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Effects of preweaning total plane of milk intake and weaning age on intake, growth performance, and blood metabolites of dairy calves

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ABSTRACT

The objective of this study was to evaluate the effects of preweaning total plane of milk intake and weaning age on intake, growth performance, and blood metabolites of dairy calves. A total of 48 Holstein calves (40 ± 1.6 kg of body weight) were used in a 2 × 2 factorial arrangement with the factors of weaning age (d 60 vs. 75) and the total plane of milk intake (medium vs. high) during the preweaning period. Calves were assigned to 1 of 4 treatments: (1) calves fed medium plane of milk (MPM) intake and weaned on d 60 of age (MPM-60d, 4 L/d of milk from d 3 to 10, 6 L/d of milk from d 11 to 55, and 3 L/d of milk from d 56 to 60 of age; total milk intake = 317 L), (2) calves fed MPM intake and weaned on d 75 of age (MPM-75d, 4 L/d of milk from d 3 to 10 and 4.5 L/d of milk from d 11 to 70 of age followed by feeding 2.25 L/d of milk from d 71 to 75 of age; total milk intake = 313 L), (3) calves fed high plane of milk (HPM) intake and weaned on d 60 of age (HPM-60d, 4 L/d of milk from d 3 to 10, 6 L/d of milk from d 11 to 20, and 8.5 L/d of milk from d 21 to 55 followed by feeding 4.25 L/d of milk from d 56 to 60 of age; total milk intake = ∼411 L); and (4) calves fed HPM intake and weaned on d 75 (HPM-75d, 4 L/d of milk from d 3 to 10, and 6 L/d of milk from d 11 to 70 of age followed by feeding 3 L/d of milk from d 71 to 75 of age; total milk intake = 407 L) with no milk refusals. All of the calves were monitored up to d 90 of age. Regardless of weaning age, starter feed intake and dry matter intake (% of body weight) were lower in calves fed HPM compared with those receiving MPM. A tendency for the plane of milk intake × weaning age interaction was observed for metabolizable energy intake with the highest value was recorded with the HPM-75d calves. The lowest efficiency of metabolizable energy intake and average feed efficiency was observed in HPM-60d calves throughout the experimental period as compared with the other groups. An interaction was found between the total plane of milk intake and weaning age regarding effects on total average daily gain, average daily gain/metabolizable energy intake, feed efficiency, final body weight, and plasma β-hydroxybutyrate levels with the highest values measured in HPM-75d calves. Weaning on d 75 versus d 60 improved wither height and hip width, which tended to increase body length at the end of the trial. The results suggest that calves fed high amounts of milk during their preweaning period benefit from extending the time of weaning from 60 to 75 d of age based on average daily gain, feed efficiency, and final body weight.

Key words: calf, plane of milk, weaning age, growth

INTRODUCTION

Preweaning management of dairy calves over the past decade has been focused on alternative milk feeding methods in an attempt to improve dairy growth performance and health without adverse effects on rumen development (Eckert et al., 2015; Omidi-Mirzaei et al., 2015). The dairy industry has undergone a radical change from low to medium or high plane of milk intake in the feeding regimen, which is close to natural intakes and expectedly yields greater preweaning growth rates. Raising calves on a high plane of nutrition leads to many beneficial effects including greater ADG during their preweaning period (Jasper and Weary, 2002; Khan et al., 2007), earlier onset of puberty (Bar-Peled et al., 1997; Bartol et al., 2013), greater milk produc-

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tion in the first lactations (Moallem et al., 2010; Soberon et al., 2012), and fewer behavioral signs of hunger (de Passillé et al., 2011; Miller-Cushon and DeVries, 2015). Despite its benefits to growth performance, the high plane of milk intake (20% BW) is still not advised for the preweaning stage under all circumstances. The reason for this is that feeding excessive amounts of milk delays initiation of solid feed intake, which may compromise early rumen development in dairy calves (Appleby et al., 2001; Jasper and Weary, 2002). In support of this, Sweeney et al. (2010) found that calves fed large amounts of milk displayed not only decreased postweaning intake but also a weight loss during an abrupt weaning scheme at 40 d of age. This weight loss could be decreased by weaning at a later age (de Passillé et al., 2011), albeit it does increase the total amount of milk required.

The weaning strategy, especially weaning age, becomes increasingly important when greater volumes of milk are offered (Meale et al., 2015). The average weaning age of calves on dairy farms in the United States is 8.4 wk (USDA, 2010). Extending weaning age when receiving high amounts of milk has been suggested to cope with the transition from milk to solid feed. Greater growth rates and more gut development at weaning were evident in dairy calves weaned at 8 wk compared with those weaned at 6 wk of age, indicating that calves might benefit from a delayed weaning when fed the preweaning high plane of milk replacer (Eckert et al., 2015). Meale et al. (2015) found that, compared with those weaned at 8 wk, calves fed an elevated plane of milk replacer and weaned at 12 wk of age exhibited greater growth rates and reduced signs of stress during weaning. Bjorklund et al. (2013) also reported that calves weaned on d 30 of age had lower weight gains and body dimensions than those weaned on d 60 or 90 of age; however, by 120 d of age, all their calves had similar final BW. Total preweaning milk consumption and the timing of weaning are critical to dairy producers, although not enough investigation has been reported on determining the effect of weaning age on intake and growth performance when calves are fed different quantities of milk.

In this study, we hypothesized that dairy calves weaned at a later age (d 75) would have higher growth performance than those weaned at 60 d of age as a result of sufficient energy supplied by liquid feed and dry feed intakes when calves are fed higher quantities of milk. It is, therefore, the objective of this study to investigate the effects of preweaning total plane of milk intake (medium vs. high) on pre- and postweaning intake, growth performance, and blood metabolites of dairy calves weaned at different ages (d 60 vs. 75).

MATERIALS AND METHODS

Experimental Treatments, Feeding, and Measurements

This experiment was conducted on a local dairy farm (Fudeh Agriculture and Animal Husbandry, Isfahan, Iran) during the period September to October 2016. All the animal procedures were approved by the Animal Care Committee of Arak University by the Iranian Council of Animal Care (1995). A total of 48 Holstein dairy calves (40 ± 1.6 kg of BW, n = 12 calves per treatment: 6 males and 6 females) were randomly assigned to 4 treatments in a 2 × 2 factorial arrangement with the factors of preweaning total plane of milk intake (medium vs. high) and weaning age (d 60 vs. 75). All the calves were housed from birth to d 90 of age in a naturally ventilated barn with individual pens (1.2 × 2.5 m) bedded with sand that was renewed every 48 h. Calves were offered 4 L of colostrum using nipple bottles within 3 h of life and 12 h after the first feeding. The quality of colostrum was measured with a digital Brix refractometer (PAL-1, Atago Co. Ltd., Bellevue, WA) and discarded if measured lower than 22 on the Brix scale (Bielmann et al., 2010). If the dam produced colostrum of insufficient quality or quantity, frozen colostrum of sufficient quality was thawed and fed to the calf. From d 3 onward, milk containing 3.16 ± 0.15% fat, 3.11 ± 0.08% CP, 4.55 ± 0.09% lactose, and 11.30 ± 0.15% TS was fed individually in steel buckets in 2 meals of equal volumes per day (at 0800 and 1600 h). Calves were assigned to 1 of 4 treatments (Figure 1): (1) calves fed medium plane of milk (**MPM**) intake and weaned on d 60 of age (**MPM-60d**, 4 L/d of milk from d 3 to 10, 6 L/d of milk from d 11 to 55, and 3 L/d of milk from d 56 to 60 of age; total milk intake = 317 L), (2) calves fed MPM intake and weaned on d 75 of age (**MPM-75d**, 4 L/d of milk from d 3 to 10 and 4.5 L/d of milk from d 11 to 70 of age followed by 2.25 L/d of milk from d 71 to 75 of age; total milk intake = 313 L), (3) calves fed high plane of milk (**HPM**) intake and weaned on d 60 (**HPM-60d**, 4 L/d of milk from d 3 to 10, 6 L/d of milk from d 11 to 20, and 8.5 L/d of milk from d 21 to 55 followed by 4.25 L/d of milk from d 56 to 60 of age; total milk intake = ∼411 L); and (4) calves fed HPM intake and weaned on d 75 of age (**HPM-75d,** 4 L/d of milk from d 3 to 10 and 6 L/d of milk from d 11 to 70 of age followed by 3 L/d of milk from d 71 to 75 of age; total milk intake = 407 L); there were no refusals of milk. The study was terminated on d 90. From d 1 to 90 of age, all the calves had free access to fresh water and a starter feed formulated according to the current NRC (2001). The ingredients and nutrient