# EVALUATION OF EFFECTIVE MICROORGANISMS ON PRODUCTION AND REPRODUCTION PERFORMANCE OF RHODE ISLAND RED CHICKEN

M.Sc. THESIS

By

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**EVALUATION OF EFFECTIVE MICROORGANISMS ON PRODUCTION AND REPRODUCTION PERFORMANCE OF RHODE ISLAND RED CHICKEN.**

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By

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APPROVAL SHEET

School of Graduate Studies

As thesis research advisor, we hereby certify that we have read and evaluated this thesis prepared, under our guidance, by Simeamelak Mekonnen Beyane entitled "Evaluation of Effective Microorganisms (EM) on Production and Reproduction Performance of Rhode Island Red Chicken" We recommend that it be submitted as fulfilling thesis requirement for the degree of Master of Science in Animal Production.


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As member of *Board of Examiners* of the *M.Sc. Thesis Open Defense Examination*, We certify that we have read, evaluated the thesis prepared by Simeamelak Mekonnen Beyane and examined the candidate. We recommended that the thesis could be accepted as fulfilling the thesis requirement for the Degree of Master of Science in Animal Production.

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External Examiner          Signature           Date

# DEDICATION

I dedicate this manuscript to my Mother Gemeja Geda Beleto, who passed away while I was conducting this research work.

# STATEMENT OF AUTHOR

I declare that the thesis hereby submitted for the M.Sc. degree at the Jimma University, College of Agriculture and Veterinary Medicine is my own work and has not been previously submitted by me or others at another University or institution for any degree. I concede copyright of the thesis in favor of the Jimma University, Collage of Agriculture and Veterinary Medicine.

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# BIOGRAPHICAL SKETCH

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## ACKNOWLEDGEMENTS

# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AACMC | Australian Agricultural Consulting and Management Company |
| AB | Anti-Biotic |
| AGP | Antibiotics Growth Promoter |
| ANOVA | Analysis of Variance |
| BPMDC | Bonga Poultry Multiplication and Distribution Center |
| CACC | Central Agricultural Census Commission |
| CFU | Colony Forming Unit |
| CSA | Central Statistic Authority |
| DFM | Direct Fed Microbes |
| DMRT | Duncan Multiple Range Test |
| ETB | Ethiopian Birr |
| EM | Effective Microorganisms |
| FAO | Food and Agriculture Organization |
| GDP | Gross Domestic Product |
| HU: | Haugh unit |
| HPMDC | Hwassa Poultry Multiplication and Distribution Center |
| JUCAVM | Jimma University, Collage of Agriculture and Veterinary Medicine |
| Md | Marek disease |
| ND | Newcastle disease |
| RIR | Rhode Island Red |
| RMD | Repeated Measure Design |
| SAS | Statistical Analysis System |
| SCD | Sustainable Community Development |
| SNNPRS | Southern Nation Nationalities Peoples Regional State |
| WLH | White Leghorn |

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# EVALUATION OF EFFECTIVE MICROORGANISMS ON PRODUCTION AND REPRODUCTION PERFORMANCE OF RHODE ISLAND RED CHICKEN

## *ABSTRACT*

*The objective of this study was to evaluate the effect of effective microorganisms (EM) on production and reproduction performance of Rhode Island Red (RIR) chickens. We conducted two experiments, in experiment one twelve groups each with 29 unsexed day old RIR chicks were randomly assigned to 4 treatments containing 0, 4, 8 and 12 ml of EM/litre of drinking water with 3 replication for study period of 12 weeks. In experiment two, eight groups each with 12 pullets and two cockerels were randomly assigned to 4 treatment levels 0, 4, 8 and 12 ml of EM/litre of drinking water with 2 replication for the study period of 22 weeks. Feed consumption, chick growth, feed conversion efficiency, survival rate, egg production, egg quality, fertility, and hatchability were used for evaluation. The results of experiment 1, showed that there was no significant difference between all the treatment groups (P>0.05) in feed consumption. The overall mean body weight gain of the groups of chicks placed on the treatment containing 12 ml of EM/liter of drinking water (T4) was significantly (P<0.05) higher than all the others and all the groups placed on 4 – 12 ml of EM/liter of drinking water showed significantly (P<0.05) higher feed conversion efficiency than the control group. About 90% of the chicks placed on T4 survived to an age of 8 weeks, the value was significantly (P<0.05) higher than all the others. The results of experiment 2, showed that there was no significant difference between all the treatment groups of pullets in feed consumption, age at first egg and survival rate (P>0.05). The overall mean body weight gain of the groups of pullets placed on the treatment containing 8 and 12 ml of EM/liter of drinking water (T3) was significantly (P<0.05) higher than the control groups, while there was no significant (P>0.05) difference for feed conversion efficiency in all treatment groups of pullets. There was no significant (p>0.05) difference between all the groups of layers in feed consumption, fertility and hatchability (P<0.05). The overall mean weekly egg production was significantly higher (P<0.05) for the groups of layers placed on the treatment containing 4 ml of EM/liter of drinking water(T2), followed by the group placed on 8-12 ml of EM/liter of drinking water(T3 and T4). In summary, the results of this study showed that inclusion of EM showed improvement in survival rate, growth, egg production, feed conversion efficiency and egg quality parameters. Production of original EM culture under local environment and investigating into the feasibility of extending EM technology to increase productivity of indigenous chickens could be the future direction of research.*

# 1. INTRODUCTION

In Ethiopia chickens are the most widespread and almost every rural family owns chickens, which provide a valuable source of family protein and income (Tadelle et al., 2003). According to CACC (2003) and FAO (2005) the Ethiopian indigenous chicken population estimated at 42.9 and 39 million, respectively while the Central Statistical Authority (2004-2005) reported 31 million for both the indigenous and commercial chickens. The imported exotic breeds of chicken are estimated to be about 2.18% of the total national chicken population of the country and the remaining 97.82% are indigenous chickens of none descriptive breeds. About 42%, 18%, and 40% of the national poultry population are chicks up to 8 weeks of age, growers aged 9 - 20 weeks and adult birds of more than 20 weeks of age respectively (CACC, 2003).

The indigenous flocks are considered to be very poor in egg production performance. The low productivity of the indigenous stock is attributed to the low egg production potential, long natural reproductive cycle, extremely high chick mortality and poor management. The Ethiopian indigenous chickens vary in color, comb type, body conformation and weight. Broodiness (maternal instinct) is pronounced. The mean annual egg production of indigenous chicken is estimated at 60 small eggs with thick shell and deep yellow yolk color (Alemu and Tadelle, 1997).

There is no planned breeding and it is by natural incubation and brooding that the indigenous chicks are hatched and raised all over rural Ethiopia. A broody hen hatching, rearing and protecting few number of chicks (6-8) ceases egg laying during the entire incubation and brooding periods of 81 days. Yet the successes of the hatching and brooding process depends on the maternal instinct of the broody hen and prevalence of predators in the area, such as birds of prey, pets and some wild animals, all of which are listed as the major causes of premature death of chicks in Ethiopia (Solomon, 2007). Mean survival rate to an age of 3-months of baby chicks reared under natural brooding condition in Ethiopia is about 40% (Hoyle 1992), indicating that the broody hen ceases egg laying for 2.7 months for the purpose of rearing 2.8 chicks to an age of 3 months.

The indigenous chickens are kept under traditional production system, characterized by small flock sizes, low input and output and periodic devastation of the flock by disease. There is no separate poultry house and the chickens live in family dwellings together with human population. It have been seen that the provision of vaccination, improved feeding , clean water and  night time enclosure improve the production performance of the indigenous chickens, but not to an economically acceptable level (Teketel, 1986 and Abebe, 1992).

Introduction of exotic chickens into Ethiopia goes back to  the early 1950's, Alamargot (1987) when four improved breeds of chickens (Rhode Island Red, Australorp, New Hampshire and White Leghorns) were imported from Kenya, Denmark and the United States to Jimma and Alemaya in 1953 and 1956, respectively.  It is  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. The centers were involved in the distribution of fertile eggs, day old chicks, pullets/cockerels, culled layers and provide management information of Rhode Island Red (RIR) breeds of chickens to the rural farming population.

Breeding and multiplication centers have been working on RIR breed due to capable of well acclimatization to the Ethiopian rural production environment with reasonable production level under smallholder management systems. However, there 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 (BPMDC and HPMDC-Managers personal communication). 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 which are distributed. The reasons for the low hatchability of RIR are not known (Shiferaw, 2006). Meseret (2010), reported that the mean percent total hatchability calculated for the indigenous chickens of the Gomma Wereda was 22%, the value of which is lower than those reported from different parts of Ethiopia, However, it was

generally reported that there is improvement in the production and reproduction performance of poultry with the addition of Effective Micro-organism (EM) in their feeding system (Safalaoh and Smith, 2001).

Effective micro-organism is a product characterized by a mix of aerobic and anaerobic microorganisms consisting of three major groups: i.e. photosynthetic bacteria, lactobacillus bacteria and yeasts and/or fungi (Higa and Wididana 2007). The EM technology is found to be useful in a wide variety of fields. Studies conducted in Asia (Chantsawang and Watcharangkul 1999) and Belarus (Konoplya and Higa 2000) reported the successful use of EM in poultry feeding. The improvement in production performance of poultry fed on the ration containing EM was reported to be attributed to improvement in feed bioavailability, balance of gastrointestinal microorganisms, and enhancement of the immunity status of the birds. The study of Yonatan (2010) suggested that there was improvement in nutritive value of coffee pulp and husk silages with the use of EM as measured by silage quality, chemical composition and *in-vitro* dry matter digestibility.

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) and in swine and fish farms in Austria (Konoplya and Higa 2000). There is no environmental and public health hazard reported from the use of EM technology in animal feeding (SCD, 2010 citing Kitazato Environmental Science Center, 1994). Therefore, the major objective of this research project was to study the effect of EM on the production and reproduction performance of RIR breed of chickens with the following specific objectives.

(1). To study the effect of effective microorganisms on egg production, egg quality, fertility and hatchability of RIR layers
(2). To study the effect of effective microorganisms on growth performance and survival rate of RIR chicks
(3). To study the level of effective microorganisms that could safely and economically be included in the  feeding system of RIR chickens.

## 2. LITERATURE REVIEW

### 2.1 Poultry Production in Ethiopia

According to the Central Statistical Authority (2004-2005) about 97.82% of the total national poultry population consists of the indigenous chickens, whereas, the remaining 2.18% consists of the introduced exotic breeds of chickens. The national chicks (0-8 weeks of age) population is characterized by high mortality of about of 40–60%. The laying flock seems to be dominated by old age and surplus breeding males. About 30.9% of the total national standing chicken population is hens of which about 16% are none layers. The four major Regional States, in terms of land area and human population (Oromiya, Amhara, SNNP, and Tigray) collectively accounts for about 96% of the total national poultry population. Chicken rearing is not common in the lowlands of Ethiopia. Somali, Gambella, Afar and Benishangul-Gumze Regional States collectively own 3.24% of the total national chicken population of which 2.2 % is owned by Benishangul-Gumuze Regional State (Solomon, 2008).

Oromiya region has about 34.4% of the total national chicken population and contributes 36% of the total annual national egg and poultry meat production. The regional rural areas constitute about 97.1% of the total regional chicken population while the urban areas constitute 2.9%. Moreover, almost all the available commercial poultry farms of the country are located in Oromiya region specifically in and in the vicinity of Debre Zeit. Before the agricultural year of 2006, the regional state owns and operates a total of seven poultry breeding and/or rearing centers at different locations (Adama, Adelle, Ambo, Bedelle, Fiche, Kerssa and Nekemte). The Amhara Regional State has about 31.3 % of the total national poultry population and contributes about 28% of the total annual national egg and poultry meat production. The regional rural areas constitute about 97.8% of the total regional chicken population while the urban areas constitute 2.2%. The Regional State has two breeding and multiplication centers (Kombolcha and Andessa). (Amsalu, 2003).

The Southern Nation and Nationality People (SNNP) Regional State provides habitat for about 18.8% of the total national chicken population and contributes about 18% of the total annual national egg and poultry meat production. The rural areas comprises of about 97.9 % of the total regional chicken population while the urban areas constitute 2.1%. There are no large commercial poultry units in this region. The Regional State Bureaus of Agriculture (RSBA) operates 4 poultry breeding and multiplication centers (Awassa, Walayita Sodo, Gubre and Bonga). The Tigray Regional State provides habitat for about 11.65% of the total national indigenous chicken population and contributes about 15% of the total annual national egg and poultry meat production. The regional rural areas constitute about 80.9% of the total regional chicken population while the urban areas constitute 19.1%. West and Central Tigray Zones together account for about 70% of the total regional poultry population (Solomon, 2008).

## 2.2 Socio-economic roles of poultry

In Ethiopia, the livestock sector contributes an estimated 18.8% to the national GDP and 40% to the agricultural GDP (FAO, 2004). Recent estimates in 2007 put the poultry population in Ethiopia at around 34.2 million with native chicken representing 94.4%, hybrid chicken 3.92% and exotic breeds 0.64% (Central Statistical Agency 2007). The total national annual poultry meat and eggs production is estimated at 72 300 and 78 000 metric tons, respectively (Tadelle *et al.*, 2003). The average number of chickens per household is estimated at 7.2 and 4.4 in Tigray and Amhara Regional State respectively, the values of which are above that of the national average of 4.1 chicken/household. Rural chicken represents a significant part of the national economy and contribute 98.5% and 99.2% of the national egg and chicken meat production, respectively (Tadelle 1996; Abera 2000). Unfortunately, the economic contribution of the sector is still not proportional to the huge indigenous chicken population mainly attributed to low genetic potential and management standard, (Alamargot, 1987).

According to Tadelle and Ogle (1996), women and children look after poultry and the earnings from the sale of eggs and chicken are often their only source of cash income. For poor families, poultry are often one of their few sources of petty cash and so the birds

are kept for sale rather than home consumption (Bush, 2006). There are no religious or social taboos associated with the consumption of poultry and poultry products. But the per capita poultry and poultry product consumption in Ethiopia is one of the lowest in the world: 57 eggs and 2.85 kg of chicken meat per annum (Alemu, 1995). Yearly rural household income from poultry ranges from ETB 50 to over ETB 300 and is largely under the control of women. This income represents 25% of the typical annual income of poor families in SNNPR (Bush, 2006).

The commercial poultry are kept as full time business, highly dependent on market for inputs, and the owners are wealthy by the Ethiopian standard. The small scale modern poultry farms could either be kept as supplementary to family income or as full time business. Reliable economic data concerning the value of commercial poultry products sold in any one year is not available. The general indications are that the intensive poultry industry plays a key role in supplying poultry meat and eggs to urban markets at a competitive price. The industry also provides employment for a range of workers from poultry attendants and truck drivers to professional managers (Solomon, 2008).

## 2.3 The Role of Feed Additives in Poultry

Feed Additives are ingredients, which are not nutrients that alter nutrient digestion and metabolism and the corresponding production performance of the animals. The efficient production performance of commercial poultry has been achieved through genetic selection and improved nutrition, housing and health management. Feed additives have also been used extensively in intensive poultry operations to minimize disease occurrence and improve growth and feed utilization. Thus, in the modern feeding practices, feed additives are assuming a position of prime importance in poultry nutrition for the purpose stimulating growth and improving feed efficiency and health status. Some of the common feed additives used in poultry diets include Plant extracts, Antibiotics, Enzymes, Amino Acid Supplements, Highly Available Minerals and Probiotics (Panda *et al*., 2003).

## 2.3.1 Plant extracts and antibiotics

Phylogenic feed additives (often also called phytobiotics or botanicals) are plant-derived products (herbs, essential oils, and oleoresins) used in animal feeding to improve animal production performance. The use of oils, herbs, and botanicals as feed additives increases secretion of digestive fluids and improve immune system of broilers which in turn results in better health status, feed utilization efficiency and production performance (Wenk, 2005). Antibiotics is reported to maximize profitability of poultry enterprises when applied at sub therapeutic levels and used for animal growth promotion rather than treating specific disease conditions. However there is much controversy in regard to the impact of antibiotics in animal diets on the development of resistant strains of microbes that could have direct human public health implications. There could be residual effects of antibiotics in animal products as well as the negative impacts associated with their extraction into the environment. The ban on the use of antibiotics as a feed additive in animal nutrition has led to a worldwide search and implementation of alternative strategies for the administration of antibiotics in livestock and poultry feed (Wenk, 2000).

## 2.3.2 Enzymes and commercial amino acids

The commercial introduction of exogenous enzymes into poultry ration is reported to have significantly reduced gut content viscosity, improved digestibility and absorption and health status of the birds. Enzymes are biological catalysts bringing about biochemical reactions. Enzymes are protein in nature and composed of amino acids arranged in a sequence. Enzymes used in poultry feeding are the product of living organisms such as bacteria, yeast, fungi and plant tissues. Commercial enzymes used in poultry feeding are industrial preparations resulting in improvement in the nutritional value of conventional animal feeds through improving digestibility of the non-starch polysaccharide fraction (Marsmann *et al*., 1997). Commercial enzymes stimulate growth and enhance nutrient utilization thereby, reducing the manure output and nutrient excretion particularly that of excess phosphorus, nitrogen, copper and zinc (Panda *et al*., 2003). According to Marsmann *et al*. (1997) enzyme supplementation significantly

improve body weight and feed conversion ratio, the effect of which are attributed to improvement in nutrient digestibility. .

Commercial amino acids are also used as feed additives in poultry feeding. The use of commercial amino acids in poultry diet formulation allows ideal amino acid balance, thereby reducing dietary nitrogen concentrations with corresponding reduction in amino acid catabolism and nitrogen pollution. The amino acids of particular interest to poultry nutrition are L-lysine, DL-methionine, L-threonine and L-tryptophan. Feeding commercial amino acids to poultry provide a consistent performance in a similar way to that obtained with feeding commercial enzymes (Panda, 2011)

### 2.3.3 Trace minerals, prebiotics and probiotics

Highly available trace minerals such as Chelates or Proteinates are reported to replace the inorganic sources currently used to meet the nutrient requirement of poultry. The trace element selenium when provided as Seyeast is reported to have specific positive effect on the metabolism and health status of poultry. The copper lysine complex, Chelated iron and zinc proteinates are further examples of the application of organic trace minerals as feed additives with a beneficial effects on the health status of poultry (Panda *et al*., 2003). Prebiotics are non digestible carbohydrates and many of these carbohydrates are short chain mono and oligosaccharides. Two of the most commonly studied prebiotic oligosaccharides are fructo-oligosaccharides and mannan-oligosaccharides.

Among the many purported alternatives to the use of antibiotics is the incorporation of probiotics, prebiotics or synbiotics into feed and/or drinking water. Probiotics are live microorganisms, which, when administered in adequate amounts, confer a health benefit on the host (FAO-WHO, 2001). The term probiotics was originated from Greek words meaning for life in contrast to the term antibiotics, which means against life. Probiotic is a culture of a single bacteria or mixture of different strains, that could be used as fed additives in poultry production. Some authorities consider feed ingredients other than bacteria, such as biologically derived extracts including dead yeasts, essential oils, enzymes, and even seaweed, to be probiotics. However, the commonly accepted

definitions indicate that  probiotics are live microbial feed additives with beneficial effect to the host animal by improving its intestinal microbial balance

Nearly all the Probiotics available in the market contain Lactobacilli and / or Streptococci and a few contain bifid bacteria, yeast and fungi.  There are several commercial probiotic products available on market.  These products are either freeze dried or non viable or micro encapsulated, viable, proliferate and establish in large numbers in the gastrointestinal tract (Fuller, 1989). Modern poultry are usually raised as densely populated flocks during which they are succumbed to various kinds of stresses, which adversely affect their production performances. The dietary use of probiotic is gaining momentum in counteracting such stresses and enhancing their beneficial effects on live weight gain, feed conversion efficiency and reduced mortality (Torres-Rodriguez *et al.*, 2007).

**2.3.4 Effective Microorganisms (EM)**

The concept of Effective microorganisms (EM) was developed by Professor Teruo Higa, University of the Ryukyus, Okinawa, Japan (Higa, 1991; Higa and Wididana, 1991). The first solution of EM developed contained over 80 microbial species isolated from Okinawa and other environments in Japan. The original EM technology was gradually refined to include  four important microbial species (Lactic Acid Bacteria, Photosynthetic Bacteria, Actinomyces and Yeast) blended into  a sugar-based (molasses) medium adjusted at  a low pH ranging between 3 .0 – 4.0.  Recently EM is defined as a product characterized by a mix of aerobic and anaerobic microorganisms consisting of three major groups: i.e. photosynthetic bacteria, lactobacillus bacteria and yeasts and/or fungi (Higa and Wididana, 2007). At present EM is produced in many countries. The technology is reported to be safe, effective and environmentally friendly (Sangakkara, 2001).

**2.3.4.1 Application of Effective Microorganisms in agriculture**

EM was initially developed and used as inoculants for soil conditioning in cereal grain, vegetable, and fruit production aimed at enhancing organic farming. At the beginning EM was directly applied to crops on the fields, or mixed with compost preparation organic materials for the purpose of reducing the time required for composting. EM is also added in the form of Bokashi (compost) made up of waste material (such as rice husk and saw dust) mixed with nitrogen rich material such as rice, corn, wheat bran, fish meal, oil cakes etc, (Sangakkara, 2001).

According to Higa and Wididana (1991), introduction of mixed culture of microorganisms to soil and plant was found to be more effective than the pure culture as a result of which three mixed culture of beneficial effective microorganisms were developed. One of the solutions (EM2) comprised of culture of photosynthetic bacteria, ray fungi, yeasts and fungi consisting of 10 genera and 80 different species. The other solution (EM3) comprised of a mixed culture of photosynthetic bacteria and a mixed culture of lactobacillus and other microorganisms producing lactic acid (EM 4) respectively.

There has been several success stories reported on the use of EM in crop production (Sangakkara, 2001). The impact of EM in promoting plant growth by controlling or suppressing pest and diseases has also been reported. . During the e 1970s and 1980s EM was reported to be an effective tool for manipulating and managing the overall microbial ecology of complex and divers systems. In the mid-1980s, researchers in Japan began to test EM for odor control and waste management and reported that EM is effective waste treatment and a biological control agent (SCD, 2010, citing Kitazato Environmental Center, 1994). One of the most valuable contributions of EM to the livestock industry was its deodorizing effect within confined poultry operations. Moreover residues from harvest or from industrial transformation process (oils, flour, skin, fruit, leaves, branches etc.) could also be transformed in to fertile compost called "Bokashi" meaning fermented organic matter.

**2.3.4.2 Application of Effective Microorganisms in poultry production**

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 is 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 microorganisms, 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). It is reported that ammonia has adverse effect on poultry production. Ammonia negatively affect growth rate, feed efficiency, egg production, susceptibility to infectious disease , and increase incidence of airsacculities and keratoconjectivitis levels (SCD, 2010, citing Moore *et al*., 1996).

The absence of normal micro flora in the cecum of poultry has been considered as a major factor in the susceptibility of chicks to bacterial infection (Barrow, 1992). EM contains selected species of microorganisms dominated by lactic acid bacteria. The colonization of chicken intestinal tract by lactic acid bacteria controls the population of pathogenic microorganisms such as Salmonella spp., Enterococci and E. coli (Edens *et al*., 1997). Lactic acid bacteria produce significant amounts of "pathogenic bacterial growth inhibitory substances" such as reuterin. EM also acts through competitive exclusion of the colonization of intestinal epithelium by pathogenic microorganisms (Fox, 1988; Jin *et al*., 1997). Rynsburge, 2009 citing Parsons, 2004, suggested that during 6-10 days of age the chick is digestively unique. He suggested morphological and functional changes in the intestine have been found to plateau at 6-10 days of age. To

maximize the genetic potential of the broiler chicken, special attention must be paid to the nature of the feed during this time

One of the simplest means of using EM is mixing it in chlorine free water. In broilers and laying hens, the use of EM either in drinking water or feed reduced the ammonia concentration within poultry house by 42.12%, and 54.25% respectively whereas, the use of EM both in water and feed at the same time reduced ammonia concentration in poultry house by 69.7% (Yongzhen and Weijiong, 1994). There is some' evidence that poultry flock receiving EM on a regular basis were unaffected by the avian flu virus, while others succumbed (The poultry forum, 2009). Jin *et al*. (1998) reported low mortality (3.2%) from the treatment groups receiving EM compared to that of the control groups (8.2%). Timmerman *et al*. (2006) reported a marked decrease in mortality after EM administration

**2.3.4.3 Effect of Effective Microorganisms on growth and egg production**
Effective Micro-organism has also been used to improve growth and egg production performance of poultry (Stavric and Kornegay, 1995). Improvement in growth performance brought with the use of EM is said to be attributed to the improvement in the gut flora of the birds which in turn resulted in improvement in digestion efficiency. Accordingly, Wenk (2000) reported that feed additives play rolls by regulating feed intake and increasing digestibility of nutrients and energy. The findings of Santoso *et al.* (2001) reported that 0.5% fermented product from *Bacillus subtilis* inclusion reduced feed consumption.

A trial conducted by Botlhoko (2009) to study the effect of EM, AGP (antimicrobial growth promoter) and combination of EM and AGP at the rate of 50ml/ per liter of water showed that feed consumption to an age of 21 days was higher for the groups of broilers fed on the control treatment. The study of Safalaoh (2006), indicated that Broilers fed diets supplemented with EM at the rate of 1ml/1000ml of water solution) showed that feed intake was lower for the EM treated birds as compared to the control groups. On the contrary, the results of this study disagree with that of Ashraf *et al.* (2005) who reported

the high feed consumption from groups of broilers supplemented with mixture of probitic microbes as compared to those placed on the negative control treatment.

Safalaoh (2006) reported better feed conversion efficiency of broilers placed on feed treated with EM.  He also reported that broilers fed diets supplemented with EM (at the rate of 1ml/1000ml of water solution) had significantly (P < 0.05) higher body weight gain as compared to the treatment groups fed on negative control treatments. The findings of Kalavathy *et al*. (2003) showed that Lactobacillus administration resulted in improved growth rates and feed conversion ratio in broiler. Rahimi (2009) also showed that  administration of EM in feed of  broilers during growing and finishing periods resulted  in  significantly better (P≤0.05) feed conversion ratio as compared to the control groups. The attempts made in the area of economic analysis of EM showed that EM is cheap product that could be used profitably in broiler production either in feed or drinking water (Dahal, 1999).

Panda *et al*. (2003) and 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  100mg/ 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 150mgkg−1. A study conducted by Nahashon *et al*. (1994) revealed improvement in hen-day egg production values as a result of supplementation. On the contrary   the addition of EM didn't have any significant effect on egg production, egg mass and feed conversion ratio (Daneshyar *et al.,* 2007 and Balevi *et al*., 2009). Yousefi and Karkoodi (2007) reported improvement in shell weight, shell thickness, serum calcium, egg quality, fertility and hatchability as a result of addition of EM. Inclusion of EM dominated by Lactobacillus acidophilus in laying hens diets 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).

# 3 MATERIALS AND METHODS

## 3.1 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 about 70 33'N latitude and 360 57' E longitude and at an altitude of 1710 meter above sea level (m.a.s.l.). The mean maximum and minimum temperature of the study area was $26.8^0C$ and $11.4^0C$, respectively and the mean maximum and minimum relative humidity was 91.4% and 39.92% respectively. The mean annual rainfall of the area is 1500mm (BPEDORS, 2000).

## 3.2 Experimental Treatments

Adequate quantities of extended/secondary EM packed in plastic jar was obtained from Weljijie P.L.C. located in Debre Zeit. This company obtains the primary culture from EMROSA P.L.C. found in Sweden. The EM was transported to JUCAVM poultry farm and stored properly until required for the formulation to the experimental treatments. Four experimental treatments shown in (Table1) were prepared by inclusion of 0, 4, 8 and 12 ml of EM solution/lit of chlorine free drinking water.

## 3.3 Management of Experimental Birds

Two experiments were conducted on two batches of RIR chickens. The first experiment dealt with day old RIR chicks, whereas the second experiment involved growers (pullets) at the age of 16 week. In experiment 1, brooder house of JUCAM was cleaned, disinfected and well prepared in advance of the arrival of the experimental chicks. A total of 350 day old chicks of Red Island Red (RIR) breed were purchased from SNNP Regional State poultry breeding and multiplication canter located in Bonga, 108 km South of Jimma town. Three hundred forty eight chicks were divided into twelve groups of 29 chicks each. Each group was housed in separate pen and randomly assigned to the four treatments with three replications for a study period of 12 weeks (table 1). All the treatment groups were fed to appetite with commercial starters ration purchased from Kality feed processing enterprise and water containing the different levels of EM (treatments) which were made available all the times.

In Experiment 2, a total of 100 RIR pullets at an age of 12 weeks were purchased from SNNPR Regional 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 purchased from Kality feed mill.  At an age 16 weeks, 96 pullets were used from a total of 100 and divided in to 8 groups each with 12 pullets. Two cockerels of the same age and breed were assigned to each group (Table 1) and each group was housed in separate pens of equal dimension (1.75m2,) each of which was properly cleaned, disinfected, and equipped with all the necessary layers house equipments. Finally the 4 treatments were randomly assigned to the experimental pullets with two replications for the study period of 22 weeks.  At the age of 5 months all the treatment groups were switched to commercial layers ration purchased from Kality feed mill. All the treatment groups were fed to appetite and chlorine free water containing different levels of EM (treatments) was made available all the times.

Table 1. Experimental layout

|  | replication | $T_1$  (0ml/lit of water) | $T_2$  (4ml/lit of water) | $T_3$  (8ml/lit of water) | $T_4$ (12ml/lit of water) | Total No. |
|---|---|---|---|---|---|---|
| Experiment one | 1 | 29 | 29 | 29 | 29 | 116 |
| | 2 | 29 | 29 | 29 | 29 | 116 |
| | 3 | 29 | 29 | 29 | 29 | 116 |
| Experiment two | 1 | 12/2 | 12/2 | 12/2 | 12/2 | 48/8 |
| | 2 | 12/2 | 12/2 | 12/2 | 12/2 | 48/8 |

*12/2 = twelve pullets and 2 cockerels/treatment, 29 = twenty-nine chicks/treatment

**3.4 Egg Quality Determination**

Twelve eggs were randomly selected from each treatment, from the eggs laid during the last three consecutive days of the 7 week laying period. The eggs were taken to JUCAVM nutrition laboratory and individually weighed using a two digit sensitive balance. The eggs were carefully opened (broken) onto a flat plate. The yolk and albumen were carefully separated and weighed.   Yolk height was measured using tripod

micrometer (0.01 mm, gauge) and yolk index was calculated according to (Akhtrs, 2007). The shell weight was weighed and 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 **(**Haugh, 1937).

**HU** = 100log (AH - 1.7EW$^{0.37}$+7.6) where; HU = Hough unit,

     Where: AH = Albumen height and   EW = Egg weight.

For egg production, data were collected daily on number per treatment and replication and weighted accordingly. Weekly egg production and egg mass calculated from the daily record.

$$\text{Hen Day production} = \frac{\text{Number of eggs produced}}{(\text{Opening Stock} + \text{Closing Stock of layers}) \times 0.5}$$

**Cost benefit analysis** was done using partial budget analysis from chick and pullet purchasing cost, feed cost, EM cost, labor cost, electric cost, and revenue from sale of 12 week age pullets, cockerels, eggs and laying hens at the end of the experiments.

**3.5 Fertility and Hatchability Determination**

Fifty fresh eggs (stored for 10 days) were taken from each treatment for comparative evaluation of fertility and hatchability of the eggs collected. These were selected against undesirable shape, size and shell structure and incubated using an electric incubator of JUCAVM. . 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 7th and 14th day of incubation. Finally hatchability was calculated as follow.

Total Hatchability =   100[Number of chicks hatched]/ Number of total eggs set

Fertile Hatchability =   100[Number of chicks hatched]/ Number of fertile eggs set

## 3.6 Data Collection

In Experiment 1, data on body weight gain, feed consumption, feed conversion ratio, survival rate, were measured throughout the study period of twelve weeks. Body weight was measured every week whereas; feed intake was measured daily. Mortality and disease conditions were recorded as occurred. In Experiment 2, data on body weight gain, feed consumption, feed conversion ratio, sexual maturity, rate of egg production, egg quality, fertility and hatchability were collected.

## 3.7 Statistical Analysis

Collected data on non-random repeated measurement (body weight, Body weight gain, feed consumption and feed conversion efficiency) were subjected to Repeated Measures Design (RMD) of SAS 9.00 version for analysis (SAS institute, 2002). List squire mean were used for comparison.

**Model:**

$$Y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{jk} + \beta\gamma_{jk} + \alpha\beta\gamma_{ijk} + \varepsilon_{ijkl}$$

Where:

$Y_{ijkl}$ =the dependent variables

$\mu$ =is the overall mean effect,

$\alpha_i$ = is the effect of the ith level of EM

$\beta_j$ = is the effect of the jth level of sex

$\gamma_k$ = is the effect of the $k_{th}$ level of week

$\alpha\beta_{ij}$ = interaction effect of EM and sex

$\alpha\gamma_{jk}$ = interaction effect of EM and week

$\beta\gamma_{jk}$ =interaction of sex and week

$\alpha\beta\gamma_{ijk}$ = interaction of EM, sex and week

$\varepsilon_{ijkl}$ = is a random error of the three factors.

# 3. RESULTS AND DISCUSSIONS

## 4.1 Experiment One

## 4.1.1 Feed consumption of chicks

The mean weekly feed consumption of the experimental chicks placed on different levels of EM are shown in Table 2. There was no statistically significant (P>0.05) difference between all the treatment groups in mean weekly feed consumption during the first 12 weeks of the feeding trial (Table 2).

Table 2. Weekly feed consumption (gm/head) of the experimental chicks placed on different level of Effective Microorganisms.

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | s.e. | p-value |
|---|---|---|---|---|---|---|
| Week 1 | 32.67 | 33.27 | 34.7 | 33.8 | 2.50 | >0.05 |
| Week 2 | 61.47 | 56.83 | 60.50 | 60.67 | 0.75 | >0.05 |
| Week 3 | 93.10 | 91.70 | 92.63 | 101.50 | 1.99 | >0.05 |
| Week 4 | 148.37 | 143.83 | 141.43 | 160.17 | 4.10 | >0.05 |
| Week 5 | 182.00 | 174.33 | 186.00 | 177.00 | 2.15 | >0.05 |
| Week 6 | 235.00 | 225.20 | 222.57 | 227.03 | 8.18 | >0.05 |
| Week 7 | 249.87 | 231.30 | 240.10 | 245.77 | 5.77 | >0.05 |
| Week 8 | 329.40 | 305.53 | 309.90 | 325.37 | 9.92 | >0.05 |
| Week 9 | 399.60 | 392.67 | 398.13 | 384.67 | 11.17 | >0.05 |
| Week 10 | 460.87 | 437.43 | 439.77 | 436.40 | 11.12 | >0.05 |
| Week 11 | 501.60 | 500.00 | 483.77 | 449.97 | 13.00 | >0.05 |
| Week 12 | 543.20 | 530.00 | 510.53 | 510.87 | 14.44 | >0.05 |

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

The overall mean weekly feed consumption was calculated to be 269.76, 260.25, 260.00 and 259.43 gm/head for $T_1$, $T_2$, $T_3$ and $T_4$ respectively indicating that the groups placed on the control treatment ($T_1$) tended to consume more. In line with this results

Safalaoh (2006), indicated that groups of broilers fed diets supplemented with EM (at the rate of 1ml/liter of drinking water ) had lower feed consumption compared to the groups fed on control treatment. These results are also in agreement with that of Santoso et al. (2001) who reported that the inclusion of 0.5% fermented product of *Bacillus subtilis* reduced feed consumption of the experimental chicks. A trial conducted by Botlhoko (2009) to study the effect of EM, AGP (antimicrobial growth promoter) and combination of EM and AGP at the rate of 50ml/ per liter of water showed that feed consumption to an age of 21 days was higher for the groups of broilers fed on the control treatment. Feed additives usually play rolls by regulating feed intake and increasing digestibility of nutrients and energy (Wenk, 2000). On the contrary, the results of this study disagree with that of Ashraf, et al. (2005), who reported higher feed consumption from groups of broilers supplemented with mixture of probitic microbs as compared to those placed on the negative control treatment. Similarly in an attempts made to study the effect of probitic (Bio-Plus 2B® ) on broilers both during growing and finishing periods Rahimi ( 2009) reported that the supplemented groups tended to consume more than the groups placed on the control treatment.

### 4.1.2 Growth performance of chicks

The mean weekly body weight gain of the experimental chicks placed on different levels of EM administered in drinking water is shown in Table 3. During the first 4 weeks of brooding there was no statistically significant (P>0.05) difference in growth performance between all the treatment groups. The groups placed on the treatment containing 12 ml of EM/liter of drinking water ($T_4$) was found to be superior to all the others in the overall mean weekly body weight gain followed by the groups placed on the treatment containing 8 ml of EM/liter drinking water ($T_3$) and the groups placed on the treatment containing 4 ml of EM/liter of drinking water ($T_2$) respectively when compared with the groups placed on the control treatment ($T_1$).

According to the results of this study, the groups placed on the control treatment ($T_1$) was significantly lower (P<0.05) than all the others in the overall mean weekly body weight gain indicating that the administration of EM in drinking water resulted in better

growth performance of the experimental chicks. This result is in agreement with that of Wenk (2000), who reported that feed additives usually play rolls by regulating feed intake and increasing digestibility of nutrients and availability of energy. However the data shown in Table 3, tends to indicate that there was no statistically significant difference (P>0.05) between the treatment groups receiving 8 ml ($T_3$) and 12 ml ($T_4$) of EM/liter of drinking water in weekly body weight gain on one hand and between the groups receiving 4 ml ($T_2$) and 8 ml ($T_3$) of EM/liter of drinking water in body weight gain on the other hand.

Table 3. Weekly cumulative body weight gain in week for experimental chicks placed on different level of Effective Microorganisms (gm/head).

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | s.e. | p-value |
|---|---|---|---|---|---|---|
| Week 1 | 5.87 | 6.2 | 6.3 | 8.0 | 0.47 | >0.05 |
| Week 2 | 25.50 | 28.27 | 27.17 | 32.2 | 1.50 | >0.05 |
| Week 3 | 53.70 | 57.23 | 56.07 | 62.27 | 2.18 | >0.05 |
| Week 4 | 113.17 | 129.23 | 132.63 | 153.00 | 11.61 | >0.05 |
| Week 5 | 152.93[b] | 181.17[b] | 187.93[b] | 209.53[a] | 11.24 | <.0001 |
| Week 6 | 211.83[b] | 241.97[ab] | 252.57[ab] | 266.00[a] | 6.31 | <0.01 |
| Week 7 | 266.70[b] | 287.60[ab] | 308.67[ab] | 318.30[a] | 7.50 | <0.05 |
| Week 8 | 344.67 | 368.60 | 377.80 | 385.13 | 10.38 | >0.05 |
| Week 9 | 391.67[b] | 407.87[ab] | 401.93[ab] | 462.20[a] | 10.71 | <0.05 |
| Week 10 | 425.47[b] | 458.77[ab] | 510.82[a] | 534.58[a] | 11.85 | <0.05 |
| Week 11 | 458.83[b] | 504.58[ab] | 576.7[a] | 589.72[a] | 12.50 | <0.0001 |
| Week 12 | 517.10[b] | 567.13[ab] | 619.2[a] | 639.05[a] | 7.96 | <0.0001 |
| Average | 247.29[d] | 269.05[c] | 288.15[b] | 305.02[a] | 3.96 | <0.05 |

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

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. Rahimi (2009) reported significantly higher (P<0.05) body weight gain of broilers placed on a probitic (Bio-Plus 2B®) organisms both during growing and finishing periods. Similarly Safalaoh (2006) also reported, significantly (P < 0.05) higher body weight gain from experimental broilers fed diets supplemented with EM, at the rate of 1ml/liter of water. The improvement brought by the addition of EM was said to be about 2 % at an age of 42 days.

The mean weekly growth performance of females and males were separately recorded during the $9^{th}$ – $12^{th}$ weeks of the feeding period. The weekly body weight of the pullets placed on the experimental treatments is   shown in Table 4.   There was no statistically significant difference (P>0.05) between all the female treatment groups in body weight gain during the $9^{th}$-$12^{th}$ weeks of feeding, however, the groups placed on the treatment containing 8 ml of EM/liter of drinking water tended to be higher than the others in growth performance.

Table 4. Weekly body weight gain of pullets placed on different level of EM (gm/head).

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | s.e. | p-value |
|---|---|---|---|---|---|---|
| Week 9 | 50.87 | 51.00 | 52.56 | 50.23 | 14.63 | >0.05 |
| Week 10 | 108.40 | 110.47 | 139.30 | 150.40 | 16.77 | >0.05 |
| Week 11 | 139.93 | 143.83 | 214.10 | 194.70 | 15.34 | >0.05 |
| Week 12 | 197.37 | 209.50 | 261.37 | 248.93 | 16.72 | >0.05 |
| Average | 124.14 | 128.70 | 166.83 | 161.07 | 8.70 | >0.05 |

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

The weekly body weight gain of the males during the 9-$12^{th}$ weeks of the feeding trial are also shown in Table 5.   The overall mean weekly body weight gain of the groups of cockerels receiving 12 ml and 8 ml of EM/liter of drinking was  significantly (p<0.05) higher than the others.  There was no statistically significant difference (P>0.05) between the   groups of cockerels placed on the treatment containing 0 ml and 4 ml of EM/liter of

drinking water in weekly body weight gain during the $9^{th}$-$12^{th}$ weeks of feeding. EM expressed different response on males and females. The result showed that cockerels are more reactive to supplementary EM than pullets as measured in terms of weekly body weight gain.

Table 5. Weekly body weight gain of cockerels placed on different level of EM (gm/head).

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | s.e. | p-value |
|---|---|---|---|---|---|---|
| Week 9 | 51.03 | 67.53 | 73.00 | 62.20 | 14.88 | >0.05 |
| Week 10 | $115.20^b$ | $118.60^{ab}$ | $155.73^{ab}$ | $173.53^a$ | 15.56 | <0.005 |
| Week 11 | $141.73^b$ | $166.87^{ab}$ | $212.70^a$ | $229.50^a$ | 15.17 | <0.05 |
| Week 12 | $210.83^b$ | $236.30^{ab}$ | $250.43^{ab}$ | $273.93^a$ | 16.66 | <0.05 |
| Average | $129.70^b$ | $147.33^{ab}$ | $172.97^a$ | $184.79^a$ | 12.02 | <0.05 |

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

Table 6. Interaction effects of different parameters.

| Effect | F Value | Pr > F |
|---|---|---|
| SEX | 2.67 | 0.1254 |
| REP | 0.23 | 0.7968 |
| T | 2.77 | 0.0823 |
| WK | 122.94 | <.0001 |
| SEX*T | 0.07 | 0.9737 |
| SEX*WK | 0.63 | 0.6425 |
| T*WK | 2.03 | 0.0436 |
| SEX*T*WK | 0.49 | 0.9105 |

*REP = Replication, T = Treatment, WK = Week, SEX = sex

According to the result (table 6) there was no interaction effect between any of the parameters.

**4.1.3 Feed conversion efficiency of chicks**

The results of feed conversion ratio of the experimental chicks placed on the different treatments are shown in Table 7. There was no statistically significant p>0.05) difference (between all the treatment groups in feed conversion ratio expressed as grams of feed consumed /gram body weight gained during the brooding period. At the first week treatment groups that received 12ml/lit of EM showed significantly better (p<0.0001) feed conversion ability than all the rest groups. In line with this (Rynsburge, 2009 citing Parsons, 2004) suggested that during 6-10 days of age the chick is digestively unique.  He suggested morphological and functional changes in the intestine have been found to plateau at 6-10 days of age. To maximize the genetic potential of the broiler chicken, special attention must be paid to the nature of the feed during this time.

Table 7. Weekly feed conversion ratio of  chicks placed on different levels of EM (gm of feed /gm body weight gain).

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | s.e. | p-value |
|---|---|---|---|---|---|---|
| Week 1 | $5.64^a$ | $5.49^a$ | $5.84^a$ | $4.23^b$ | 0.68 | <0.0001 |
| Week 2 | 3.75 | 3.20 | 3.51 | 2.93 | 0.22 | >0.05 |
| Week 3 | 3.50 | 3.19 | 3.35 | 3.15 | 0.13 | >0.05 |
| Week 4 | 2.39 | 2.54 | 2.52 | 2.35 | 0.31 | >0.05 |
| Week 5 | 3.35 | 2.77 | 2.77 | 2.55 | 0.22 | >0.05 |
| Week 6 | 3.57 | 3.00 | 2.93 | 2.85 | 0.12 | >0.05 |
| Week 7 | 3.76 | 3.33 | 3.17 | 3.16 | 0.12 | >0.05 |
| Week 8 | 3.87 | 3.52 | 3.41 | 3.46 | 0.07 | >0.05 |
| Week 9 | 4.43 | 4.06 | 4.20 | 3.71 | 0.14 | >0.05 |
| Week 10 | $5.18^a$ | $4.57^b$ | $4.16^b$ | $4.03^b$ | 0.14 | <0.0001 |
| Week 11 | $5.92^a$ | $5.14^{ab}$ | $4.53^b$ | $4.41^b$ | 0.19 | <0.01 |
| Week 12 | $6.28^a$ | $5.51^{ab}$ | $5.04^b$ | $4.87^b$ | 0.16 | <0.0001 |
| Average | $4.35^a$ | $3.86^b$ | $3.78^b$ | $3.48^c$ | 0.13 | <0.001 |

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

Within the $2^{nd}$ up to $9^{th}$ week there was no statistical significant (P>0.05) difference between all treatment levels for feed conversion ratio. However, there was improvement in feed conversion ratio (i.e. decrease of feed intake per unit of body weight gain) with the addition 4-12 ml of EM/liter of drinking compared to the control group.

Statistically significant (P<0.01) difference in feed conversion ratio between the treatment groups was recorded starting from the $10^{th}$ week of the feeding trial. Feed conversion ratio as defined by the amount of feed consumed per unite body weight gain was significantly (p<0.05) higher for the groups receiving control treatment ($T_1$) than all the others, indicating that there was improvement in feed conversion efficiency as a result of inclusion of 4-12 ml of EM/liter of drinking water of growers. The mean weekly feed conversion ratio brought by the groups assigned to the treatment containing 12 ml/liter of drinking water ($T_4$) was significantly(P<0.01 higher than all the others) followed by the groups receiving 4 ml and 8 ml of EM/liter of drinking water ($T_{2 \& 3}$) respectively. There was no statistically significant (P>0.05) difference in feed conversion ratio between the groups receiving 4 and 8 ml of EM/liter of drinking water ($T_2 \& T_3$).

The results of this study are in agreement with that of (Kalavathy et al., 2003) who reported improved feed conversion ratio of broiler offered supplementary administration of Lactobacillus. Rahimi (2009) also reported significantly better (P<0.05) feed conversion ratio of broilers placed on a probitic (Bio-Plus 2B®) organisms during the last phase of the finishing period. He reported significantly better feed conversion ratio from the groups of broilers placed on a probitic (Bio-Plus 2B®) organisms during the first three of rearing.

### 4.1.4 Rate of survival

The survival rates of the experimental chicks are shown in Table 8. About 90% of the experimental chicks assigned to the treatment containing 12 ml of EM/liter of drinking water ($T_4$) survived to an age of 4 weeks, the survival rate of which is higher than all the others. This result agrees with the report of FAO/WHO which indicated that inclusion of

live microorganisms in feed or water in adequate amounts confers a health benefit on the host animals (Wenk, 2000). The results of this experiment also showed that the survival rate to an age of 8 weeks for the treatment groups receiving 0 ml of EM/liter of drinking water ($T_1$) was lower, 75.86%, than all others 86.21, 87.36, and 87.86 for $T_2$, $T_3$, and $T_4$ respectively.

The results of a survey conducted by Hoyle (1992) on small scale poultry keeping in Welaita, North Omo region also indicated that the most challenging period for indigenous chicks kept under natural brooding condition in Ethiopia is from is 2 to 4 weeks after hatching (Solomon, 2007). There has been no mortality recorded from all the treatment groups starting from the $9^{th}$ week of the experimental period showing that all the mortality recorded occurred during the first 8 weeks of brooding. The majority of the death recorded during the first 8 weeks of brooding was attributed to sticking of feces on anus and mechanical damage. Highest survival percentage also observed in $T_4$ (94.21%) for male chicks while treatment groups of females receiving 4ml/lit of water ($T_2$) showed highest (93.1%) survival percentage at the age of week eight.

Table 8. Mean weekly survival rate of experimental chicks placed on different level of Effective Microorganisms.

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| Week 4 | 82.76 | 87.36 | 87.36 | 89.66 |
| Week 8 | 75.86 | 86.21 | 87.36 | 87.36 |
| Week 8 females | 73.56 | 93.1 | 82.76 | 66.67 |
| Week 8 males | 78.27 | 71.74 | 84.79 | 94.21 |

The result of this study is similar to the result obtained by Jin et al (1998), who reported improved survival rate of chicks with the administration of EM. The researchers reported reduction in mortality of the experimental chicks from 8.2% to 3.2% as a result of administration of EM. Timmerman *et al*. (2006) showed marked decrease in mortality after EM administration. According to Barrow (1992),   the absence of normal micro flora in the cecum of poultry has been considered as a major factor in the susceptibility of

chicks to bacterial infection. Hanekon *et al.* (2001) and Safalaoh and Smith (2001) reported that EM was successfully used for increasing survival rate in integrated animal units and poultry farms in South Africa. Improvement in health status of the birds seems to be attributed to the colonization of chicken intestinal tract by lactic acid bacteria which controls the population of pathogenic microorganisms such as Salmonella, Enterococci and E. coli spp (Edens *et al*. (1997).
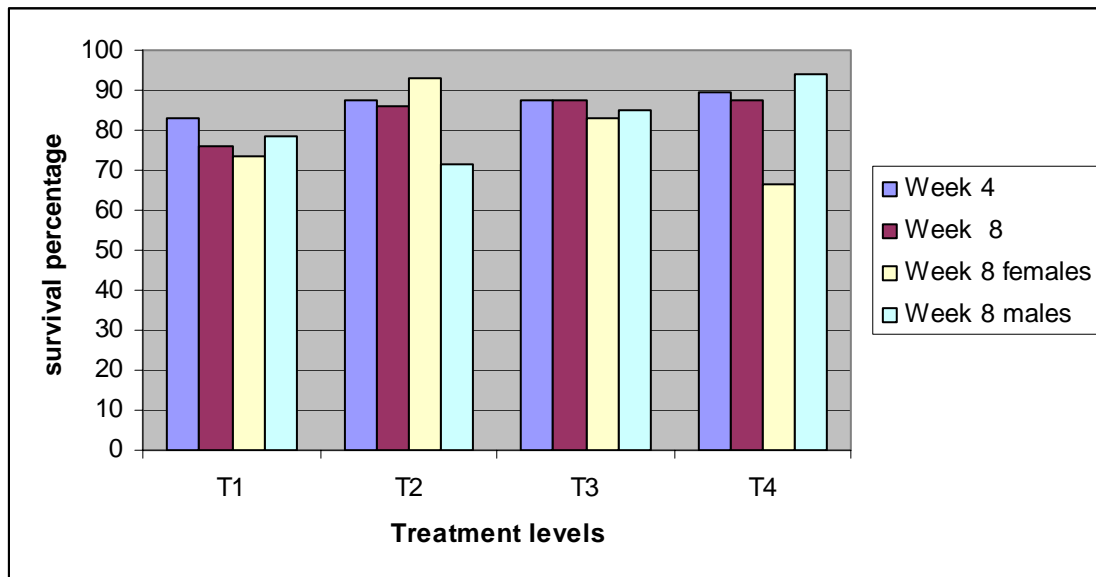


Figure 1. Survival rate of chicks placed on different levels of Effective Microorganisms to an age 8 weeks

### 4.2 Results of Experiment Two

### 4.2.1 Production Performance of the Experimental Pullets

The results of the weekly feed consumption of the experimental pullets are shown in Table 9. There was no significant ($p>0.05$) difference between all the treatment groups in mean weekly feed consumption, even though groups receiving 0 ml of EM/liter of drinking water ($T_1$) tended to consume more than the others. 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. In line with this result, Safalaoh (2006) recorded lower feed consumption of broilers fed diets supplemented with EM (at the rate

of 1ml/liter of drinking water) as compared to the groups placed on the control treatment. The results of this study disagree with that of Botlhoko (2009) who reported increased feed consumption and digestibility of nutrients and availability of energy by broilers to an age of 21 days with the administration of EM. The results of this study also disagree with that of Rahimi ( 2009) who reported higher level of feed consumption of broilers fed on feed containing EM in a form of probitic (Bio-Plus 2B® ).

Table 9. Weekly feed consumption (gm/head) of experimental pullets placed on different levels of Effective Microorganisms.

| 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 |
| Week23 | 653.45 | 631.05 | 577.50 | 642.95 | 12.33 | >0.05 |
| Week24 | 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, $T_2$ = 4ml of EM/lit of water, $T_3$ = 8ml of EM/lit of water; $T_4$ = 12ml of EM/lit of water.

The mean weekly body weight gain of the experimental pullets placed on the experimental treatments is shown in Table 10. 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 during the last 4 weeks was significantly (P<0.05) lower than the groups placed on the treatment 8 ml of EM/liter drinking water ($T_3$). There was no significant difference between the treatment groups assigned to 4 – 12 ml/liter of

drinking water in weekly body weight gain at any time of the feeding trial. The results of this study showed that, there has been no significant difference (p>0.05 between all the treatment groups in feed conversion efficiency (Table 11). However, the groups placed on the control treatment tended to have poor feed conversion efficiency than the all the others.

Table 10. Weekly cumulative body weight gain (gm/head) of pullets placed on different levels of Effective Microorganisms.

| 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 | $453.22^b$ | $556.31a^b$ | $615.34^a$ | $581.26a^b$ | 16.94 | <0.05 |
| Week 22 | $528.39^b$ | $629.04^{ab}$ | $699.14^a$ | $654.05^{ab}$ | 17.30 | <0.05 |
| Week23 | $600.45^b$ | $705.95^{ab}$ | $776.20^a$ | $729.15^{ab}$ | 17.59 | <0.005 |
| Week24 | $672.62^b$ | $780.55^{ab}$ | $847.08^a$ | $799.95^{ab}$ | 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, $T_2$ = 4ml of EM/lit of water, $T_3$ = 8ml of EM/lit of water; $T_4$ = 12ml of EM/lit of water.

Table 11. 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 |
| Week23 | 9.08 | 8.22 | 7.51 | 8.67 | 0.50 | >0.05 |
| Week24 | 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; Means in a row without superscripts are statistically not significant (p>0.05); $T_1$ = control, $T_2$ = 4ml of EM/lit of water, $T_3$ = 8ml of EM/lit of water; $T_4$ = 12ml of EM/lit of water.

### 4.2.2 Production performance of the laying flock

### 4.2.2.1 Feed consumption of layers

The mean weekly feed consumption of the experimental layers is shown in Table 12. There was no significant (p>0.05) difference between all the treatment groups of layers in weekly feed consumption but the groups placed on the control treatment tended to consume more than the others groups, Similar trend was 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.

Table 12. Mean weekly feed consumption of layers placed on different levels of EM (gm/head)

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | s.e. | p-value |
|---|---|---|---|---|---|---|
| Week25 | 694.05 | 649.95 | 634.55 | 653.10 | 22.1911 | >0.05 |
| Week26 | 707.70 | 657.30 | 648.90 | 657.30 | 23.1671 | >0.05 |
| Week27 | 758.80 | 667.10 | 690.55 | 667.80 | 62.8036 | >0.05 |
| Week28 | 811.30 | 709.10 | 679.35 | 681.10 | 42.2117 | >0.05 |
| Week29 | 832.65 | 773.15 | 753.20 | 714.00 | 31.9779 | >0.05 |
| Week30 | 847.35 | 814.10 | 776.65 | 751.45 | 23.2298 | >0.05 |
| Week31 | 864.85 | 834.05 | 795.90 | 767.55 | 21.3528 | >0.05 |
| Week32 | 868.70 | 850.50 | 813.05 | 788.90 | 19.4594 | >0.05 |
| Week33 | 874.65 | 859.95 | 816.20 | 798.00 | 18.1224 | >0.05 |
| Week34 | 882.70 | 869.40 | 823.90 | 815.15 | 17.5796 | >0.05 |
| Week35 | 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 |
| Week37 | 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; Means in a row without superscripts are statistically not significant (p>0.05); $T_1$ = control, $T_2$ = 4ml of EM/lit of water, $T_3$ = 8ml of EM/lit of water;  $T_4$ = 12ml of EM/lit of water.

### 4.2.2.2 Egg Production Performance

The results of egg production performance of the experimental chickens are shown in Table 13.  Age at 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 first egg. All the treatment groups seem to be slightly late in sexual maturity, probably attributed to higher body weight attained during the growing period. Referring to Table 13, the results obtained showed that the egg production performance of all the treatment groups was low by any standard particularly during the first 3 weeks of the feeding trial. The overall mean weekly egg production 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).

There was no statistically significant difference(P<0.05) the groups placed on control treatment and the treatment containing 8 ml of EM/liter of drinking water in mean weekly egg production. Surprisingly the mean weekly egg production of the groups placed on the treatment containing 12 ml of EM/liter of drinking water was significantly lower than all the others(P<0.05). The groups placed on the treatment containing 4 ml of EM/liter of drinking water 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, followed by the groups assigned to the control treatment   (0.52 egg/head/day).   The results obtained tends to indicate 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. Unfortunately however, the administration of 8 - 12 ml of EM/liter of drinking water tended to depress daily egg production. Moreover, the results of egg mass analysis (Table 13)  showed that egg mass production per week per bird (the weight of eggs produced per week per bird measured in gram) was largest for the groups assigned to the treatment containing 4 ml of EM/liter of drinking water than all the others(P<P0.05). There was no significant different between all the others   (P>0.05) in weekly egg mass production/ bird.

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  100mg/ 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 150mgkg−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 1100ppm Lactobacillus was significantly    higher than that of the control (P<0.05).

Table 13. Weekly egg production (eggs/week/bird) performance of the experimental layers placed on different levels of Effective Microorganisms. .

| 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 |
| Week25 | 0.30 | 0.34 | 0.34 | 0.24 | >0.05 | 42.84 |
| Week26 | $0.75^{ab}$ | $1.09^a$ | $0.75^{ab}$ | $0.38^b$ | <0.05 | 20.17 |
| Week27 | $1.54^{ab}$ | $1.96^a$ | $1.54^{ab}$ | $0.88^b$ | 0.1 | 22.83 |
| Week28 | $2.08^a$ | $2.38^a$ | $2.08^a$ | $1.13^b$ | <0.005 | 5.82 |
| Week29 | $2.42^b$ | $3.13^a$ | $2.50^b$ | $1.59^c$ | <0.05 | 9.32 |
| Week30 | $2.54^b$ | $3.46^a$ | $2.55^b$ | $2.05^c$ | <0.005 | 5.88 |
| Week31 | $2.96^{ab}$ | $3.46^a$ | $2.71^b$ | $2.21^b$ | <0.05 | 9.95 |
| Week32 | $3.00^b$ | $3.55^a$ | $2.59^b$ | $2.38^c$ | <0.005 | 4.53 |
| Week33 | $3.30^{ab}$ | $3.55^a$ | $2.84^{bc}$ | $2.42^c$ | <0.05 | 6.00 |
| Week34 | $3.38^a$ | $3.67^a$ | $2.96^b$ | $2.63^b$ | <0.01 | 4.48 |
| Week35 | $3.42^{ab}$ | $3.71^a$ | $3.09^{bc}$ | $2.67^c$ | <0.05 | 5.53 |
| Week36 | $3.46^{ab}$ | $3.88^a$ | $3.17^{bc}$ | $2.84^c$ | <0.05 | 4.84 |
| Week37 | $3.63^b$ | $4.13^a$ | $3.34^{bc}$ | $3.05^c$ | <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, $T_2$ = 4ml of EM/lit of water, $T_3$ = 8ml of EM/lit of water; $T_4$ = 12ml of EM/lit of water.

Table 14. Weekly egg mass (gm/bird/week) of layers placed on different levels of Effective Microorganisms.

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | p-value | CV |
|---|---|---|---|---|---|---|
| Week25 | 14.17 | 16.12 | 16.66 | 10.68 | >0.05 | 42.23 |
| Week26 | 38.64[ab] | 53.96[a] | 38.99[ab] | 19.65[b] | <0.05 | 18.46 |
| Week27 | 82.18[ab] | 103.80[a] | 81.10[ab] | 46.68[b] | 0.05 | 22.68 |
| Week28 | 113.50[a] | 126.52[a] | 111.28[a] | 61.55[b] | <0.005 | 6.13 |
| Week29 | 133.94[b] | 169.36[a] | 134.20[b] | 87.67[c] | <0.01 | 8.21 |
| Week30 | 143.71[b] | 188.75[a] | 135.49[b] | 111.37[c] | <0.005 | 4.28 |
| Week31 | 167.61[ab] | 189.11[a] | 142.21[b] | 119.79[c] | <0.05 | 10.76 |
| Week32 | 171.38[ab] | 201.19[a] | 145.19[b] | 134.23[c] | <0.05 | 5.85 |
| Week33 | 190.13[ab] | 203.98[a] | 162.23[bc] | 138.82[c] | <0.05 | 7.20 |
| Week34 | 179.98[ab] | 214.65[a] | 173.25[bc] | 154.49[c] | <0.05 | 5.46 |
| Week35 | 200.80[ab] | 217.49[a] | 181.70[bc] | 158.78[c] | <0.05 | 6.26 |
| Week36 | 206.49[ab] | 229.88[a] | 191.15[bc] | 171.16[c] | <0.05 | 5.43 |
| Week37 | 219.85[b] | 248.84[a] | 204.20[bc] | 186.13c | <0.05 | 4.64 |
| Average | 144.64[b] | 166.41[a] | 132.84[c] | 107.78[d] | <0.001 | 2.95 |

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

### 4.2.2.3 Feed conversion ratio

The feed conversion ratio of the experimental layers is shown in Table 15 and 16. The amount of feed (Kg) consumed/ kg or /dozen of eggs produced was lowest for the groups assigned to the treatment containing 4 ml of EM/liter of drinking water followed by the groups placed on control treatment and the treatment containing 8 ml of EM/liter of drinking water respectively. According to the results of this study, the groups placed on the treatment containing 4ml 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 18).

At present EM is already commercialized, 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 4ml of EM could safely be offered for 4 laying hen/day and. worth's 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 4ml of EM/liter of water worth's 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 agree 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. He reported 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.  Anderson and Davis (2002) also reported relatively higher cost of egg production with the use of EM in feed.

Table 15. Feed conversion ratio (Kg/Kg of  egg mass) of  the  layers placed on different levels of EM

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | p-value | CV |
|---|---|---|---|---|---|---|
| Week25 | 59.01 | 43.63 | 40.55 | 64.09 | >0.05 | 43.80 |
| Week26 | 19.09[a] | 12.27[a] | 16.915[a] | 33.57[b] | <0.05 | 19.19 |
| Week27 | 10.14 | 6.43 | 8.69 | 15.37 | >0.05 | 37.44 |
| Week28 | 7.64[a] | 6.74[a] | 6.11a | 11.23[b] | <0.05 | 13.67 |
| Week29 | 6.535[b] | 5.34[a] | 6.12b[a] | 10.01[c] | <0.005 | 5.52 |
| Week30 | 6.09[b] | 4.50[a] | 5.94[b] | 7.18[c] | <0.05 | 6.55 |
| Week31 | 5.28[ab] | 4.53[a] | 6.67[b] | 6.77[b] | >0.05 | 11.697 |
| Week32 | 5.13[ab] | 4.27[a] | 5.92[ab] | 6.01[b] | <0.05 | 7.83 |
| Week33 | 4.65 | 4.22 | 5.07 | 5.82 | >0.05 | 9.37 |
| Week34 | 4.47 | 4.05 | 4.76 | 5.29 | >0.05 | 7.23 |
| Week35 | 4.46 | 4.01 | 4.63 | 5.23 | >0.05 | 8.54 |
| Week36 | 4.36 | 3.83 | 4.40 | 4.90 | >0.05 | 6.86 |
| Week37 | 4.130[ab] | 3.56[a] | 4.180[b] | 4.56[b] | <0.05 | 5.07 |
| Average | 5.77[b] | 4.77[c] | 5.77[b] | 7.00[a] | <0.005 | 2.93 |

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

Table 16. Feed conversion ratio (Kg/ dozen of eggs) of the layers placed on different levels of Effective Microorganisms

| Age | $T_1$ | $T_2$ | $T_3$ | $T_4$ | p-value | CV |
|---|---|---|---|---|---|---|
| Week25 | 35.29 | 24.89 | A 24.54 | 38.97 | >0.05 | 44.21 |
| Week26 | 11.96$^a$ | 7.33$^a$ | 10.55$^a$ | 21.24$^b$ | <0.05 | 20.71 |
| Week27 | 6.51 | 4.09 | 5.49 | 9.80 | >0.05 | 36.95 |
| Week28 | 4.99$^a$ | 4.31$^a$ | 3.92$^a$ | 7.37$^b$ | <0.05 | 13.87 |
| Week29 | 4.34$^b$ | 3.48$^a$ | 3.94$^{bc}$ | 6.65$^c$ | <0.005 | 5.74 |
| Week30 | 4.13$^{ab}$ | 2.95$^a$ | 3.80$^b$ | 4.72$^b$ | <0.05 | 8.59 |
| Week31 | 2.97$^{ab}$ | 3.58$^a$ | 4.40$^b$ | 4.42$^b$ | >0.05 | 11.79 |
| Week32 | 3.52$^{ab}$ | 2.91$^a$ | 3.99$^b$ | 4.08$^b$ | <0.05 | 6.92 |
| Week33 | 3.22$^{ab}$ | 2.92$^a$ | 3.48$^{ab}$ | 4.03$^b$ | >0.05 | 9.08 |
| Week34 | 3.14$^{ab}$ | 2.85$^a$ | 3.35$^{ab}$ | 3.74$^b$ | >0.05 | 7.39 |
| Week35 | 3.14$^{ab}$ | 2.82$^a$ | 3.27$^{ab}$ | 3.75$^b$ | >0.05 | 9.47 |
| Week36 | 3.12$^{ab}$ | 2.73$^a$ | 3.19$^{ab}$ | 3.58$^b$ | >0.05 | 7.65 |
| Week37 | 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, $T_2$ = 4ml of EM/lit of water, $T_3$ = 8ml of EM/lit of water; $T_4$ = 12ml of EM/lit of water.

**4.2.2.4 Egg quality, fertility and hatchability**

The results of the egg quality parameters of the eggs collected from the experimental layers are shown in Table 17.  There was no significant (p>0.05) difference between all the treatment groups in all the parameters considered except in Hough unit and Yolk   and Albumen height. There was no statistically significant difference between the eggs collected from the groups placed on different level of EM administered /liter of drinking

water in Hough unit and yolk and albumen height. On the other side, the Hough unit, yolk and albumen height recorded from eggs collected from the groups placed on the control treatment ($T_1$), were significantly lower than that recorded from the eggs collected from all the others.

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Table 17. Quality, fertility and hatchability of eggs collected from the layers assigned to different levels of EM.

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | 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 (gm) | 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 (gm) | 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 (gm) | 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 (gm) | 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, $T_2$ = 4ml of EM/lit of water, $T_3$ = 8ml of EM/lit of water; $T_4$ = 12ml of EM/lit of water.

The results of this study showed that there was significant improvement in egg quality (Hough unit, yolk and albumen height) with the administration of 8 - 12 ml of EM/liter of drinking water. 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- 750 mg of EM /kg of feed. As shown in Table 18, 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 by (CACC 2003 and 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.

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. The results of this study agrees with that of Meseret (2010), who reported that the mean percent total hatchability calculated for the indigenous chickens of the Gomma Wereda was 22%, the value of which is lower than those reported from different parts of Ethiopia, with the exception of that of Jimma (Brännänng and Pearson, 1990; Tadelle and Ogle, 1996 and Mekonnen, 2007). In a trail in which, eggs randomly purchased from Gamma Wereda market places were 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 (number of fertile eggs that hatched in to normal chick) recorded from both market and freshly collected eggs in Gomma Wereda were very low (Meseret 2010).

Table 18. Partial budget analysis of experiment one and two placed on different level of Effective Microorganisms (currency in Ethiopian Birr, ETB).

| Trt/parameters | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Partial budget analysis for experiment one | | | | |
| Total cost/T | 637.49 | 700.48 | 714.07 | 736.49 |
| Total income/T | 1213.33 | 1423.33 | 1350.00 | 1233.33 |
| Net return/T | 575.85 | 722.85 | 635.93 | 496.84 |
| Net return over the control | - | 147.00 | 60.08 | -79.01 |
| Partial budget analysis for experiment two | | | | |
| 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

# 5. SUMMARY AND CONCLUTION

Feed additives potentially improve productivity and health of chickens. This project was proposed to evaluate one of widely known additives, Effective microorganisms, to improve production and reproduction constraint of Rhode Island Red chickens. For experiment one, EM solution was rated at 0, 4, 8 and 12 ml per drinking water. Body weight gain, fed consumption feed conversion ratio; survival and cost benefit of growers were measured to evaluate EM for grower RIR chicks. For experiment two, EM solution was rated at 0, 4, 8 and 12 ml per drinking water. Pullet growth, feed consumption, feed conversion ratio age at maturity, egg production, feed consumption, feed conversion ratio/egg mass and dozens of egg and cost benefit were analyzed to evaluate the EM effect.

The result of this study showed that EM could improve production and reproduction performance of RIR chicken. Even though, the three EM treatment levels (4ml, 8ml, and 12ml) showed their own merits to improve overall performance of RIR growers, based on key parameters (survival rate, feed cost, EM cost and profit) treating chickens with different rate of EM based on their age is recommendable.

Due to lack of difference in survival rate after eight week of growers and insignificant feed intake, feed conversion efficiency and age at maturity, treating pullets between 8weeks up to 15 days before maturity for egg lay could not be economically feasible due to unreasonable EM cost.

Even though, better egg quality and lower feed consumption were obtained from 8ml EM/lit of water treated groups, due to higher egg production, FCR/dozen of egg, FCR/kg of egg mass and highest profit, 4ml treatment could provide better production and economic value than any of the treatment levels

Therefore, the following recommendations could safely be suggested based on the finding.

➢ Since $T_4$ showed highest feed conversion ability for the first week and high percent survival between day-old to four weeks age, 12ml of EM/lit of chlorine free water (or spring or dug well water) is recommendable for this age group.

➢ Due to lack of significant difference for the EM treated groups ($T_2$, $T_3$ and $T_4$) between four and eight week age 4ml of EM would be economical for this age groups in a chlorine free water (or spring or dug well water).

➢ Since there was insignificant survival difference between all treatment groups ($T_1$, $T_2$, $T_3$ and $T_4$) after eight week it is economical to terminate EM provision for chicks,

➢ Since EM showed insignificant difference for pullet it is economical not to provide EM for this age group. However 4ml of EM/lit 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 end of production period would be economical.

➢ Since weight gain of female RIR growers performed better at 8 ml of EM/lit of water while male RIR grow best at 12ml of EM/lit water. There need further investigation to determent the levels for broiler type breeds.

➢ Even though EM is found at low cost (20 ETB/lit) it is imported from abroad, there for it need to investigate effective microbes (EM) from country environment for a sustainable and economically efficient use of EM.

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