

Effect of Inclusion Rate of Effective Microbes (EM) on Growth Rate of Lambs Fed Low Protein Diet

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Abstract

Background: A great majority of animal feed is roughage based (poor in quality) in crop-livestock mixed farming system of southern Ethiopia. EM is considered as one of the options that may improve poor quality feeds dominant in the area. A study was conducted to determine inclusion rate of effective microbes (EM mixed with wheat bran, EM-bokashi) on growth rate of lambs fed low protein diets at Dubo Mante research sub-station. **Method:** Twenty four (24) post pubertal male sheep of similar age (about 12 months age) with an average weight of 14.1 ± 1.74 kg were purchased from local market. The lambs were assigned randomly to one of the four treatments (T1=0% EM, T2=1% EM, T3=3% EM, T4=5% EM). Water and rhodes (*Chlorias gayana*) hay were offered *ad libitum*. **Results:** EM-bokashi supplemented at 5% resulted in significantly ($P < 0.05$) higher intake and growth rate in terms of weight gain than those supplemented with 3% EM-bokashi. Likewise, lambs supplemented with 3% EM-bokashi showed significantly ($P < 0.05$) higher growth rate than those supplemented with 1% while the difference between 1% and the control (0%) is not significant. Similarly, lesser disease occurrence was observed in lambs supplemented with EM-bokashi than untreated animals. Supplementing 5% EM-bokashi added 51.2% and 43.6% additional economic incentives over the control and 1% EM level, respectively. Generally, both weight gain and profitability increased as level of EM supplementation advanced. **Conclusion:** Additional weight in terms of daily weight gain and profitability considered in this experiment are crucial in the livelihood of small-scale farmers. Hence, 5% EM-bokashi could be recommended as biologically and economically profitable inclusion level for lambs fed on low protein diet under smallholder farmer's management conditions.

Keywords: - Lambs, growth, roughage, strategic supplementation, effective micro-organisms

Introduction

Small ruminants are integral components of crop-livestock mixed and serve as investment and insurance due to high fertility, short generation interval and their ability to produce in limited feed resource and their adaptation in harsh environment (Tsedeke, 2007; Deribe et al., 2014). Smallholder farmers raise sheep and goats as a major source of meat and immediate cash income in different parts of the country. Despite large number and importance of sheep in the areas, productivity is low due to a number of factors among others feed shortage both in quality and quantity, and health constraints (Tibbo, 2006; Legesse, 2008; Kocho et al., 2011). The limitation in production due to shortage of feeds and poor nutrition is usually profound in areas where high seasonal dynamics in feed sources, fragile ecologies and environments exposed degradation. Moreover, a great majority of feeds in crop-livestock mixed farming systems is roughage feeds with low feed values. Improving feeds and nutrition through technologies that improves rumen fermentation of roughage feeds, improves protein supply to micro organisms and reduce methane emission is important to boost the overall productivity, health, and well-being of sheep flocks (Woju, 2012). In this regard, use of effective microbes (EM-bokashi) for better management of crop residues is thus imperative (Safalaoh and Smith, 2001).

EM is a mixture of groups of organisms that has a reviving effect on the natural environment (Daly and Stewart, 1999) and consists of around 80 species of selected beneficial microorganisms including lactic acid bacteria, yeasts, photosynthetic bacteria, and actinomycetes, among other types of microorganisms such as fungi (Xu, 2000). The technology of Effective Microorganisms commonly termed (EM Technology) was developed in the 1980's at the University of the Ryukyus, Okinawa, Japan. The inception of the technology was based on blending a multitude of microbes, and was subsequently refined to include three principal types of organisms commonly found in all ecosystems, namely Lactic Acid bacteria, Yeast Actinomyces and Photosynthetic bacteria (Higa, 1996).

The use of EM in animal husbandry is clearly identified in many parts of the world. A study in Asia where EM was first introduced and is used extensively reported the successful use of EM in poultry and swine units (Konoplya and Higa, 2000) and is added to feed and sprayed for sanitation in these units. Research in South Africa also highlight the potential of using EM for treating pig manure (Hanekon et al., 2001) which promotes growth of the animals. According to Yohgzhen and Weijiong (1994) and Anon (2002) EM has shown to reduce odour of livestock waste and accelerates conversion into manure compost (Yohgzhen and Weijiong, 1994). EM as additive improves physiological activity in animals and better feed conversion

efficiencies (Konoplya and Higa, 2000; Safalaoh & Smith, 2001).

EM prepared mixing with wheat bran (EM-bokashi), creates probiotics, which increases quantity, availability, digestibility and assimilation of nutrients in animal body. EM equilibrates the micro-flora within the intestines of the animals and consequently improves feed conversion and weight gain due to increased nutrient assimilation. EM reduces production of methane suppresses disease-inducing organisms (Higa, 1996). In Ethiopia, the assumption that non-conventional supplements such as EM could help reduce high price of concentrates that had been used rumen manipulation and efficient use of fibrous feed materials as., Therefore, this study was designed to inclusion level of EM to be included as an additive in low quality feeds to boost small ruminant production in crop-livestock mixed farming systems of southern Ethiopia.

Materials and methods

Study area descriptions

The study was conducted at Areka Agricultural research Centre, Mante Dubo experimental sub-station, located at about 305 kms from Addis Ababa and 200 kms from the regional city, Hawassa, through Wolaita soddo road. The station is located at an altitude of 1711 meters above sea level (masl) and situated at N 07° 06.4312' and E037° 41.688'. The station has 39 hectares of land, of which about 27 ha is used for grazing. The rainfall of the area is 100-1200 mm with bimodal type of rainfall, the heavy rainy season from July to September while light rainy between March to May. Production of forage such as 'desho' (*Pennisetum pedicellatum*), Napier grass (*P. pedicellatum*), rhodes grass (*Chloris gayana*) and others is commonly produced and distributed for Dorper sheep breeding, evaluation and distribution (BED) site to improve mutton yield of local sheep breeds. There are huge crop leftovers and grass hays produced for livestock feeding during dry season but are poor in quality.

Experimental animal and housing arrangement

Individual pen prepared and partitioned using wooden poles and timber materials. Twenty four (24) post pubertal male lambs of similar age (less than one year) with an average weight of 14.1±1.74 kg were purchased from the local market, Doyogena woreda of southern region. The lambs were kept in quarantine for fifteen days for acclimatization and to monitor their health condition and ensure that they are protected from diseases. Six (6) lambs were assigned for each treatment and grouped (blocked) by their weight and put under each feed treatment. All lambs were dewormed with recommended dose of Albendazole before the trial started.

EM of different treatment level was added as a supplementary feed with a recommended feed intake percentage for small ruminants. Fifteen weeks weight gain data were collected. Feed troughs were made empty 1-2 hours before the next feeding. The basal feed, Rhodes hay (with 85 % DM, 7.13% CP, 70.24% NDF and 60.61% *in vitro* digestibility) offered *ad libitum* and lambs were watered twice a day. Three hundred gram of wheat bran (as feed basis mixed EM, EM-bokashi) was offered as a supplement for all experimental animals under each treatment. The treatments were, T1=control (without EM-bokashi), T2= 1% EM-bokashi, T3=3% EM-bokashi and T4=5% EM-bokashi. The supplementation was expected total feed intake (600 gram) as feed basis in the total mixed ration.

Data collection and analysis

Weight (initial weight, weekly weight and final weights), health condition and other disease records were collected. Frequency of disease occurrence was analyzed with descriptive statistics. The data were analyzed using General linear Model of Statistical Analysis System (SAS, 2008). Means were separated using Tukey's test at $P < 0.05$.

Results and discussion

There was great variation in weight gain between sheep fed different level of EM-bokashi supplementation. EM-bokashi of 1% supplementation was not significantly ($P > 0.05$) different from the control (without EM-bokashi supplementation). Lambs fed on 5% EM-bokashi supplementation showed the highest body weight gain as compared to other supplementation levels. The highest level of supplementation (5%) was in line with other literatures done on small stock and poultry. Increasing EM-bokashi supplementation level beyond 5% has not been suggested. The body weight increase with the increasing level of EM-bokashi supplementation in this experiment agrees with other experiments conducted in Debrezeit Agricultural research centre with more level of supplementation in water solution (Woju, 2012) and in Nepal (Dahal, 1997; Daly et al., 1999). This could be due to improved CP content of the mixture in the 5 % EM-bokashi in comparison with other level of supplementation (Chernet, 2012; Woju, 2012).

Approximate position for Table 1

Six types of disease were diagnosed during the experimental period but no death occurred. Systemic infection was diagnosed on all experimental animals under each treatment group with more frequency under control group

(3 times) followed by 1 % EM-bokashi (2 times). But it was the same in the other two levels of treatments (3% and 5% EM-bokashi supplementation) (1 time). Pneumonia was diagnosed with equal frequency in the control, 1% and 5% but not in the 3% EM-bokashi supplementation. Orf occurred with similar frequency and duration in all treatment groups on almost all experimental lambs. The lower frequency of occurrence of systemic infection under the two higher level of supplementation may indicate the effect of EM-bokashi on improving health condition of animals (Bruchem, 1998). The result is also in line with the findings of Woju (2012) who reported reduced disease and methane emission from EM supplemented animals. **Approximate position for Table 2**

Growth rate

The average initial weight of the lambs used in this experiment was not significant among the treatments (Table 3). At the beginning of the experiment due to adaptation or the depressing role of EM-bokashi, the control was significantly higher compared to treatment effects up until 105 days of age while the final weight of the lambs supplemented with the highest level (5%) of EM-bokashi was significantly higher compared with T3. Likewise, sheep treated with T3 had higher final growth rate compared with T2 while the differences between T2 and the control was not significant in the majority of the cases. The results agree with other reports (Safalaoh & Smith, 2001; Woju, 2012). The fact that rumen fermentation improved due to EM supplementation, productivity per unit feed improves under EM supplementation (Woju, 2012).

Approximate position for Table 3

For the first 90 days, lambs fed on diets without of EM-bokashi supplementation were better than those supplemented with EM-bokashi (Figure 1). However, when lambs adapted to experimental diets the differences between supplemented and not supplemented become more profound. The results agree with reports of Safalaoh and Smith (2001) and Woju (2012). **Approximate position for Figure 1**

Partial budget analysis

Profitability was calculated using Cost Benefit Ratio (CBR). In this economic analysis labour cost incurred for feeding experimental animals during the trial period was not considered as it exaggerates the expense. EM (liquid) used in this experiment was purchased from Woljeejii Agricultural Industry P.L.C and labour cost for bokashi preparation was included in bokashi purchase cost. As it is shown in the table below, 5 % EM-bokashi supplementation is profitable under this experiment. The emerging industrial options globally and in areas where this study conducted is an opportunity to efficiently utilize the technology options (Woju, 2012). **Approximate position for Table 4**

Conclusion

Small ruminants, particularly sheep, are dependent on hay and crop residues in crop-livestock mixed farming systems. Animals lose weight during the dry season as most of the feeds in this period are poor in quality. Technological options that improve feed intake and rumen digestibility of these bulk feeds is essential to boost productivity. In this experiment, both weight gain and growth rate increased as level of EM-bokashi supplementation increased. Inclusion of EM-bokashi at 5% has also been supported with economic profit. Moreover, the frequency of disease occurrence reduced with increased level of EM-bokashi supplementation. Hence, EM-bokashi supplementation at 5% level is biologically and economically profitable for lambs fed on low protein diet under smallholder farmer's management conditions.

'Declarations'

All the authors approved the manuscript for publication consideration. The manuscript is neither published nor submitted for publication consideration. With the following details declarations:

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Competing interests

Not applicable

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Authors' contributions

Dr G initiated the idea, wrote concept note and designed the experiment; Mr M and Dr G run the experiment and generated data; Mr W takeover the data and analyzed with consultation with Dr G. Dr T & Y followed up the veterinary aspects of the experiment.

Authors' information

Dr Gemiyo is a PhD in Animal Nutrition; Mr Mengistu is again Animal nutritionist by profession; Mr Wolde and Dr Getachew are researchers in this team while Dr Tessema and Dr Yilma are veterinarians.

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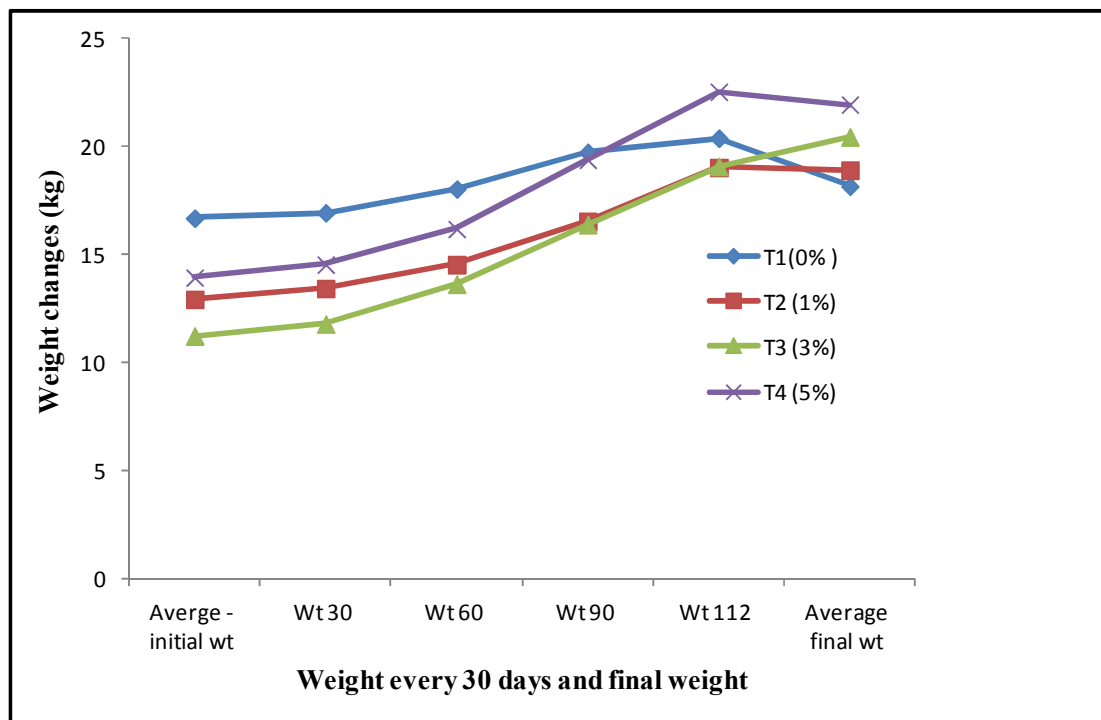


Fig 1 Trends of weight changes over experimental period of lambs supplemented with effective microbes (EM-bokashi) and fed on low protein diets

Table 1 Mean daily weight gain (g/day) of lambs supplemented with EM-bokashi fed on low protein diet

Treatment	N	Mean	Std. Error	95 % CI
1 (Control, with EM-bokashi)	6	0.27 ^c	0.031	0.19 - 0.35
2 (1% EM-bokashi)	6	0.32 ^c	0.031	0.24 - 0.4
3 (3% EM-bokashi)	6	0.43 ^b	0.031	0.35 - 0.51
4 (5% EM-Bokashi)	6	0.53 ^a	0.031	0.45 - 0.61

Means with the different letters (^{a,b,c}) are not significantly different at 5% level of significance

Table 2 Frequency of disease occurrence on lambs supplemented with EM-bokashi fed on low protein diet

Description	Level of EM-bokashi supplementation			
	T1	T2	T3	T4
Frequency of systemic infection	3.00	2.00	1.00	1.00
Frequency of pneumonia	1.00	1.00	0.00	1.00
Frequency of heart water	1.00	0.00	0.00	1.00
Frequency of skin lesion	0.00	0.00	1.00	0.00
Frequency of pink eye disease	0.00	1.00	1.00	1.00
Frequency of orf	1.00	1.00	1.00	1.00

Table 3 Growth rate of lambs fed low protein diet and supplemented with EM-bokashi

Treatment	Average initial wt	Wt 15	Wt 30	Wt 45	Wt 60	Wt 75	Wt 90	Wt 105	Average final wt	Wt gain
T1	14.1 ^a	16.8 ^a	16.9 ^a	17.8 ^a	18.1 ^a	19.2 ^a	19.7 ^a	20.1 ^a	18.2 ^c	4.1 ^c
T2	14.3 ^a	13.1 ^b	13.5 ^b	13.9 ^b	14.6 ^b	15.4 ^c	16.5 ^b	18.4 ^b	18.9 ^c	4.7 ^c
T3	14.0 ^a	11.2 ^c	11.8 ^c	12.6 ^c	13.6 ^c	14.9 ^c	16.4 ^b	18.2 ^b	20.5 ^b	6.4 ^b
T4	14.0 ^a	14.2 ^b	14.55 ^b	14.9 ^b	16.2 ^b	17.6 ^b	19.4 ^a	21.4 ^a	22.0 ^a	7.9 ^a

Means with the different letters (^{a,b,c}) are not significantly different at 5% level of significance ;Wt, weight

Table 4 Estimation of partial budget for lambs supplemented with EM-bokashi fed on low protein diet

Description	Treatment			
	T1	T2	T3	T4
Initial weight	14.08	14.26	14.03	14.03
Final weight	18.18	18.92	20.46	21.96
Cost of EM-bokashi/head	0	10.72	32.32	53.76
Animal purchase cost/head	436.33	442.01	434.78	434.78
Total cost (A)	436.33	452.73	467.1	488.54
Animal selling price/head (B)	563.43	586.52	634.21	680.71
Income (B-A)	127.1	133.79	167.11	192.17