediary metabolism (Baldwin *et al*., 2004).

Early access to water and calf starter has been shown (Anderson *et al*., 1987) to stimulate greater butyrate production, earlier expansion of the ruminal digestion and lowered weaning age when compared to milk feeding alone. However, debate exists as to the optimal processing method or 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 study by Coverdale *et al*. (2004). Beharka *et al*. (1998), however, reported a trend for an enhanced BW of calves fed 25% alfalfa hay, when a ground starter rather than a whole grain starter was fed. No effects of particle size on weight gain were observed by Greenwood *et al*. (1997) with starter containing 15% hay. Franklin *et al*. (2003) recently reported that the traditional ground starter and a pelleted starter were equally effective in enhancing grain intake and reducing weaning age. The ongoing debate over the

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optimal processing of the calf starter diet was the impetus for the current study. The objective was to compare the effects of offering either the finely ground or the commercial pelleted form of the same starter concentrate on pre-weaning calf performance.

MATERIALS AND METHODS

Experimental Design, Treatments and Calves

Sixteen (8 males and 8 females) pre-weaning Holstein calves with 45.5±2.3 kg (mean±SE) initial BW at 20±3 days of age were used. Calves were monitored until 10 weeks of age at the Calf Housing Facilities of Lavark Research Station (Isfahan University of Technology, Iran). At the beginning of the experiment, calves were grouped based on gender, age and BW and assigned randomly to either of two treatments. The same numbers of calves from each gender (4 males and 4 females) were allocated to each treatment. As a result, the initial average BW (45.5 vs. 45.3 kg) and age (20 vs. 20 days) of the calves were comparable between treatments. The two treatments were 1) the conventional finely ground (GS) and 2) the commercial pelleted (PS) forms of the same starter concentrate (i.e., the type and inclusion rate of dietary ingredients were similar for both starters, Table 1). Ground starter was produced by grinding all dietary ingredients using an on-farm hammer mill (Isfahan Dasht, model 5543 GEN, Isfahan, Iran) with a standard screen size of 1 mm. The pellets were produced after grinding of the starter meal and averaged 11 mm in length and 4.4 mm in diameter. Calves were housed in individual hutches and received milk by 10% of BW twice daily at 0800 and 1500 h until 7 weeks of age. At 8 weeks of age, the daily offer of milk was reduced to 8% of BW and ended at 60 days of age if a minimum of 75 kg BW was obtained. Otherwise calves remained on milk until the BW criterion was met. Such a weaning strategy was adopted to maintain the associative effect of milk on calf response to the treatments across the animals. Calves were offered the starter *ad libitum* and had free access to clean, fresh water for the entire experiment. Starter intake and orts were recorded daily and their dry matter content was determined by oven-drying for 48 h at 60°C. Calves were weighed weekly at 0800 h.

Statistical Procedures

A mixed model of repeated measures was used to analyze the data with Restricted Maximum Likelihood estimation method in MIXED Procedure of SAS (2003). Since the backbone design of the

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

Ingredients	Dietary DM (%)
Corn grain	34.50
Barley grain	18.00
Soybean meal	34.00
Wheat bran	6.00
Sugarcane molasses	2.00
Alfalfa hay	2.00
Zeolite®	1.50
Dicalcium phosphate	1.50
Minerals and vitamins supplement[1]	0.50
DM (%)	89.00
NE_m (Mcal/kg)[2]	2.26
NE_g (Mcla/g)[2]	1.71
CP (%)	21.80
NDF (%)	18.30
ADF (%)	7.70
Ether extract (%)	4.90
Ca (%)	0.50
P (%)	0.70

[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)

repeated measures was a randomized complete block, the initial statistical model included the fixed effects of treatment, gender, initial age, week and the interactions. Due to insignificance, gender was excluded from the model. The effect of calf nested within treatment was modeled as the random error term to test the fixed effect of treatment. The effects of week and treatment × week were tested against the residual error and the degrees of freedom were calculated using Kenward-Roger method. The Akaike's Information Criterion (Wang and Goonewardene, 2004) was used to adopt the best fitted covariance structure in the final models. To control the experimental error further, the initial BW values were modeled as a covariate for the variance analysis of BW, ADG, and starter intake. Polynomial regression equations were developed (Morris, 1999) to fit the weekly starter intake to the age and BW of individual calves. The resulting equations were used to estimate the Weaning Criterion (WC) or the calf age at a daily intake of 680 g starter (NRC, 2001) and age at 75 kg BW. The weaning criteria estimates were then subjected to variance analysis and significance levels were declared at $p<0.05$. The post-trial, power test (SAS, 2003) proved that 8 calves per treatment were sufficient to detect statistical differences if truly existed.

RESULTS

Starter intake was not significantly altered ($p>0.10$) by dietary treatments when examined weekly (Fig. 1A). The average daily starter intake across the experimental week, however, tended to be greater ($p = 0.07$) for calves fed the PS than for calves fed the GS (Table 1). Dietary treatments did not affect ($p>0.80$) final BW (Table 2). Calves on PS had greater ADG than did calves on GS at wk-2, whereas

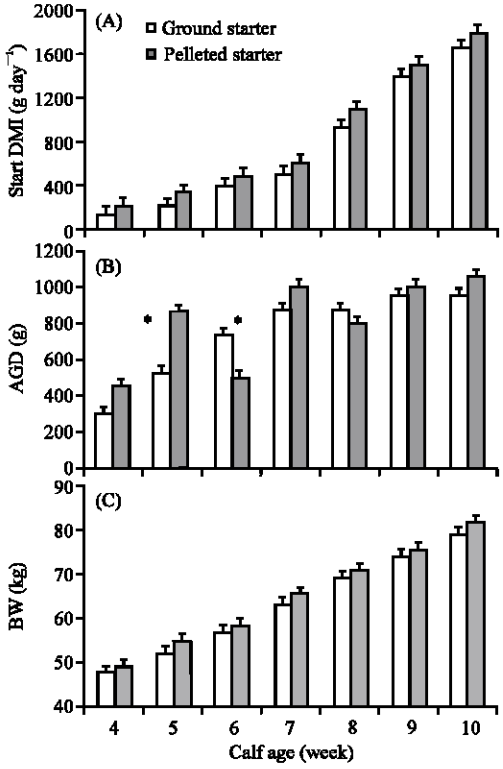

Fig. 1: Time-trend effect of offering either a conventional ground starter or a commercial pelleted starter on (A) Starter Dry Matter Intake (DMI) ($p>0.10$), (B) Average Daily Gain (ADG) (* = $p<0.05$) and (C) Body Weight (BW) ($p>0.10$) of Holstein calves

Table 2: Effect of offering Ground (GS) or Pelleted (PS) Starters on Body Weight (BW), starter intake, Average Daily Gain (ADG) and weaning criterion of Holstein calves

	Starter diet			
Item	GS	PS	SEM	Treatment effect
Initial BW (kg)[1]	45.80	45.40	2.30	0.90
Final BW (kg)	78.20	78.80	1.90	0.80
Total BW gain (kg)	32.60	33.20	1.90	0.82
ADG (g)	741.30	783.00	37.70	0.45
Starter intake, (g day^{-1})	716.50	851.60	48.60	0.07
ADG: starter intake	1.03	0.95	0.07	0.66
Weaning criterion (day)[2]	50.80	47.60	2.50	0.31
Age at 75 kg BW (day)[3]	64.30	64.10	2.80	0.95

[1]Modeled as a covariate to analyze weekly BW, ADG and starter intake data. [2]Age at a daily intake of 680 g starter (NRC, 2001) estimated using polynomial equations fitting starter intake to the age of individual calves. [3]Estimated using polynomial equations fitting weekly starter intake to BW of individual calves, SEM = standard error of the treatment least square means

GS fed calves gained more weight than did PS fed calves at wk-3 (Fig. 1B). The ADG of calves on GS and PS across weeks, estimated using regression equations, was similar ($p = 0.45$). This similarity in overall ADG was reflected in comparable ($p>0.30$) estimates of WC, or the age at a daily intake of 680 g starter (Table 2). The comparable pattern in weekly starter intake and the similar age at a daily intake of 680 g starter resulted in an equal time period ($p>0.90$) to achieve 75 kg BW for calves on GS and PS (Table 2 and Fig. 1C).

DISCUSSION

Two biological factors would potentially affect the statistical in/sufficiency of sample size in animal studies: 1) pre-trial overestimation of the biological inter-treatment differences that would not become apparent until the experiment is over and 2) unpredictable environment. This means despite adopting a proper sample size, the unexpected conditions may prohibit a potent bio-statistical test. Notably, small statistical differences detected using extremely large and expensive sample sizes would have little biological meaning for small and mid holders.

Calves on PS tended to consume more starter than calves on GS. In contrast, Franklin *et al*. (2003) reported a greater grain intake for calves fed GS than for calves fed PS. This discrepancy could be due to dissimilar types and inclusion rates of the dietary ingredients used to formulate PS and GS by Franklin *et al*. (2003). In our study, the type and inclusion rate of dietary ingredients were similar between two treatments. The NDF content of PS was, in contrast, relatively higher than that of GS (16.2 vs. 13.6%) in the study of Franklin *et al*. (2003). The higher NDF could impact on the retention time of gut-fill and feed intake (Allen *et al*., 2000). Also, the probable differences in pellet particle size, firmness and palatability between the two studies might have contributed to the different starter intake responses.

The lack of any significant differences in final BW and ADG was in agreement with the results of Franklin *et al*. (2003). Similarly, Coverdale *et al*. (2004) found no differences in BW and ADG of pre-weaning dairy calves fed rolled and whole grains as compared to calves fed finely ground grains. However, bull calves fed GS tended to weigh heavier than those fed unground starter containing chopped hay and rolled grains (Beharka *et al*., 1998). Consistent, adequate and early intake of a moderately fermentable starter has been recommended for an early, less-stressful weaning of young calves (Anderson *et al*., 1987; Franklin *et al*., 2003). If less-stressful, early weaning would in turn save milk and reduce labor cost. The moderate fermentability of the starter seems achievable by dietary inclusion of coarse, non-forage particles or moderate forage particles (10-20 mm) (Coverdale *et al*., 2004; McGavin and Morrill, 1976). Such a controlled fermentability is considered vital to stimulate rumination, maintain VFA metabolism by rumen epithelia and inhibit the keratinization of the rumen papillae (Coverdale *et al*., 2004; Greenwood *et al*., 1997). The forage inclusion rate was, nonetheless,

limited to 2% of starter DM in the current study to enable an exclusive comparison of the two physical forms of the same starter, which would otherwise be puzzled with probable associative effects of forage fiber on starter intake, rumen development and WC. The present study was conducted in a dairy farm with an approximate commercial weaning age of 75-85 days. Thus, consuming an essential amount of starter by pre-weaning calves may be easily accomplished by no later than 6-7 weeks of age. This would effectively minimize the costs of raising calves on milk and the health problems associated with late weaning.

CONCLUSIONS

Calves fed the finely ground or the pelleted form of a similarly formulated starter concentrate had comparable ADG, BW and age at a daily intake of 680 g starter. Therefore, the traditional ground starter appeared as efficacious for early starter intake and growth of pre-weaning dairy calves as the commercial pelleted starter. Future research with a more limited offer of milk would more specifically attribute the transition performance to physical properties of the starter. Investigating the post-weaning response to physical form of the calf diet would be complementary.

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