Gemiyo D, et al., J Anim Res Vet Sci 2017, 1: 004
DOI: 10.24966/ARVS-3751/100004

HSOA Journal of
Animal Research and Veterinary Science

Research Article

Effect of Supplementing Effective Microbes (EM) on Growth Rate of Lambs

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Abstract

Roughage constitute a major feed source for animals under crop -livestock mixed farming system of southern Ethiopia, however, this feed is characterised by poor quality hence it is poorly digested. Effective Microbe (EM) is considered as one of the options that may improve poor quality feeds. 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. 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 libtum*. 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. Based on weight in terms of daily gain and economic profitability 5% EM-Bokashi supplementation could be recommended as biologically and economically profitable for lambs fed on low quality diets.

Keywords: Growth lambs; Roughage; Strategic supplementation

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Citation: Gemiyo D, Mengistu S, Tessema F, Yilma M, Wolde S, et al., (2017) Effect of Supplementing Effective Microbes (EM) on Growth Rate of Lambs. J Anim Res Vet Sci 1: 004.

Received: September 22, 2017; **Accepted:** November 28, 2017; **Published:** December 12, 2017

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 [1,2]. 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 [3-6]. The limitation in production due to shortage of feeds and poor nutrition is usually profound in mid and highland areas of Ethiopia where high seasonal dynamics in feed sources, fragile ecologies and environments exposed degradation. Moreover, Roughage constitute a major feed source for animals in crop-livestock mixed farming systems is roughage feeds which is characterised by poor quality. 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 [7]. In improving better use of roughage feeds, use of effective microbes (EM-Bokashi) for better management of crop residues is thus imperative [8].

EM is a mixture of groups of organisms that has a reviving effect on the natural environment [9] and consists of around 80 species of selected beneficial micro organisms including lactic acid bacteria, yeasts, photosynthetic bacteria, and actinomycetes, among other types of microorganisms such as fungi [10]. 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 [11].

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 [12] 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 [13], which promotes growth of the animals. According to [14] EM has shown to reduce odour of livestock waste and accelerates conversion into manure compost. EM as additive improves physiological activity in animals and enhance feed conversion efficiencies [8,12].

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 [11]; however, this was not tested in Ethiopia. The hypothesis was that non-conventional supplements such as EM could not help to reduce high price of concentrates that had been used in rumen manipulation and efficient use of fibrous feed materials. Therefore, this study was designed to determine supplementation level of EM in improving poor quality feeds n 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. The station is located at an altitude of 1711 meters above sea level (masl) and situated at ''N 07' 06.4312` and E 037' 41.688'' longitude and latitude, respectively. 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 pendicellatum*), Napier grass (*P. pedicellatum*), rhodes grass (*Chlorias 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 was prepared and partitioned using wooden poles and timber materials. Twenty four (24) post pubertal male lambs of similar age (six to seven months) 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. The lambs were monitored daily (in the morning and late in the afternoon) to 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 and acclimatized for about 14 days. All lambs were dewormed with recommended dose of Albendazole before the trial started. Animals were monitored for any signs of sickness, temperature level changes and the like daily in the morning and late afternoon during the experimental period.

EM of different treatment level could be added as a supplementary feed with a recommended feed intake percentage for small ruminants [7]. 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 with expectation of total feed intake (600 g) as feed basis in the total mixed ration.

Partial budget analysis

Total value of production, revenue, is the sum of sale of sheep. 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. An interest rate of 4% in the Ethiopian banks during the study period, representing the market rate of the capital, was used to reflect the opportunity cost of capital pertaining to investment in sheep. Capital value of sheep= (number of sheep meant for growth study x average of purchase and sale price of a sheep). The formula for partial budgeting is:

Net profit= (Revenue) - (EM per liter and processing cost + value of family labor + interest on capital)

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 using descriptive statistics. The growth data were analyzed using General linear Model of Statistical Analysis System (SAS, 2008). Means were separated using Tukey's test at $P < 0.05$.

The statistical model was:

$Y_{ijk}=\mu + A_i + B_{ij} + e_{ik}$ where;
Y_{ijk}=Values of the response variables (weight gain, growth rate); μ is the overall mean;
A_i is the effect of inclusion level of effective microbe (0, 1%, 3%, 5%)
B_{ij} is the effect of block and
e_{ik}=random errors.

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 Center with more level of supplementation in water solution [7] and in Nepal [9,15]. This could be due to improved microbial activity the mixture in the 5% EM-Bokashi in comparison with other levels of EM supplementation [7,16]. Whenever affordable, one might also consider higher EM (higher than 5%) supplementation level. However, further studies might be designed to determine biological and economic threshold (Table 1).

S. No.	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

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

Means with the different letters (^{a,b,c}) are significantly different at 5% level of significance

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 [17]. The result is also in line with the findings of [7] who reported reduced disease and methane emission from EM supplemented animals.

Growth performance

At the beginning of the experiment due to poor adaptation or the depressing role of EM-bokashi, the control was significantly higher compared to treatment effects (Table 2). After 105 days of age 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 to each other. This result agrees with other reports [7-8]. The fact that rumen fermentation was improved due to EM supplementation, the weight gain improved with increasing level of EM supplementation [7].

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 and Woju [7-8].

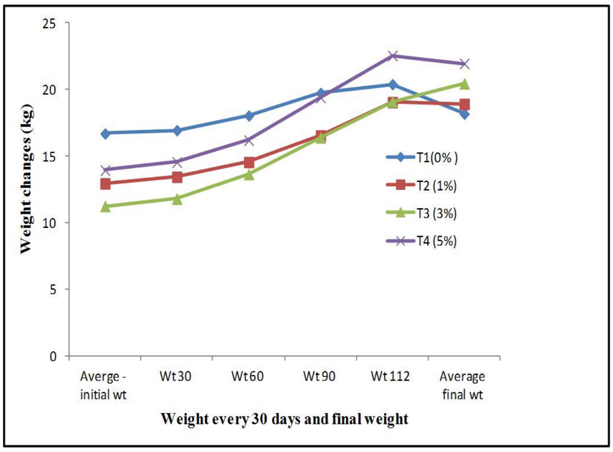

Figure 1: Trends of weight changes over experimental period of lambs supplemented with effective microbes (EM-Bokashi) and fed on low protein diets.

Partial budget analysis

Profitability was calculated using costs and benefit out of EM supplementation. 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 Woljeji Agricultural Industry P.L.C and labour cost for bokashi preparation was included in bokashi purchase cost. As it is shown in the table 3, 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 technological options [7].

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 quality diets.

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:

Ethics Approval and Consent to Participate

All animal ethics procedures were followed in handling and feeding experimental animals. As the experiment did not consider rumen fermentation (rumen collection) and carcass analysis, ethics approval was not supported with a certificate.

Competing Interests

Not applicable

Funding

Funding obtained from Southern Agricultural Research Institute is dully acknowledged.

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.

Treatment	Average initial wt	Wt 15	Wt 30	Wt 45	Wt 60	Wt 75	Wt 90	Wt 105	Average final wt (kg/head)	Wt gain (kg/head)
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}	19.4a	21.4^{a}	22.0^{a}	7.9^{a}

Table 2: Mean growth performance (kg/head) of lambs fed low protein diet and supplemented with EM-Bokashi from 15 to 105 days.

Means with the different letters (^{a,b,c}) are significantly different at 5% level of significance ;Wt, weight

Description	Treatment			
	T1	T2	T3	T4
Initial weight	14.1	14.3	14	14
Final weight	18.2	18.9	20.5	22
Cost of EM-bokashi/head	0	10.72	32.32	53.76
Animal purchase cost/head	436.3	442.01	434.8	434.78
Total cost (A)	436.3	452.73	467.1	488.54
Animal selling price/head (B)	563.4	586.52	634.2	680.71
Income (B-A)	127.1	133.79	167.1	192.17

Table 3: Estimation of Partial Budget (ETB) for lambs supplemented with EM-Bokashi fed on low protein diet.

ETB, Ethiopian Birr, 1$ Dollar=22.3 ETB

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

Acknowledgement

SARI, Southern Agricultural Research Institute, funded this study and is dully acknowledged. Areka Research centre provided facilities and financial support to undertake the experiment.

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