Livestock Science 135 (2011) 17–25

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Effect of yeast cultures supplementation on live weight change, rumen fermentation, ciliate protozoa population, microbial hydrolytic enzymes status and slaughtering performance of growing lamb

M.K. Tripathi *, S.A. Karim

Division of Animal Nutrition, Central Sheep and Wool Research Institute, Avikanagar 304 501 (via-Jaipur), Rajasthan, India

ARTICLE INFO

Article history:
Received 21 September 2009
Received in revised form 20 May 2010
Accepted 7 June 2010

Keywords:
Yeast culture
Fermentation
Hydrolytic enzymes
Carcass characteristics
Lamb

ABSTRACT

Yeast cultures are being exploited as a substitute of antibiotics in animal feeding to promote gut health and performance. This experiment assessed the effect of supplementation of the live yeast cultures on live weight change, rumen fermentation, ciliate protozoa population, microbial hydrolytic enzymes status and slaughtering performance of growing lamb during post weaning phase of growth. Sixty weaner lambs were fed *ad libitum* a composite feed mixture (CFM) for 91 days in five equal groups. The CFM had roughage to concentrate (R:C) ratio of 25:75. In addition to CFM control lambs were supplemented sterilized culture while other lamb groups received either *Kluyveromyces marximanus* (NRRL3234; KM), *Saccharomyces cerevisiae* (NCDC42; SC), *Saccharomyces uvarum* (ATCC9080; SU) or mixed (all tree cultures in 1:1:1 ratio) culture. The yeast cultures contained $1.5–2.0\times10^9$ cells per ml, which were fed at 1 ml per kg live weight to each lamb of treatment groups. Dry matter intake was similar among control and yeast culture supplemented lambs ranging from 68.4 to 81.2 g/kg $W^{0.75}$. However, daily gain was higher ($p=0.002$) in SC and mixed yeast culture supplemented lambs. Half carcass weight ranged from 14.2 to 15.1 kg and dressing 52.2 to 53.5% were similar among five lamb groups. Similarly, other carcass traits did not change by yeast supplementation. The SU and mixed culture supplementation declined rumen fluid pH and total volatile fatty acid (TVFA) concentration. Individual yeast cultures increased but mixed yeast culture reduced total ciliates protozoa. Individual cultures increased *Entodinomorphs* while mixed culture reduced its number in rumen ecosystem. The SU culture increased ($p=0.023$) *Diplodinomorphs* population. Proteases activity was 499, 407, 284 and 144 units higher respectively, in mixed, SC, SU and KM culture supplemented lambs. Cellular activity of α-amylase enzyme was lower in SC, KM and mixed yeast culture lambs. Extra cellular activity of β-glucosidase enzyme was similar ($p=0.581$), whereas cellular ($p=0.007$) and total activity was higher ($p=0.029$) in SU culture lambs. The extra cellular and total activity of xylanase was not different but cellular activity was higher ($p=0.042$) in KM lambs. The carboxymethyle cellulase activity was similar among the five animal groups. The SC, SU and mixed culture supplementation improved feed intake ($p=0.722$) by 8.0, 13.3 and 18.8% and daily gain ($p=0.002$) by 26.6, 11.7 and 18.8% respectively in lambs. The SC culture feeding promoted feed intake and growth by 8 and 26.6% respectively showing the suitability of growth promoting microbial feed additive. The SC culture supplementation in rumen ecosystem also facilitated microbial growth and improved activity of short chain polysaccharides degrading micro-organism. Therefore, SC culture can be used as a growth promoting feed additives in meat animal production.

* Corresponding author. Tel.: +91 1437 220143; fax: +91 1437 220163.
E-mail address: mktripathi@gmail.com (M.K. Tripathi).

1871-1413/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.livsci.2010.06.007

1. Introduction

The modern animal production system in the World is searching eco-friendly and healthy means for the enhancement of animal productivity in general and meat animal production in particular. In animal feeding, probiotics are being explored as substitute of antibiotic feed additives that improves gut health and promotes animal performance. Microbial products are known to promote rumen metabolic development by modulating rumen function and fermentation activity of its microflora, which improves ruminant production performance. Yeast products having beneficial effects in livestock production are generally characterized to have a minimum concentration of viable cells 10^9 per g dry product. Beneficial effects and mode of action of yeast additives on rumen microbiota have been extensively studied, mostly in *in-vitro* studies or with animal models using rumen cannulated sheep or lamb reared in sterile isolators and harbouring simple microflora. However the rumen harbour a complex microbial ecosystem hence the mode of action of yeast and therefore the effects may change by the interaction with normal microbiota of rumen medium. The improvement of rumen metabolic development is based either on the live yeasts or yeast cultures or on spent culture medium whereas research results with yeast additives having both these materials on ruminant metabolic activity and performance are contradictory. Agarwal et al. (2002) and Tripathi et al. (2008) using yeast or yeast culture could not observe improvement on growth or rumen microbial population and rumen fermentation in young ruminants. In contrast, Kumar et al. (1997) by feeding yeast culture found increase in rumen bacteria numbers, which modified volatile fatty acid production. When *Saccharomyces cerevisiae* was included at 20 g/kg diet DM, feed intake and growth enhanced. Kawas et al. (2007) and Chaucheyras-Durand et al. (2008) suggested that varying response of yeast supplementation attribute depend on the strain of yeast culture, the nature of diet, and the physiological state of animal. Growth and development of the animals is the basis for meat production whereas amount and site of fat in the carcass influences its quality (Karim et al., 2007; Sen et al., 2004). The information on influence of probiotics on carcass yield and quality and distribution of carcass tissues are limited. Further, very little is known on carcass and meat quality of lambs raised in semi-arid region. Therefore, the present study was aimed to assess the effect of different yeast culture supplementation as growth promoting additive on rumen fermentation, hydrolytic enzymes status, and carcass characteristic of lamb in post weaning phase of growth.

2. Materials and methods

2.1. Yeast cultures production

Pure cultures of edible dairy yeast (*Kluyveromyces marxianus* NRRL3234 "KM," *Saccharomyces cerevisiae* NCDC42 "SC" and *Saccharomyces uvarum* ATCC9080 "SU") were obtained from the National Dairy Cultures Collection Centre of National Diary Research Institute, Karnal India. The fridge-dried cultures were activated aseptically with 4–5 drops of sterilized broth medium and transferred to 20 ml broth, incubated at 28 °C for 48 h. These were sub-cultured every fortnight for the production of bulk cultures. The broth medium contained glucose 20 g, peptone 20 g and yeast extract 10 g in each liter of distilled water. The pH of liquid medium was maintained 6.5 ± 0.2 at 28 °C. The medium sterilized by autoclaving at 15 psi and 121 °C for 15 min, cooled at room temperature, 10 ml liquid culture was added aseptically to each liter of medium, incubated at 28 °C for 36 h, with shaking for 60 cycles/min. Three strains were cultivated separately and stored at 4 °C.

2.2. Feeding and management of experimental lambs

Animal trial was carried out on sixty randomly selected lambs (90 ± 3.5 days old and 15.9 ± 0.50 kg BW), in five equal groups, penned and fed individually *ad libitum* a composite feed mixture (CFM) having roughage to concentrate (R:C) ratio of 25:75 for 91 days. The CFM contained dry matter 977, organic matter 902, crude protein 166, neutral detergent fiber 604, and cellulose 126 g/kg (Table 1), and other essential nutrients required for growing lambs (ICAR, 1998). One group was supplemented sterilized culture medium (Control) while other groups were dosed with one of the three or a mixed yeast culture orally each day just after offering the fresh feed of the day. The mixed live yeast culture (MLC) had KM, SC and SU cultures in ratio of 1:1:1. The cultures were drenched at 1 ml/kg live weight, which had $1.5–2.0 \times 10^9$ live cells/ml. Animals received CFM once daily in an excess of 10% of previous days intake. Feed samples were collected weekly for DM determination and three or four-week samples were pooled for chemical analysis. Animals were weight for 2 consecutive days every 7 days immediately before offering

Table 1
Composition of diet fed to weaner lambs.

Ingredient composition	*g/kg*
Roughages source	
Khejri (*Prosopis cenraria*) leaves	125
Pala (*Zuzuphus numularia*) leaves	125
Concentrate source	
Maize grain	280
Barley grain	280
Groundnut oil meal	80
Mustard oil meal	80
Supplements	
Mineral premix [a]	18
Common salt	10
Vitamin premix (vitablend) [b]	2

Chemical composition (g/kg dry matter)

	Composite feed mixture	Khejri	Pala
Dry matter	977.0	962.8	958.2
Organic matter	902.3	840.5	842.1
Crude protein	166.2	105.0	96.2
Neutral detergent fiber	603.7	481.8	624.9
Acid detergent fiber	324.9	261.7	527.3
cellulose	126.1	141.1	164.3
Lignin	62.0	75.1	116.4
Hemicellulose	278.8	220.1	97.6

[a] Mineral mixture contained (g kg^{-1}) calcium 320, phosphorus 62, manganese 2.7, zinc 2.6, iron 1, fluorine 0.9, iodine 0.1, and copper 0.1.
[b] Vitamin premix contained (IU per g) vitamin A 50000 and vitamin D_3 5000.