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Effect of rumen protected fat supplementation on milk yield and its composition: A review

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Abstract
Role of the bypass fat/RPF (Rumen Protected Fat) in the rations of the high producing dairy animals is very crucial for enhancing the energy density of ration. Dietary fat, that resists lipolysis and bio hydrogenation in rumen by rumen microorganisms, but gets digested in lower digestive tract, is known as bypass fat or rumen protected fat or inert fat. High producing buffaloes in early lactation do not consume sufficient dry matter to support maximal production of milk. Demand for energy is very high during early stage of lactation but supply is not commensurate with demand due physiological stage. It may affects production potential of animal in the whole lactation length resulting in lower milk yield. Rumen protected fat plays an important role as source of energy in the ration of high yielding dairy animals for optimum productivity. So, diets containing rumen protected fat often stimulate increased milk production, milk fat percentage because of increased energy intake, improved efficiency of utilization of energy.

Keywords: Rumen protected fat, milk yield and milk composition

Introduction

Most of the animals in developing countries including India are fed on agriculture by-products and low quality crop residues, which have inherent low nutritive value and digestibility. The shortage of feed resources coupled with their poor nutritive value lowers the productivity of dairy animals. Demand for energy is very high during early stage of lactation but supply does not commensurate with demand thus affecting the production potential of animal (Sirohi *et al.*, 2010) [40]. Hence, during early lactation, dairy animals are often forced to draw on body reserves to satisfy energy requirements thereby leading to substantial loss in body weight which adversely affects production, resulting in lower milk yield (Kim *et al.*, 1993) [16]. Cereal grains and fats play an important role as sources of energy in the ration of dairy animals but due to use of cereals for human consumption and monogastric animals the alternate source of energy in dairy ration is supplemental fat (Saijpaul *et al.*, 2010) [33]. Inclusion of unprotected fat in dairy ration is limited to 3% of dry matter (DM) intake, beyond which digestibility of DM and fibre are reduced (NRC, 2001) [23]. Besides, unprotected fat has depressing effect on rumen cellulolytic microbial activity (Ranjan *et al.*, 2010) [31]. By protecting the fats from ruminal degradation, the fat content of the ration can be increased up to 6- 7% of the DM intake. Supplementing ration of lactating animals with rumen protected fat enhances energy intake in early lactation which reduces deleterious effect of acute negative energy balance (Tyagi *et al.*, 2010) [47]. Rumen protected fat in the form of calcium salts of fatty acids has been known to increase energy density of the ration without adversely affecting the DM intake and digestibility (Naik *et al*. 2009) and also help to increase milk yield (Erickson *et al*. 1992) and milk fat percentage or both (Chouinard *et al*. 1998) [21, 8, 4]. Several workers studied responses to supplementation of bypass fat has been reported to increase milk and FCM yields in lactating buffaloes (Thakur and Shelke, 2010) [45].

Effect of RPF on Milk Yield

Sklan *et al*. (1989) reported that fat corrected milk yield was increased with Ca salts of fatty acid supplementation despite nonsignificant changes in milk yield and fat contents [44]. West and Hill (1990) found no difference on milk yield when cows were fed CSFA [50]. Bypass fat supplementation show no improvement in milk yield (Schauff and Clark, 1989; Skaar *et al.*, 1989; Klusmeyer *et al.*, 1991b; Sklan *et al.*, 1992; Elliott *et al.*, 1996) [34, 42, 18, 43, 7]. Erickson *et al*. (1992) found an increase in milk yield by cows fed calcium salts of long-chain fatty acid in early lactation [8]. Similar results were also reported (Schneider *et al*., 1988; Klusmeyer *et al*., 1991a; Erickson *et al*., 1992; Wu *et al.*, 1993; Tomlinson *et al*., 1994) [37, 17, 8, 51, 46]. Schauff and Clark (1992) reported increase in FCM yield of lactating cows, when Ca-LCFA was supplemented up to 6% of the dietary DM, but, it decreased at 9% of the dietary DM [35]. Maiga and Schingoethe, (1997) observed diets containing supplemental fat often stimulate increased milk production because of increased energy intake, improved efficiency of utilization of energy, or both [20]. Garg and Mehta, (1998) showed significant increase in milk yield and milk fat content by feeding rumen protected fat [11]. Castaneda Gutierrez *et al*. (2005) reported that milk yield was not affected by dietary supplementation of Ca salts of CLA in lactating dairy cows [3]. Elek *et al*. (2008) and Lima *et al*. (2007) observed significant improvement in milk yield on supplementing RPC in dairy cows [6, 19]. Hammon *et al*. (2008) have also showed the positive effect of rumen protected fat in increasing the milk yield during early lactation by correcting the negative energy balance of the animal [14]. Purushothaman *et al.* (2008) showed that feeding of Ca salt of palm oil fatty acids supplementation in the ration of lactating cows caused a substantial improvement in the milk yield, FCM yield and fat yield in milk of dairy cows [28]. Duske *et al*. (2009) reported that supplementation of bypass fat before parturition could reduce the detrimental effects of NEBAL which could improve lactation as well as the metabolic performance [5]. Barley and Baghel, (2009), Sirohi *et al.* (2010) showed positive effects of supplementing bypass fat on milk production and daily fat yield in lactating animals [2, 40]. Thakur and Shelke, (2010) studied responses to supplementation of bypass fat has been reported to increase milk and FCM yields in lactating buffaloes [45]. On supplementation of bypass fat in the diet of dairy animals, the milk yield is increased by 5.5-24.0% (Naik *et al.*, 2009b; Tyagi *et al*., 2009a; Thakur and Shelke, 2010; Sirohi *et al.*, 2010; Gowda *et al*., 2013; Parnerkar *et al*., 2011) [22, 48, 45, 40, 12, 25]. The average daily milk yield increased by 1.13 kg day–1 in the bypass fat supplemented group (Wadhwa *et al*., 2012) [49]. Ranjan *et al*. (2012) reported that bypass fat supplementation at 1.4% of DMI (200 g day–1) increased the milk production and feed efficiency in lactating Murrah buffaloes [30]. Rajesh, (2013) reported that supplementation of PF during early lactation improved milk yield and reproductive performance in crossbred cows [29]. Rajesh, (2013) reported an improvement of 6.02% in milk yield of early lactating crossbred cows fed 75 g day–1 per animal PF[29].Similar amount of PF feeding to Murrah buffaloes resulted in 10% increase of milk yield in organized herd (Singh, 2015) and 17% increase under field conditions (Khan *et al*., 2015) [39, 15].

2.3 Effect of RPF on Milk Composition

Schneider *et al.* (1988) reported no difference in milk protein composition from dietary CSFA [37]. Atwal *et al*. (1990), Garcia-Bojalil *et al*. (1998) observed no effect milk fat contents from feeding rumen-bypass fat [1, 10]. Schneider *et al.* (1990) reported no difference in milk protein composition from dietary CSFA [36]. Erickson *et al*. (1992), Sklan *et al*. (1992), Rodriguez *et al*. (1997) reported when rumen-bypass fat was supplemented to the diet of dairy cows the reduction of fat and crude protein contents [8, 43, 32]. Klusmeyer *et al.* (1991a, 1991b), Sklan *et al.* (1992), Elliott *et al*. (1996) reported increase of milk fat from feeding rumen-bypass fat [17, 18, 43, 7]. Preston, (1995) reported that bypass oil (protected with calcium salts) is incorporated directly into milk and body fat, thus saving glucose needed for NADPH synthesis, when fat is synthesized from acetate [27]. Rodriguez *et al*. (1997) reported that reduction in milk protein contents might be a result of reducing microbial protein production or insufficient essential amino acids to meet the requirements of dairy cows for milk production [32]. Similar responses were also observed by West and Hill, (1990), Kim *et al*. (1993), Wu *et al*. (1993) [50, 16, 51]. Garg and Mehta, (1998) who reported significant increase in milk yield and milk fat content by feeding rumen protected fat [11]. Fahey *et al.* (2002) observed milk lactose increase with oil and by-pass fat [9]. Fahey *et al.* (2002) observed the increase in milk fat yield by feeding rumen-by-pass fat [9]. Gulati *et al*. (2003) suggested that feeding protected fat supplements increased fat, protein and yield of milk significantly [13]. Piperova *et al*. (2004) concluded that treatments had no effect on lactose contents of milk by adding rumen protected fat in the diet of the dairy animals [26]. Piperova *et al*. (2004) reported rather a decrease in milk fats contents with the supplementation of rumen-bypass fats [26]. Piperova *et al*. (2004), Palmquist and Griinari, (2006) reported that milk protein contents remained unaffected by the treatments of bypass fat [26, 24]. Purushothaman *et al.* (2008) reported that feeding of Ca salt of palm oil fatty acids supplementation in the ration of lactating cows caused a substantial improvement in the milk yield, FCM yield and fat yield in milk of dairy cows [28]. Rajesh, (2013), Yadav *et al*. (2015) reported that supplementation of bypass fat increases milk fat in lactating cows [29, 52]. Naik *et al*., (2009b), Tyagi *et al.*, (2009a), Thakur and Shelke, (2010) and Sirohi *et al*., (2010) reported that supplementation of bypass fat has no effect on the milk protein [22, 48, 45, 40]. Contrarily Chouinard *et al*., (1998) reported that supplementation of bypass fat (Ca-LCFA) has negative effect on the milk protein percentage; an overall effect of -0.12 percentage unit [4]. Naik *et al*. (2009), Tyagi *et al.*, (2009a), Thakur and Shelke, (2010) and Sirohi *et al*., (2010) reported that on supplementation of bypass fat in the diet of dairy animals, the SNF (Solid Not Fat) of milk was unaffected [21, 48, 45, 40]. Naik *et al.* (2009b) reported that total solid contents were not influenced by the supplemental bypass fat [22].

Conclusions

It may be concluded that by supplementation of bypass fat it is possible to increase milk production and fat content. Farmers are typically paid on the basis of the fat content of the milk they are producing, hence increase in fat percent and milk yield there would be increase in revenue of the dairy farmers. So, use of bypass fat as an energy source is beneficial regarding productive performance of buffaloes.

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