Sjournals
Scientific Journals

Scientific Journal of Animal Science (2016) 5(7) 329-332
ISSN 2322-1704
doi: 10.14196/sjas.v5i7.2204

CODEN (USA): SJASAB

Contents lists available at Sjournals
Scientific Journal of **Animal Science**
Journal homepage: www.Sjournals.com

Review article

Effects of defaunation on rumen fermentation features, feed intake, digestibility and animal performance

Desta Tekle Gebru*
Abergelle Agricultural Research Center, P.O. Box 44, Abyi Adi, Tigray Agricultural Research Institute, Mekelle, Ethiopia.

*Corresponding author; Abergelle Agricultural Research Center, P.O. Box 44, Abyi Adi, Tigray Agricultural Research Institute, Mekelle, Ethiopia.

ARTICLE INFO

Article history,
Received 11 June 2016
Accepted 10 July 2016
Available online 17 July 2016
iThenticate screening 14 June 2016
English editing 08 July 2016
Quality control 14 July 2016

Keywords,
Bacteria
Fibre
Organic matter
Protozoa
Weight gain

ABSTRACT

The objective of the review was to provide compiled information on the effects of defaunation on rumen fermentation features, feed intake, digestibility and animal performance for development workers, academic user's, researchers and other interested readers. Defaunation is the selective removal of protozoa from the rumen of animals. Based on the most of information reviewed defaunation decreases rumen pH, ruminal ammonia concentration, methane emissions, fibre carbohydrate digestibility and organic matter digestibility, and it increases total volatile fatty acids concentration, numbers of bacteria, feed conversion efficiency and weight gain but it did not affect dry matter intake.

1. Introduction

Ruminant animals are nutritionally dependent on the activity of microorganisms present in the rumen. This dependence is based on microbial activity that degrades plant fiber, uses nonprotein nitrogen, and transforms phytotoxins or toxins produced by plants. The rumen contains a complex microbial ecosystem comprising mainly strictly anaerobic bacteria and protozoa with small numbers of anaerobic fungi and facultatively anaerobic bacteria (Hespell, 1987). It is the rumen microbes that makes possible for ruminants to digest and metabolize feed

materials that may otherwise be indigestible (Arse and Yosef, 2013). Any changes within this population can affect digestion and animal performance. The ciliate protozoa of the rumen have been classified into two groups depending upon their morphological characteristics, that holotrich and entodiniomorphid protozoa (Kamra, 2005). Furthermore, these can also be classified as soluble sugar utilizers, starch degraders and lignocellulose hydrolysers.

Defaunation is the selective removal of protozoa from the rumen of animals. Such animals can be used to test the essentiality of the ciliate protozoa for ruminants. Defaunation also provides a method of growing selected types of protozoa in the rumen in attempts to study the contribution to the host of each component species of rumen microfauna (Abou Akkada et al., 1968). The review's objective was to provide compiled information on the effects of defaunation on rumen fermentation features, feed intake, digestibility and animal performance for development workers, academic user's, researchers and other interested readers.

2. Effects of defaunation

2.1. Effect on rumen fermentation features

Ruminal pH was higher in the defaunated animals (Grummer et al., 1983; Kamra, 2005). Eugene et al. (2004) noted that the level of concentrate in the diet strongly interfered with the effect of defaunation on the pH in the rumen which is increased with a high level of concentrate whereas it decreased with a low level of concentrate. Grummer et al. (1983) reported that total volatile fatty acid concentration tended to be higher in the defaunated animals. However, Kurihara et al. (1968) and Maguy et al. (2004) reported that a total volatile fatty acid concentration is increased in the presence of protozoa. Grummer et al. (1983); Eugene et al. (2004) and Kamra (2005) documented that in absence of ciliate protozoa high propionate fermentation existed. Defaunation decreased the proportion of butyrate (Grummer et al., 1983; Eugene et al., 2004; Maguy et al., 2004). Newbold et al. (1986) and Kamra (2005) reported that defaunation increased mean ruminal concentrations of lactate. Kurihara et al. (1968) and Jouany (1996) reported that defaunation decreased ruminal ammonia concentration.

Newbold et al. (1986) reported that rumen pH, proportions of acetic acid, propionic acid and butyric acid remained virtually unchanged between the faunated and defaunated animals which was disagreed to the most of reviewed information. Number of bacteria in rumen fluid was higher in defaunated animals (Kurihara et al., 1968; Rowe et al., 1985; Kamra, 2005). Defaunation decreased methane (CH4) emissions (Hegarty, 1999; Kamra, 2005; Qin et al., 2012) but this varies with diet and it is greatest on high concentrate (Hegarty, 1999). According in vitro experimental study on cereal grains, Qin et al. (2012) reported that defaunation decreased pH of culture solution at 3 h, 6 h and 12 h incubation times, proportions of acetate at 6 h and 12 h, butyrate at 3 h, 6 h and 12 h, and while it increased the proportion of propionate at 3 h, 6 h and 12 h, total VFA concentration and bacterial numbers at 6 h and 12 h.

2.2. Effects on feed Intake and digestibility

Defaunation did not affect dry matter intake (Fahmy et al., 1998; Eugene et al., 2004) but defaunation improved feed conversion efficiency (Eugene et al., 2004; Kamra, 2005). Ushida et al. (1991) examined effect of defaunation and refaunation of the rumen on cellulose digestion in vitro with special reference to ammonia supply and he found that cellulose digestion was increased by the presence of either protozoa or ammonia. Jouany and Senaud (1979) noted the presence of ciliate protozoa in the rumen gave increase in the digestibility of lignocellulose and consequently of organic matter (OM). This increase was especially high in animals contaminated with rumen fauna, including the strain *protozoa multivesiculatum*. Cellulolytic activity of rumen bacteria was modified by presence of ciliates, but in a manner which varied according to the main carbohydrate in the diet (Jouany and Senaud, 1979). It was greater when ciliates were present in animals on the « cellulose » diet and it was greatly reduced by inoculating one or more types of ciliates into the rumen of animals with an intake of readily fermentable carbohydrates inducing a lower pH of rumen content (Jouany and Senaud, 1979).

Santra and Jakhmola (1998) reported that protozoa being the major source of cellulase activity in the rumen, their elimination decreases fibre digestion in rumen. These authors also suggested that in most of the tropical countries, crop residue (rich in lignocelluloses) are the major source of feed to ruminants and so the presence of protozoa in rumen seems to be desirable. Maguy et al. (2004) also explained that defaunation decreased the total activity of fibrolytic polysaccharidase. Based on a quantitative meta-analysis was done by Eugene et al. (2004); defaunation decreased OM and cell wall carbohydrate digestibility whereas the duodenal nitrogen flow and

duodenal microbial nitrogen were enhanced by defaunation. Belanche et al. (2007) also stated that defaunation decreased urinary N, showing a better efficiency of N use. Qin et al. (2012) recorded that defaunation increased in vitro effective cereal grain degradability of dry matter.

2.3. Effects on animal performance

Bird and Leng (1978) indicated that growth rates were increased by 43% in cattle on higher protein intake and where protozoa were removed.In cattle given a molasses-based diet, low in bypass protein, growth rates can be stimulated by defaunation without an effect on feed intake, the main effect apparently arising through an increased efficiency of utilization of feed (Bird and Leng, 1978). Similarly, Veira (1986) investigated that defaunation of young growing ruminants that were fed high energy diets, containing low levels of ruminal nondegradable protein, results in increased growth rate and feed efficiency. Fahmy et al. (1998) reported that rate of body weight gain was affected by defaunation and supplementation with ruminally-protected amino acids. Defaunated sheep supplemented with amino acids gained weight most rapidly whereas faunated sheep fed the control diet gained weight most slowly. Fahmy et al. (1998)also notedthe surprisingly slow growth of faunated animals fed the control diet may have been caused by protozoa in the rumen decreasing the flow of bacterial protein to the small intestine.

Based on a quantitative meta-analysis was applied on 90 publications and 169 comparisons by Eugene et al. (2004) defaunation increased average daily gain.The absence of rumen protozoa also result in increased rate of wool growth in lambs on low level of protein supplementation (Bird et al., 1979). Moate (1989) observed substantially increased yields of milk and milk protein in defaunated Friesian cows. Hegarty (1999) suggested that protozoa decrease the supply of protein available to the host animal and their elimination offers benefits in potentially increasing livestock production.

3. Conclusion

It can be concluded that based on the most of information reviewed in this topic, defaunation decreases rumen pH, ruminal ammonia concentration, methane production, fibre (cellulose) carbohydrate digestibility and organic matter digestibility. On the hand, defaunation increases total volatile fatty acids concentration, numbers of bacteria, feed conversion efficiency and average daily gain and but it did not affect feed intake.

Acknowledgments

The author is grateful to Professor Yadav K.R., lecturer at School of Graduate Studies, Haramaya University, Ethiopia who contributed constructive comments during preparation of this review.

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How to cite this article: Gebru, D.T., 2016. Effects of defaunation on rumen fermentation features, feed intake, digestibility and animal performance. Scientific Journal of Animal Science, 5(7), 329-332.