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Full Length Research Paper

The effect of effective microorganisms on production and quality performance of Rhode Island Red layers

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Rhode Island Red (RIR) breed of chickens are reported to be capable of acclimatization to the Ethiopian rural production environment. However, there have been serious complaints that the reproduction performance of RIR breeds of chicken is low. This study was conducted to evaluate the effect of Effective Micro-organisms (EM) on reproduction performance of Rhode Island Red (RIR) layers. A total of 96 RIR pullets of 16 weeks old were divided into 8 groups, each with 12 pullets. These were randomly assigned to 4 treatments containing 0, 4, 8 and 12 ml of EM/liter of drinking water in completely randomized design with 2 replications for a study period of 22 weeks. Feed consumption, feed conversion efficiency, egg production, egg quality, fertility, and hatchability were used as evaluation parameters. The results obtained showed that there was no significant difference among all the treatment groups in feed consumption, sexual maturity, survival rate and feed conversion efficiency (P>0.05) to an age of pullets, whereas the mean body weight gain of the groups of 24 weeks placed on the treatment containing 8 to 12 ml of EM/liter of drinking water were significantly (P<0.05) higher than the control groups. The results obtained also showed that there was no significant (P>0.05) difference between all the treatment groups of layers in feed consumption, fertility and hatchability (P<0.05) to an age of 37 weeks. On the other side, the mean weekly egg production and feed conversion efficiency during the laying period were significantly higher (P<0.05) for the groups of layers placed on the treatment containing 4 to 12 ml of EM/liter of drinking water compared to that of the groups placed on the control treatments. In summary, the results of this study showed that inclusion of 4 to 12 ml of EM/liter of drinking water resulted in significant improvement in survival and growth rate, egg production, feed conversion efficiency and egg quality parameters. Extending EM technology to indigenous chickens could be the future direction of research.

Key words: Egg production and egg quality, effective micro-organisms, feed conversion, Rhode Island Red (RIR) chickens.

INTRODUCTION

The introduction of exotic chickens into Ethiopia dates back to the early 1950's, when Rhode Island Red (RIR) breed of chickens were imported along with other exotic genetic materials. It was the Ministry of Agriculture (MoA) that was given the mandate for national poultry extension work from the very beginning, and MoA established several poultry breeding and multiplication centers in different parts of the country. The centers were involved in the distribution of fertile eggs, day old chicks, pullets/cockerels, culled layers and provision of management information of Rhode Island Red (RIR) breeds of chickens to the rural farming population. The RIR breed of chickens distributed were reported to be capable of well acclimatization to the Ethiopian rural production environment with reasonable production level under smallholder management systems. However, there

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Table 1. Treatment allocation to the experimental birds.

Treatments	Rep/Treat.	Chicks/Rep	Total
0 ml of EM/liter of drinking water, control (T1)	2	12	24
4 ml of EM/liter of drinking water (T2)	2	12	24
8 ml of EM/liter of drinking water (T3)	2	12	24
12 ml of EM/liter of drinking water (T4)	2	12	24
Total	8	48	96

have been serious complaints by the farming community and the multiplication centers, suggesting that the production performance of RIR breeds of chickens is low as measured by age at sexual maturity, rate of egg production, fertility and hatchability. The information obtained from Amhara Regional State, Rural Development Bureau of Agriculture indicates that the farming community is facing problems as a result of poor fertility and hatchability of the RIR breed of chicken distributed. It was also reported that there is improvement in the production and reproduction performance of poultry with the addition of Effective Micro-organism (EM) (Safalaoh and Smith, 2001).

Effective Micro-organisms are live microbial feed supplements with beneficial effect to the host animal by improving its intestinal microbial balance (Fuller, 1989). A diverse micro-biota was found throughout the digestive tract of animals with relatively higher concentration in the cecum (Mead, 1997). This micro flora has a role in nutrition particularly in the area of detoxification of certain compounds, stimulation of animal growth, and improvement of the health status and well-being of the host animals through protection against pathogenic bacteria (Van der Wielen et al., 2002). The improvement in production performance of poultry fed on the ration containing EM was reported to be attributed to the improvement in feed bioavailability, balance of gastrointestinal micro-organisms, and enhancement of the immunity status of the birds. EM was reported to be successfully used for increasing productivity in integrated animal units and poultry farms in South Africa (Hanekon et al., 2001; Safalaoh and Smith, 2001). Effective Micro-organism has also been used to improve growth and egg production performance of poultry (Stavric and Kornegay, 1995).

Inclusion of EM dominated by Lactobacillus acidophilus in laying hens diets was reported to have improved some quantitative and qualitative parameters of eggs. There has been an increase in the number of laid eggs, decrease in feed intake, improvement in feed conversion ratio, egg specific gravity and an increase in the Haugh Units (Daniele et al., 2008). Panda et al. (2003, 2008) reported significant increase in the egg production performance of White leghorn layers with dietary supplementation of a probiotic (*L. sporogenes*) at the rate of 100 $mgkg^{-1}$ diet (6×10^8 spores). All these probiotics and experimental EM effects showed that the use of standardized EM would have improvement effect on layers. Therefore, the objective of this study was to solve the problem of reproduction performance of RIR layers.

METHODOLOGY

Description of experimental site

This experiment was conducted at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM), located at 357 km southwest of Addis Ababa at an altitude of 1710 m above sea level. The mean maximum and minimum temperature of the study area was 26.8 and 11.4°C, respectively and the mean maximum and minimum relative humidity was 91.4 and 39.92% respectively. The mean annual rainfall of the area is 1500 mm (BPEDORS, 2000).

Experimental treatments

Adequate quantities of activated EM·1® packed in plastic jar was obtained from Weljijie PLC located in Debre Zeit which intern located at 70 km east of Addis Ababa. Weljijie PLC obtains the original EM·1® culture from EMRO Malaysia Sdn. Bhd. Activated EM·1® was made at the ratio of 5% molasses, 5% original EM•1® of the total volume which was mixed with chlorine free clean water. The major groups of micro-organisms in EM•1® are lactic acid bacteria, yeast and phototrophic bacteria. Activated EM·1® was transported to JUCAVM poultry farm and stored properly until required for the formulation of the experimental treatments. Four experimental treatments shown in Table 1 were prepared by inclusion of 0, 4, 8 and 12 ml of EM solution/liter of chlorine free drinking water. The treatments were prepared on daily basis.

Management of the experimental birds

A total of 100 RIR pullets at an age of 12 weeks were purchased from Southern Nation Nationality and peoples State poultry breeding and multiplication centre located in Bonga and transported to JUCAVM poultry farm. These were housed in well prepared grower's house and placed on grower's commercial ration. At 16 weeks of age, 96 pullets were divided into 8 groups, each with 12 pullets. Two cockerels of the same age and breed were assigned to each group and each group was housed in separate pens of equal dimension that were properly cleaned, disinfected, and provided with all the necessary layers house equipments in advance. Finally, the 4 treatments were randomly assigned to the experimental pullets with two replications (smaller replication was due to shortage of experimental house during the study period) for the study period

Table 2. Weekly mean feed consumption (g/head) of pullets placed on different levels of EM.

Age	T_1	T_2	T_3	T_4	s. e.	p-value
Week 16	512.05	528.85	515.20	466.90	21.32	>0.05
Week 17	559.65	547.05	530.25	530.60	7.80	>0.05
Week 18	571.55	551.95	545.30	550.90	10.84	>0.05
Week 19	579.95	561.75	555.45	562.80	7.73	>0.05
Week 20	593.60	577.50	565.95	589.40	10.52	>0.05
Week 21	609.00	593.60	574.00	607.25	15.46	>0.05
Week 22	632.45	603.40	583.45	614.95	21.07	>0.05
Week 23	653.45	631.05	577.50	642.95	12.33	>0.05
Week 24	679.7	647.15	604.10	651.70	11.01	>0.05
Average	599.04	582.48	561.24	579.72	9.92	>0.05

s. e = standard-error; Means in a row without superscripts are statistically not significant (p>0.05); T_1 = control; T_2 = 4 ml of EM/liter of water; T_3 = 8 ml of EM/liter of water; T_4 = 12 ml of EM/liter of water.

of 22 weeks (Table 1). At 5 months of age, all the treatment groups were switched to commercial layers ration; the feed composition is a secret of the factory, quality feed manufacturing factory. All the treatment groups were fed to appetite and chlorine free water containing different levels of EM (treatments) was made available at all times.

Egg quality determination

Twelve eggs laid during the last three consecutive days of the 7 weeks laying period were randomly selected from each treatment. The eggs were individually weighed, carefully opened (broken) onto a flat plate and the yolk and albumen were separately weighed. Yolk height was measured using tripod micrometer (0.01 mm gauge) and yolk index was calculated according to the method described by Akhtrs (2007). Egg shell thickness was measured using calibrated micrometer screw gauge. Yolk color was measured using roach color fan. Haugh unit was calculated using the formula adopted from the study of Haugh (1937).

Fertility and hatchability determination

Fifty fresh eggs (stored for 10 days) were taken from each treatment, selected against undesirable shape, size and shell structure and incubated. The eggs, incubator and all the fixtures were fumigated with formalin plus potassium permanganate (Altman et al., 1997). The incubation temperature, humidity and turning device were adjusted in advance according to the recommendations of the manufacturer. Candling was done on the 7^{th} and 14^{th} day of incubation aimed at calculating fertility and hatchability.

Statistical analysis

Since repeated data were collected on the same animal daily/weekly it was appropriate to use Repeated Measures Design (RMD). Data on body weight gain, feed consumption, feed conversion ratio, sexual maturity, and rate of egg production, egg quality, fertility and hatchability were collected throughout the study period. The data collected were subjected to Repeated Measures Design (RMD) of SAS 9.00 version for analysis (SAS Institute, 2002). Least square mean were used for comparison.

RESULTS AND DISCUSSION

Feed consumption during growing

There was no significant (p>0.05) difference between all the treatment groups in mean weekly feed consumption to an age of 24 weeks, though the groups receiving 0 ml of EM/liter of drinking water tended to consume more than the others (Table 2). The other treatment groups showed proportional reduction in feed consumption as a result of increase in the volume of EM administered /liter of drinking water.

Similarly there was no significant difference between (P>0.05) all the treatment groups in weekly body weight gain during the first 5 weeks of the feeding trial. Weekly body weight gain brought by the treatment groups assigned to the control treatment was significantly (P<0.05) lower than the groups placed on the treatment containing 8 to 12 ml of EM/liter of drinking water during the last 4 weeks of feeding. There was no significant difference between the treatment groups assigned to 4 to 12 ml of EM/liter of drinking water in weekly body weight gain and feed conversion efficiency at any time of the feeding trial (Tables 3 and 4).

Significant (P<0.05) difference in mean daily body weight gain between the treatment groups of pullets was recorded after 5 weeks of the feeding trial whereas: there was no significant difference in feed consumption between all the treatment groups at any time The results of this study are in agreement with that of Kalavathy et al. (2003) who reported improved body weight gain of broiler with supplementary administration of Lactobacillus. Mean weekly feed consumption of T1, T2, T3 and T4 833.89, 793.85, 766.07 and 754.36 g head was attained by the groups placed on 0, 4, 8 and 12 ml of EM/liter of drinking water respectively (Table 5). Similar trend was also reported by Balevi et al. (2009) from the trial conducted to study the effect of dietary supplementation of commercial

Table 3. Mean weekly body weight gain (g/head) of pullets placed on different level of EM.

Age	T_1	T_2	T_3	T_4	s. e	p-value
Initial BW	877.45	867.00	846.65	822.45	5.16	>0.05
Week 16	70.02	73.30	69.80	74.80	6.69	>0.05
Week 17	146.34	160.51	160.51	163.54	5.50	>0.05
Week 18	225.33	269.76	282.47	290.18	14.29	>0.05
Week 19	306.19	370.54	413.31	395.53	22.76	>0.05
Week 20	387.56	475.84	525.45	495.83	19.79	>0.05
Week 21	453.22^{b}	556.31^{ab}	615.34^{a}	581.26a^{b}	16.94	<0.05
Week 22	528.39^{b}	629.04^{ab}	699.14^{a}	654.05^{ab}	17.30	<0.05
Week 23	600.45^{b}	705.95^{ab}	776.20^{a}	729.15^{ab}	17.59	<0.005
Week 24	672.62^{b}	780.55^{ab}	847.08^{a}	799.95^{ab}	18.85	<0.05
Average	376.68^{b}	446.87^{ab}	487.70^{a}	464.92^{a}	14.51	<0.05

s. e = standard-error; Means in a row having similar superscripts are statistically not significant (p>0.05); T_1 = control; T_2 = 4 ml of EM/liter of water; T_3 = 8 ml of EM/liter of water; T_4 = 12 ml of EM/liter of water.

Table 4. Feed conversion ratio of pullets placed on different levels of EM.

Age	T_1	T_2	T_3	T_4	s. e	p-value
Week 16	7.31	7.23	7.39	6.24	0.33	>0.05
Week 17	7.36	6.27	5.85	5.98	0.24	>0.05
Week 18	7.27	5.05	4.53	4.36	0.40	>0.05
Week 19	7.20	5.81	4.27	5.35	0.70	>0.05
Week 20	7.38	5.49	5.05	5.95	0.54	>0.05
Week 21	9.32	7.38	6.39	7.14	0.49	>0.05
Week 22	8.45	8.30	6.97	8.57	0.52	>0.05
Week 23	9.08	8.22	7.51	8.67	0.50	>0.05
Week 24	9.44	8.72	8.53	9.23	0.50	>0.05
Average	8.09	6.94	6.28	6.83	0.22	>0.05

s. e = standard-error; T_1 = control; T_2 = 4 ml of EM/liter of water; T_3 = 8 ml of EM/liter of water; T_4 = 12 ml of EM/liter of water.

Table 5. Mean weekly feed consumption of layers placed on different levels of EM (g/head).

Age	T_1	T_2	T_3	T_4	s. e	p-value
Week 25	694.05	649.95	634.55	653.10	22.1911	>0.05
Week 26	707.70	657.30	648.90	657.30	23.1671	>0.05
Week 27	758.80	667.10	690.55	667.80	62.8036	>0.05
Week 28	811.30	709.10	679.35	681.10	42.2117	>0.05
Week 29	832.65	773.15	753.20	714.00	31.9779	>0.05
Week 30	847.35	814.10	776.65	751.45	23.2298	>0.05
Week 31	864.85	834.05	795.90	767.55	21.3528	>0.05
Week 32	868.70	850.50	813.05	788.90	19.4594	>0.05
Week 33	874.65	859.95	816.20	798.00	18.1224	>0.05
Week 34	882.70	869.40	823.90	815.15	17.5796	>0.05
Week 35	893.90	870.80	835.80	827.40	15.8818	>0.05
Week36	897.75	879.90	839.30	837.20	14.3614	>0.05
Week 37	906.15	884.80	851.55	847.70	11.4247	>0.05
Average	833.89	793.85	766.07	754.36	32.97	>0.05

s. e = standard-error; T_1 = control, T_2 = 4 ml of EM/liter of water, T_3 = 8 ml of EM/liter of water; T_4 = 12 ml of EM/liter of water.

Table 6. Mean Weekly egg production of the layers placed on different levels of EM.

Age	T_1	T_2	T_3	T_4	p-value	CV
Sexual maturity (days)	179.5	179.5	185.0	180.5	>0.05	4.05
Week 25	0.30	0.34	0.34	0.24	>0.05	42.84
Week 26	0.75^{ab}	1.09^{a}	0.75^{ab}	0.38^{b}	<0.05	20.17
Week 27	1.54^{ab}	1.96^{a}	1.54^{ab}	0.88^{b}	0.1	22.83
Week 28	2.08^{a}	2.38^{a}	2.08^{a}	1.13^{b}	<0.005	5.82
Week 29	2.42^{b}	3.13^{a}	2.50^{b}	1.59^{c}	<0.05	9.32
Week 30	2.54^{b}	3.46^{a}	2.55^{b}	2.05^{c}	<0.005	5.88
Week 31	2.96^{ab}	3.46^{a}	2.71^{b}	2.21^{b}	<0.05	9.95
Week 32	3.00^{b}	3.55^{a}	2.59^{b}	2.38^{c}	<0.005	4.53
Week 33	3.30^{ab}	3.55^{a}	2.84^{bc}	2.42^{c}	<0.05	6.00
Week 34	3.38^{a}	3.67^{a}	2.96^{b}	2.63^{b}	<0.01	4.48
Week 35	3.42^{ab}	3.71^{a}	3.09^{bc}	2.67^{c}	<0.05	5.53
Week 36	3.46^{ab}	3.88^{a}	3.17^{bc}	2.84^{c}	<0.05	4.84
Week 37	3.63^{b}	4.13^{a}	3.34^{bc}	3.05^{c}	<0.01	4.03
Average	2.52^{b}	2.95^{a}	2.35^{b}	1.88^{c}	<0.001	2.94

CV = Coefficient of Variation; Means in a row having similar superscript are statistically not significant (p>0.05); T_1 = control, T_2 = 4 ml of EM/liter of water, T_3 = 8 ml of EM/liter of water; T_4 = 12 ml of EM/liter of water.

probiotic (ProtexinTM) containing either 0, 250, 500 or 750 ppm on egg production performance. The researchers reported the highest daily feed consumption from the control group.

Egg production

Age at the first egg of all the treatment groups ranged between 179 and 186 days and there was no significant difference (P>0.05) between all the treatment groups in sexual maturity as measured by the age at the first egg. All the treatment groups seem to be slightly late in sexual maturity, probably attributed to higher body weight attained during the growing (pullet) period. The results obtained also showed that the mean weekly egg production performance of all the treatment groups was low by any standard (Table 6). The mean weekly egg production to an age of 37 weeks of the groups placed on the treatment containing 4 ml of EM/liter of drinking water was significantly higher than all the others (P<0.05). These groups attained daily egg production of 59% (0.59 egg/day/head) at an age of 37 weeks, the value of which was significantly higher (P<0.01) than all the others, indicating that the daily egg production performance of the experimental chicken improved by 12% as a result of administration of 4 ml of EM/liter of drinking water as compared to the control groups. On the contrary, the administration of 8 to 12 ml of EM/liter of drinking water tended to depress mean weekly egg production.

Feed conversion ratio

The amount of feed consumed/ kg or dozen of eggs produced was lowest (Table 7) for the groups assigned to the treatment containing 4 ml of EM/liter of drinking water indicating that these groups were produced at cheaper rate than all the others (P<0.05). This is further confirmed by the results of the partial budget analysis of laying performance of the experimental layers (Table 9). At present, EM is already commercialized and readily available and in Jimma, a liter of EM is sold at 20 ETB. Assuming daily water consumption of a laying hen at about 250 ml, a liter of drinking water containing 4 ml of EM could economically (0.08 Birr/hen/day) and safely be offered for 4 laying hen/day and it is worth about 0.08 ETB. Market egg price in Jimma is about 2 ETB and the mean daily increment of 0.28 eggs brought with the administration of 4 ml of EM/liter of water is worth about Birr 0.56/hen/day. This shows that the use of 4 ml of EM /liter of drinking water seems to have significant economic implication when used at relatively large scale poultry production.

Egg quality, fertility and hatchability

The results of the egg quality parameters of the eggs collected from the experimental layers are shown in Table 8. There was no significant (p>0.05) difference between all the treatment groups in all the quality parameters considered except in Hough unit and yolk and albumen height, all the three of which were found to be significantly lower (p<0.05) for the groups placed on the control treatment compared to all the others.

The results of this study showed that there was significant improvement in egg quality (Hough unit, yolk and albumen height) with the administration of 4 to 12

Table 7. Feed conversion ratio (feed consumed/ kg or dozen of eggs produced) of the layers placed on different levels of EM.

Age	T_1	T_2	T_3	T_4	p-value	CV
Week 25	35.29	24.89	A 24.54	38.97	>0.05	44.21
Week 26	11.96^{a}	7.33^{a}	10.55^{a}	21.24^{b}	<0.05	20.71
Week 27	6.51	4.09	5.49	9.80	>0.05	36.95
Week 28	4.99^{a}	4.31^{a}	3.92^{a}	7.37^{b}	<0.05	13.87
Week 29	4.34^{b}	3.48^{a}	3.94^{bc}	6.65^{c}	<0.005	5.74
Week 30	4.13^{ab}	2.95^{a}	3.80^{b}	4.72^{b}	<0.05	8.59
Week 31	2.97^{ab}	3.58^{a}	4.40^{b}	4.42^{b}	>0.05	11.79
Week 32	3.52^{ab}	2.91^{a}	3.99^{b}	4.08^{b}	<0.05	6.92
Week 33	3.22^{ab}	2.92^{a}	3.48^{ab}	4.03^{b}	>0.05	9.08
Week 34	3.14^{ab}	2.85^{a}	3.35^{ab}	3.74^{b}	>0.05	7.39
Week 35	3.14^{ab}	2.82^{a}	3.27^{ab}	3.75^{b}	>0.05	9.47
Week 36	3.12^{ab}	2.73^{a}	3.19^{ab}	3.58^{b}	>0.05	7.65
Week 37	3.00^{ab}	2.58^{a}	3.07^{b}	3.37^{b}	<0.05	5.51
Average	3.97^{b}	3.24^{c}	3.93^{b}	4.83^{a}	<0.005	3.99

CV = Coefficient of Variation; Means in a row having similar superscript are statistically not significant (p>0.05); T_1 = control; T_2 = 4 ml of EM/liter of water; T_3 = 8 ml of EM/liter of water; T_4 = 12 ml of EM/liter of water.

Table 8. Quality, fertility and hatchability of eggs collected from the layers placed on EM.

Parameter	T_1	T_2	T_3	T_4	p-value	CV
Egg length (cm)	5.59	5.60	5.63	5.55	>0.05	0.18
Egg breadth (cm)	4.27	4.25	4.27	4.27	>0.05	1.17
Egg volume	59.27	58.67	59.40	58.71	>0.05	3.03
Egg weight (g)	56.08	56.24	56.56	56.63	>0.05	3.19
Hough unit	52.31^{b}	60.50^{ab}	64.97^{a}	63.51^{a}	<0.05	5.91
Yolk height (mm)	12.62^{b}	14.19^{a}	14.26^{a}	14.16^{a}	<0.05	2.17
Yolk diameter (cm)	3.64	3.71	3.68	3.74	>0.05	2.23
Yolk index	0.348	0.383	0.389	0.379	>0.05	4.15
Yolk color	1	1	1	1	>0.05	0.00
Yolk weight (g)	13.39	13.74	13.89	14.19	>0.05	4.69
Albumen height (mm)	3.34^{b}	4.04^{ab}	4.63^{a}	4.32^{a}	<0.05	8.02
Albumen weight (g)	35.80	34.795	35.51	34.88	>0.05	8.02
Shell thickness (mm)	0.359	0.351	0.335	0.372	>0.05	6.12
Shell weight (g)	5.49	5.49	5.27	5.95	>0.05	5.27
Fertility (%)	92.00	94.00	93.91	93.56	>0.05	3.12
Hatchability (%)	39.13	38.32	41.31	34.27	>0.05	9.60

CV = Coefficient of variation; Means in a row having similar superscript are statistically not significant (p>0.05); T_1 = control, T_2 = 4 ml of EM/liter of water, T_3 = 8 ml of EM/liter of water; T_4 = 12 ml of EM/liter of water.

ml of EM/liter of drinking water. Unfortunately, however, the percentage hatchability reported from this study ranged between 34 and 41% all of which are very low by any standard. There was no significant difference (P>0.05) between all the treatment groups in hatchability. Hatchability and rate of chick survival are one of the major determinant factors of productivity in poultry.

Feed consumption of layers

Significant (P<0.05) difference between the groups of treatment in pullets was recorded after the 1st 5 weeks of the feeding trial. The results of this study are in agreement with that of Kalavathy et al. (2003) who reported improved body weight gain of broiler with supplementary

Table 9. Partial budget analysis on different level of EM (Birr, ETB).

Treatment/ parameters	T1	T2	T3	T4
Total cost/T	1457.39	1451.66	1427.25	1466.73
Total income/T	1746.00	1878.00	1675.00	1545.00
Net Return/T	288.61	426.34	247.76	78.27
Net return over control	-	138.33	-40.85	-210.34

Total cost = cost of birds feed; EM, labor water and electric; Total income = sale of birds and eggs.

administration of Lactobacillus. Mean weekly feed consumption of T_1, T_2, T_3 and T_4 833.89, 793.85, 766.07 and 754.36 g head was attained by the groups placed on 0, 4, 8 and 12 ml of EM/liter of drinking water respectively. Similar trend was also reported by Balevi et al. (2009) from the trial conducted to study the effect of dietary supplementation of commercial probiotic (ProtexinTM) containing either 0, 250, 500 or 750 ppm on egg production performance. The researchers reported the highest daily feed consumption from the control group.

Egg production

Weekly egg production on the 13th week of laying was 3.63, 4.13, 3.34 and 3.05 for the treatment groups assigned to 0.4.8 and 12 ml of EM/liter of drinking water respectively. The group receiving 4 ml of EM/liter of drinking water was significantly higher ($p<0.01$) in egg production than the others. In line with the results of this study, Panda et al. (2008) reported significant increase in the egg production performance of White leghorn layers with dietary supplementation of a probiotic (*L. sporogenes*) at the rate of 100 mg/ kg^{-1} diet (6 × 108 spores). However, no further benefit in egg production was noticed by increasing the level of probiotic supplementation from 100 to 150 $mgkg^{-1}$. Panda et al. (2003) and Kurtoglu et al. (2004) reported that the addition of EM at a rate of 100 or 200 mg/kg of feed resulted in significant improvement in egg production. According to Nahashon et al. (1994) layers fed diets supplemented 0, 1100, and 2200 ppm Lactobacillus produced 88.9, 90.4, and 89.5%, hen-day egg production respectively and the egg production value attained by the groups fed on diet supplemented by 1100 ppm Lactobacillus was significantly higher than that of the control ($P<0.05$).

Feed conversion ratio

The result showed that treatment level containing 4 ml of EM/liter of drinking water consumed significantly less amount of feed (kg) / kg or /dozen of eggs produced and produced at cheaper rate than all the others ($P<0.05$). This is further confirmed by the results of the partial budget analysis of laying performance of the experimental layers (Table 9).

Market egg price in Jimma is about 2 ETB and the mean daily increment of 0.28 eggs brought with the administration of 4 ml of EM/liter of water is worth about 0.56 ETB. This shows that the use of 4 ml of EM /liter of drinking water seems to have significant economic implication when used at relatively large scale poultry production. This result seems to be in line with that of Dahal (1999) who reported that the use of EM (either in water or feed) in broiler production was found to be safe and profitable. Higher profit per bird from the use of EM in water as compared to the use of EM in feed due to additional cost of bokashi preparation was reported by Dahal (1999).

Egg quality, fertility and hatchability

The Hough unit, yolk and albumen height recorded from eggs collected from the groups placed on the control treatment were significantly lower ($p<0.05$) than that recorded from the eggs collected from all the others. In agreement with this result, an increase in the Hough Units ($P<0.05$) have been recorded by Daniele et al. (2008) with the use of probiotics. Similarly, Yousefi and Karkoodi (2007), reported improvement in egg quality, as a result of addition of 100 to 750 mg of EM /kg of feed. As shown in Table 8, there were no significant difference between eggs collected from all the treatment groups in fertility and hatchability. The percent fertility of eggs collected from all the treatment groups ranged between 92 and 94%, the values of which are very high by the Ethiopian standard as reported (CACC, 2003; Alemu, 1997 cited in Solomon, 2008). Percent fertility of 75, 80, and 90 was reported from the traditional breeding centers and commercial poultry farms in Ethiopia respectively. On the other hand, there was no significant difference ($P>0.05$) between all the treatment groups in hatchability.

Hatchability and rate of chick survival are one of the major determinant factors of productivity in poultry. The results of this study agrees with that of Meseret et al. (2011), who reported that the mean percent hatchability calculated for the indigenous chickens of the Gomma Wereda (Jimma Zone) was 22%, the value of which is

lower than those reported from different parts of Ethiopia, with the exception of that of Jimma (Tadelle and Ogle, 1996; Mekonnen, 2007). In a trail in which eggs were randomly purchased from Gamma Wereda market places and incubated at JUCAVM along with freshly collected eggs, there was no significant deference between the fresh (27.39) and market (17.63) eggs in percent hatchability. Percent hatchability recorded from both market and freshly collected eggs in Gomma Wereda were very low (Meseret et al., 2011). In summary, the results of this study showed EM could safely and economically be included at 4 ml /liter of drinking water in layers production.

Conclusion

Even though, better egg quality and lower feed consumption were obtained from 8 ml EM/liter of water treated groups due to higher egg production, FCR/dozen of egg, FCR/kg of egg mass and highest profit, 4 ml treatment could provide better production and economic value than any of the treatment levels. Since EM showed insignificant difference for pullet, it is economical not to provide EM for this age group. However, 4 ml of EM/liter of water showed better performance of egg production and egg quality, provision of this amount of EM fifteen days before onset of egg lay up to the end of production period would be economical. Since weight gain of females RIR growers performed better at 8 ml of EM/liter of water while males RIR grew best at 12 ml of EM/liter water. There is a need for further investigation to determine such level of EM for broiler type breeds.

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