Probiotics and lamb performance: A review

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Probiotics are naturally occurring microbes, which upon administration improve the health status of the animal by competing with the pathogenic microbes and nutrient utilization by having a positive influence on gut microflora. Addition of probiotics in the lamb’s diet has been reported to improve feed utilization and growth performance of the animals. The exact mechanism through which they affect the animal performance is not well known. However, it is stated that they work synergistically with the ruminal microorganisms. They also increase the ruminal pH, which favours the growth of cellulyotic bacteria. Improvement in the colonization of cellulyotic bacteria may result in improved digestion process and nitrogen flow towards lower digestive tract. Furthermore, their anti-pathogenic activity may reduce the stress on animal. Because of higher profit margin in intensive small ruminant production, farmers are shifting from traditional to high input feeding systems. In order to harvest, real benefits from small ruminants which are raised on nutrient rich diet, feed additives like probiotics are used to enhance the efficiency of nutrient utilization in growing ruminants. However, reports regarding the effect of probiotics administration on growing and fattening performance and carcass characteristics of the lambs are inconsistent. This might be related to the type and level of probiotics used and ingredient composition of the experimental diet. Thus, further research to understand the interaction of direct fed microbials with ruminal microorganisms is to have better understanding about adequate dose level at particular stage of lamb growth. This short review article is an attempt to recapitulate the effects of feeding probiotics on different aspects of lamb production which directly or indirectly influence the productivity and hence profitability associated with this enterprise.

Key words: Probiotics, lambs performance, microbial growth.

INTRODUCTION

Probiotics are non-pathogenic microbes which occur in nature and the gastrointestinal tract of ruminants, where they exert a positive influence on the host physiology (Dunne et al., 1999). Probiotics improve microbial ecosystem (Sandine, 1979; Musa et al., 2009), nutrient synthesis and their bio-availability resulting in better growth performance in farm animals (Oyetayo and Oyetayo, 2005). In addition to that probiotics also improve nutrient absorption (Teeler and Vanabelle, 1991), reduce the incidence of intestinal infection (Casas and Dobrogosz, 2000) and restore the gut microflora in case of diarrhoea (Musa et al., 2009). They are also known to increase ruminal pH (Umberger and Notter, 1989), total volatile fatty acids (VFAs) and ruminal biomass (Newbold et al., 1996) and thus influence the cellulyotic activity and microbial protein synthesis and fiber degradation (Martin and Nisbet, 1990; Yoon and Stern, 1996). It is also considered that they compete with other pathogenic micro-organisms for the provision of nutrients and other growth factors (Rolfe, 2000).

They enhance immunity (Aattouri et al., 2001) by promoting the antibodies, IgA and cytokines production (Trebiachvsky and Splichal, 2006). A positive impact of probiotics supplementation on nutrient intake, weight gain and feed conversion ratio (FCR) in ruminants has been reported by many workers (Chiofalo et al., 2004; Antunovic et al., 2006; Whitley et al., 2009). However, the actual mechanism through which probiotics improve animal performance is not known (Koop-Hoolihan, 2001).
However, different environmental factors may affect the gut microbial ecology; they include diet, medication, stress, age and general living conditions (Vlková et al., 2009). Positive effects of probiotics on the rumen environment and performance of ruminants have been intensively studied because they can beneficially modify microbial activities, fermentative and digestive functions in the rumen. It is further stated that probiotics can stimulate specific groups of beneficial bacteria in the rumen, and has provided mechanistic models that can explain their effects on animal performance (Dutta et al., 2002).

This short review article briefly elaborate the effects of probiotics feeding on nutrients intake, digestibilities, nitrogen balance, blood metabolites and growth performance in growing lambs.

**Nutrient intake**

Diet composition and probiotics supplementation are known to influence the performance of ruminants. Probiotics supplementation has been found to increase feed intake (Chiofalo et al., 2004; Antunovic et al., 2005, 2006; Desnoyers et al., 2009). Similarly, Chademana and Offer (1990) reported a promoting role of probiotics on dry matter intake (DMI) and fiber degradability. This might be because of improved cellulolytic bacteria in the rumen of lambs fed probiotics supplemented diets (Wallace and Newbold, 1993). Other possible reason for increased DMI in response to probiotics supplementation may be their positive effect on ruminal pH, leading to improved fiber degradation and DMI (Umberger and Notter, 1989). *Lactobacillus plantarum* splits certain carbohydrates into simpler substances like glucose, which provides energy. *Apergillus oryzae* helps in producing enzymes that are involved in carbohydrate/fiber digestion leading to improved animal performance.

Titi et al. (2008) observed that supplementation of yeast culture in the diets of lambs and kids had no effect on DMI.

Likewise, Hernandez et al. (2009) noticed no change in DMI of lambs fed grass diets which contain probiotics. Haddad and Goussous (2005) also reported similar findings. Kiesling et al. (1982) added lactobacillus culture to the diet of steers for a 209 day finishing period and found no difference in DMI among the treated and controlled group. In the same way, Swinney-Floyd et al. (1999) fed *Propionibacterium* and *Lactobacillus* spp. independently or in a combination and found that treatments did not influence DMI in calves. The DMI was not affected in feed lot cattle fed high concentrate diets; however supplementation with *Propionibacterium* P15 resulted in an increase in protozoal numbers with associated increase in ruminal ammonia concentration and a decrease in the number of amylolytic bacteria compared with the un-supplemented group (Ghorbani et al., 2002). In conclusion, supplementation of probiotics may influence DMI by affecting ruminal pH and digestion of the nutrients.

**Nutrient digestibility**

Probiotics improve nutrient digestibility (Abd El-Ghani, 2004), degradation of fiber (El-Waziry and Ibrahim, 2007) and ruminal digestion (Kamel et al., 2004) more likely fiber degradation (Dawson and Tricarico, 2002) by increasing pH in the rumen (Mohamed et al., 2009; Paryad and Rashidi, 2009), enhancing growth and/or cellulolytic activity by rumen bacteria (Dawson and Tricarico, 2002) and preventing ruminal acidosis by balancing the VFAs ratios in the rumen (Arcos-Garcia et al., 2000). Haddad and Goussous (2005) reported that the supplementation of yeast culture (YC; Diamond V® YC) in the diets of Awassi lambs resulted in higher dry matter (DM), organic matter (OM) and apparent crude protein (CP) digestibility (678, 683 and 653 g/kg, respectively) compared to control (632, 645 and 589 g/kg, respectively).

Similarly, neutral detergent fiber (NDF) digestibility was also higher in the yeast culture supplemented group. Abd El-Ghani (2004) observed that bucks fed diet containing yeast culture supplements had higher nutrient digestion compared to those fed a concentrate and roughage diet. Krehbiel et al. (2003) reported that feed additives and direct-fed microbes improved digestibility of the diet. In contrast, Titi et al. (2008) reported that addition of probiotics (yeast culture) had no effect on DM, CP and NDF digestibility. However, in the same study, digestibility of OM and acid detergent fiber (ADF) increased in lambs and kids supplemented with yeast culture in the diet. Whitley et al. (2009) also reported improved apparent DM, CP, NDF and ADF digestibility in meat goats fed diet supplemented with commercial probiotics than control group. In conclusion, supplementation of probiotics in the diet may result in improved nutrient digestibility.

**Blood metabolites**

Blood urea nitrogen (BUN) concentration is indicative of renal function (Oltner and Wiktorsen, 1983). Weaned lambs (60 days old) supplemented with 0.1% probiotics (PDFM®) had statistically lower concentration of glucose and BUN (Antunovic et al., 2005). Antunovic et al. (2006) also examined lower concentration of urea (5.51:7.97 mmol/l) in the blood serum of lambs fed diets with probiotics as compared to the control diets. Lower BUN in lambs containing probiotics could be due to improved utility of N in the rumen (Bruno et al., 2009) and lower blood glucose might be attributed to higher fiber digestion leading to more production of ketogenic moieties.
However, Abo El-Nor and Kholif (1998) reported higher BUN values in response to probiotics supplementation. This higher BUN concentration may be due to incapacity of ruminal microflora to detoxify the ammonia optimally (Butler, 1998). Whereas, other researchers reported no differences in BUN concentration when probiotics supplemented groups were compared with the control (Masek et al., 2008; Bruno et al., 2009).

Glucoseogenesis is a major source of glucose in lambs (Huntington and Eisemann, 1988) as it is responsible for the satisfaction of 75% of the total glucose needs in ruminants (Donkin and Hammon, 2005). Antunovic et al. (2006) reported unaltered blood glucose levels in the diets of lambs containing probiotics. While, Abo El-Nor and Kholif (1998) reported higher blood glucose concentration in cows fed diets containing probiotics. This increase in glucose concentration in the probiotics supplemented group might be related to a temperate improvement in glucoseogenesis and increased lactate absorption (de Valdez et al., 1997). However, no differences were noticed in blood glucose concentration in lambs fed diets with or without probiotics (Ding et al., 2008). Creatinine is produced in the muscle tissue and its normal concentration indicates the optimal physical activity. Belewu et al. (2008) noticed no change in creatinine in goats fed diets supplemented with probiotics. Likewise, Antunovic et al. (2006) found similar results in growing lambs. Galip (2006) also found no difference in blood creatinine level in rams supplemented with probiotics.

Nitrogen balance

Probiotics supplementation improves the microbial activities in rumen resulting in enhanced NH₃ capture to synthesize microbial protein (Erasmus et al., 1992) and have profound influence in lambs (Jouany et al., 1998a). Probiotics alone or in combination increase the N-intake (Mohamed et al., 2009) and ruminal N pool (Jouany et al., 1998a). Probiotics have been reported to enhance the N-retention (Paryad and Rashidi, 2009) by enhancing microbial peptidolytic and proteolytic activities in the rumen (Cole et al., 1992), and post-ruminal amino acid flow (Enjalbert et al., 1999; Erasmus et al., 1992). This augmentation in post-ruminal amino acid flow has also been reported by other researchers (Putnam et al., 1997; Doreau and Jouany, 1998). However, Hernandez et al. (2009) reported no effect of probiotics supplementation on N-retention, N-intake and fecal and urinary N in lambs fed mature orchard grass. Jouany et al. (1998b) also reported no change in urinary N excretion in response to probiotics supplementation.

It is well documented that probiotics impart their favorable effects to ruminants even at post ruminal level. Positive effects of probiotics on nutrients intake may be attributed to numerous factors like they attach to the intestinal mucosa and prevents potential pathogen establishment leading to improved nutrient digestion which enhances dry matter intake (Seo et al., 2010). Furthermore, it is also stated that probiotics also help to maintain lower pH in the GIT, thereby inhibiting growth of pathogens and modulate microbial balance in the GIT and prevent illness caused by intestinal pathogens or stress (Dicks and Botes, 2010). Production of anti-bacterial compounds such as bacteriocin and hydrogen peroxide have also been reported to favour animal fed on diets containing probiotics (Frizzo et al., 2010). It has also been reported that probiotics may also help in reducing the load of undesirable microbes which may cause diseases in human being (Arthur et al., 2010). Favorable effects of probiotics on rumen fermentation which may ultimately improve the utilization of feed and thereby animal performance has also been observed in buffaloes (Malik and Bandla, 2010).

Growth performance

Feed additives like probiotics have been reported to improve FCR in ruminants (Robinson, 2002). Probiotics supplementation improves feed efficiency (Abdelrahman and Hunaiti, 2008). Probiotics improve microbial ecology (Sandine, 1979; Musa et al., 2009), nutrient synthesis and their bio-availability resulting in better weight gain in farm animals (Oyetayo and Oyetayo, 2005). Haddad and Goussous (2005) observed that the supplementation of yeast culture (YC; Diamond V® YC) in the diets of Awassi lambs resulted in higher weight gain (266 g/day) as compared to control (212 g/day). Similarly, Jang et al. (2009) found that the probiotics supplementation tended to increase weight gain in lambs. Higher weight gain in lambs fed diets containing probiotics could be due to augmented microbial protein synthesis leading to more amino acids supply at post-ruminal level (Erasmus et al., 1992). Body weight gain improved by 1.90% and daily gain by 2.50% in lambs fed diets with probiotics Bioplus 2B compared to the control group. Better weight gain may also be related to higher consumption and better efficiency of feed utilization in the probiotics-supplemented group (Antonovic et al., 2006). Lambs fed diets with Probios® had improved weight gain (24.7 and 6.4%) during the first two weeks and from the 2nd to 4th week (Pond and Goode, 1985).

In contrast, Titi et al. (2008) reported that yeast supplementation had no effect on growth rate in lambs and kids. Baranowski et al. (2007) also observed no difference in the mean daily live weight gain (238 g versus 225 g) in lambs fed diet supplemented with linseed and mineral bioplex than lambs fed control diet only. Feed conversion ratio also remained unchanged across the treatments. Whiteley et al. (2009) found that growth performance of goats remained unaltered with probiotics supplementation, except in one growth trial in
which weight gain and FCR was higher in probiotics supplemented group compared with the control. Antunovic et al. (2005) reported that probiotics feeding improved daily gains and average body weights. Similarly, Abas et al. (2007) reported higher body weight gain in Kivircik male yearling lambs supplemented with direct feed microbial culture (Cylactin® LBC ME 10) than the control group. Mutassim et al. (2008) reported that supplementation of 2 g cyc-methionine/d resulted in significantly higher total body gain and average daily gain compared to control. Anandan et al. (1999) found significantly higher weight gain in the Cheghu crossbred kids fed the probiotics supplement (curds) orally @ 15 ml/day compared to the control (4.37 versus 3.15 kg and 44.6 versus 32.1 g/day) indicating that curds as probiotics may be supplemented for the improvement of growth performance of kids. Probiotics enhanced digestion and feed FCR and improved weight gain in small ruminants (Robinson, 2002). Higher weight gain in ruminants might be due to more cellolytic activity resulting in improved fiber degradation (Russell and Wilson, 1996) because of reduced activity of more ammonia producing microbes that made the protein available for absorption at post-ruminal level (Chaucheyras-Durand et al., 2008).

Adequate data on lamb production support that, supplementation of probiotics to the basal diet is effective and may be helpful to improve growth performance of the ruminants. Efficiency of feed utilization improved in growing lambs fed diets supplemented with probiotics (pioneer PDFM®) which indicated the biological changes in rumen (Antunovic et al., 2005). Antunovic et al. (2006) also reported better efficiency of feed utilization in lambs fed diets with probiotics compared to the diets without probiotics but the differences were statistically non-significant. Better efficiency of feed utilization was also noted in lambs fed diets containing Probios® during the 1st two weeks and from 2nd to 4th week (Pond and Goode, 1985).

Haddad and Goussous (2005) found that the supplementation of yeast culture (YC; Diamond V® YC) in Awassi lambs resulted in better FCR. Jang et al. (2009) noticed that the probiotics supplementation to the basal diet tended to improve FCR. Mutassim et al. (2008) found that supplementation of 2 g cyc-methionine/lamb/day showed better FCR compared to control, indicating that feeding Awassi lambs yeast and methionine in the form of cyc-methionine with low level of 2 g/day improves the efficiency of feed utilization. Swinney-Floyd et al. (1999) fed Propionibacterium and Lactobacillus spp. independently or in a combination and reported that FCR did not differ among various treatments. Above studies indicated that, supplementation of probiotics in the diet of ruminant animals improved FCR resulting in better gain.

**Carass characteristics**

Reports regarding the effect of probiotic supplementation on carcass characteristics are inconsistent. Cassava waste diets treated with probiotics resulted in higher carcass weight as compared to the placebo (Belewu and Jimoh, 2005). However, no changes were observed in weights and proportions of carcass cuts in response to probiotics supplementation (Titi et al., 2008). Similarly, Whitley et al. (2009) reported that carcass weight and weights of various cuts (shoulder, loin, leg etc.) remained unaltered by probiotics supplementation in meat of goat. Probiotics supplementation to finishing diets did not influence carcass characteristics of ruminants (Kiesling et al., 1982). Belewu and Jimoh (2005) found no effect of probiotics supplementation on the weights of lungs, heart and kidney.

Mutassim et al. (2008) reported that supplementation of 2 g cyc-methionine/lamb/day showed significantly higher dressing percentage (DP) compared to the control diet. Similar findings were reported by Belewu and Belewu (2005) in goats supplemented with probiotics. Likewise, Abdelrahman and Hunaiti (2008) noticed higher DP by lambs fed diets supplemented with probiotics. In ruminants lactate-utilizing or lactate-producing bacteria did not affect the marbling and DP (Ware et al., 1988). However, higher (2%) values for back fat thickness in response to probiotics supplementation in goats, as compared to control were reported by Whitley et al. (2009). Similarly, Pelicano et al. (2005) reported 11.6% higher values for fat in animals supplemented with probiotics. This change in body fat may because of changes in relative concentration of volatile fatty acids (VFAs) resulting in more lipogenesis and fat distribution in different tissues of the body (Elam et al., 2003).

**CONCLUSIONS**

Probiotics may improve the ruminal microflora and increase the ruminal pH. So, their effect on the fiber digestion may be more intense in growing and fattening lambs receiving high concentrate diets. It is further stated that inclusion rate and level of concentrate in the total feed significantly influence rumen ecology and thereby nutrients digestion and availability in ruminants. However, more research work to study their interactions with ruminal microbes and the effect of their level and type used should be carried out.

**REFERENCES**


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