Effect Of Effective Microorganism (EM) On The Nutritive Quality Of Coffee Husk Silage

Yonatan Kassu, Solomon Demeke, TayeTolemariam, YehenewGetachew

Abstract: the experiment was conducted to study the effect of Effective Microorganisms (EM) on the nutritive quality of coffee husk silages. Eight treatment silages were produced by ensiling chopped grass hay in combination with 10, 20, 30 and 100% of dry processed coffee husk with and without the use of EM as biological inoculants. The nutritive quality of the treatments silage was evaluated on the basis of fermentation characteristics, chemical composition and in-vitro dry matter digestibility. The results obtained showed that the best silages were prepared by ensiling pure coffee husk and chopped grass hay in combination with 30% coffee husk with the use of EM as measured by visual appraisal and pH value. The pH value (4.2) obtained from the treatment silage containing 100% coffee husk with the inoculation of EM is significantly lower (P< 0.001) than that of all the others and similar to the acidity limit recommended for good quality silage. According to the results of the laboratory chemical analysis, there was significant improvement in the total ash, ether extract(EE) and crude protein(CP) content of pure coffee husk ensiled with the use of EM. The EE and CP content of the 100% coffee husk tended to decrease when it ensiled with grass hay. On the contrary, there was significant (P<0.001) decrease in cell wall (NDF, ADF and hemicelluloses) content of pure coffee husk ensiled with the use of EM as biological inoculants'. The results obtained also showed that there was significant reduction (P<0.001) in the anti-nutritional factors content (lignin, caffeine and condensed tannin) of pure coffee husk ensiled with the use of EM. Moreover there was significant improvement (P<0.001) in in-vitro dry matter digestibility of coffee husk ensiled with the EM. From the result its shows clearly that there was substantial improvement on nutritive quality of coffee husk when treated withEM. However, the output of the current result on the performance of the animal seems to be the future direction of intensive research.

Index Terms: Anti-nutritional factors, chemical composition, coffee husk, EM, grass hay, IVDMD

1. Introduction

One of the major constraints to animal production in Ethiopia is inadequate nutrition. Animals are normally fed on natural pasture and crop residues of low feeding value. Efficient utilization of agricultural and agro-industrial by-products for animal feeding could improve the nutritional status [1]. Coffee is an agricultural crop of significant economic importance in Ethiopia. About 600,000 hectares of the country's agricultural land is planted to coffee and mean national annual coffee production is estimated at 350,000 tons [2] from these About 143,500 tons of coffee by-product was estimated to be generated from coffee processing in the year 2009 in Ethiopia. At present small amount of coffee is used as fertilizer and source of fuel whereas, large quantities of the by-product are accumulated at the production site warranting disposal and environmental problems. Currently coffee pulp constitute a source of serious contamination and environmental problem which due to bulkiness and lack of technology eventually end up in polluting rivers, generating offensive odors and encouraging proliferation of flies and causing disease. Thus, the use of coffee husk as animal feed has significant economic and environmental implication in Ethiopia.

- *Yonatan kassu*
- *Department of Animal and Range Science*
- *WolaitaSodo University; Ethiopia*
- *Kassuyonatan@gmail.com*

Unfortunately Coffee husk is fibrous, high in cell wall components, low feed intake and poor in feeding value, protein digestibility and nitrogen retention are the major factors limiting the use of coffee husk as animal feed [3]. These effects appear to be due to the presence of caffeine, tannins and other polyphenols in coffee husk. Three factors appear to be important in relation to caffeine and effects observed in various animals: the relatively high concentration of nitrogen in caffeine; its known effect of stimulating increased activities and its diuretic effect [4]. The anti-nutritional effects of tannins are associated with their ability to combine with dietary protein, cellulose, hemicellulose, pectin and mineral retarding their digestion and utilization [5]. Coffee husk could best considered as a possible feed ingredient for ruminant animals if these anti-physiological factors are eliminated or at least neutralized [6]. It was reported that silages treated with microbial inoculants exhibited improvement in chemical composition [7]; [8].by signifying this Effective Micro-organisms (EM) couldbetter be used as biological inoculant's to improve the nutritive quality and value of conventional (high fiber feed stuffs) and non-conventional feed stuffs (high anti-nutrition content and fiber) like coffee pulp, husk, cassava and most root and tuber crops, etc. EM 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 [9]. Microorganisms in EM assist one another for survival in a food chain system and thereby form a synergy that fights off pathogens and rotting microorganisms.EM is self-sterilizing(pHbetween3.4-3.7); therefore, pathogens cannot survive in EM [10].Photosynthetic bacteria are independent self-supportingmicroorganisms. These bacteria synthesize useful substances from secretions of roots, organic matter and/or harmful gases (example, hydrogen sulfide) by using sunlight as sources of energy.

Fig 1. Accumulation of Coffee husk in the production site

Theuseful substances comprise of amino acids, nucleicacids, bioactive substances and sugars, all of whichpromote plant growth and development. Thesemetabolites act as substrates for bacterial growth. Thus,increasing photosynthetic bacteria, which enhance othereffective microorganisms [9]. Lactic acidbacteria produce lactic acid from sugars, and othercarbohydrates produced by Photosynthetic bacteria andyeast. Thus, food and drinks, such as yogurt and pickleshave been made by using Lactic acid bacteria for a longperiod of time. However, lactic acid is a strong sterilizer. Itsuppresses harmful microorganisms and increases rapiddecomposition of organic matter. Moreover; Lactic acidbacteria enhance the breakdown of organic matter suchas lignin and cellulose, caffeine, condensed tannin and ferment these materialswithout causing harmful influences arising from undecomposedorganic matter [11],[12]. Theyeaststhat are present in effective microorganisms have a wide range of functions.They produce antimicrobialsubstances to kill off all harmful pathogens. In addition,they also produce beneficial substances, such ashormones,enzymes and vitamin B. Their secretions areuseful substrates for effective microorganisms such aslactic acid bacteria and actinomycetes. Yeasts synthesizeantimicrobial and useful substances from amino acidsand sugars secreted by photosynthetic bacteria, organicmatter and etc. Actinomycetes, the structure of which isintermediate to that of bacteria and fungi, producesantimicrobial substances from amino acids secreted byphotosynthetic bacteria and organic matter. Theseantimicrobial substances suppress harmful fungi andbacteria. Actinomycetes can co-exist with photosyntheticbacteria. Thus, both species enhance the quality of thesoil environment, by increasing the antimicrobial activityof the soil [9]. Fermenting fungi such asAspergillus and Penicillium decompose organic matterrapidly to produce alcohol, esters and antimicrobialsubstances. Thesesuppress odors and preventinfestation of harmfulinsects and maggots. Eachcomponent of effective microorganisms (photosyntheticbacteria, lactic acid bacteria, yeasts, actinomycetes andfermenting fungi) has its own important function.However, photosynthetic bacteria are the pivot of EMactivity. Photosynthetic bacteria support the activities ofother microorganisms. On the other hand, photosyntheticbacteria also utilize substances produced by othermicroorganisms. This phenomenon is termed"coexistence and co-prosperity". EM products that are ofimportance for poultry production are Stock EM,Multiplied EM and Bokashi (solid form of EM). Stock EMis the basic, concentrated EM solution that contains allthe beneficial microorganisms. EM Bokashi is an essential supplement feed for animalsand is made from 1 to 2% Multiplied EM, 1% molassesand 98% water, which is then added to organic feedmaterials which could be wheat bran or rice husk. It has various applications, but is mostly used as a form of animal feed [13]. The EM technology is found to be useful in a wide variety of fields. Studies conducted in Asia [14] and in Belarus [15] reported the successful use of EM in poultry feeding. also EM was reported to be positivelyimpact onimproving the nutrient content of feed stuffs productive performance of chicken in Ethiopia [11],[16]and in swine and fish farms in Austria [15]. The present study was therefore conducted to evaluate the effect of effective microorganism (EM) on the nutritive quality and anti-nutritional factor of coffee husk silage.

2. Material and Methods

2.1. Preparation of the silages

Coffee husk were collected fromGommaWeredacoffee processing station of Jimma zone and transported to Jimma University. Adequate quantities of grass hay (natural pasture of mixed grass species dominated by *Hyperchenniahirta* harvested at late stage of heading) were chopped using manually operated chopper.EM was prepared by thoroughly mixing one liter of EM solution with one liter of molasses and 18 liters of chlorine free water. The coffee husk with 10, 20, 30 and 100% level combination with chopped grass hay with and without the addition of EMwere thoroughly mixed(eight treatment silages as shown in table 1) and ensiled in plastic containersmade airtight during a period of 30 days fermentation process.

Table 1. Composition of the treatment silages

	Treatments							
	T1	T2	T3	T4	T5	T6	T7	T8
EM	+	+	+	+	-	-	-	-
CH %	10	20	30	100	10	20	30	100
hay%	90	80	70	-	90	80	70	-

+= inoculated with EM, - indicates ensiled without EM

2.2. Chemical analysis

All the silages were evaluated for quality on the basis of visual appraisal and pH value. The pH values of the treatment silages were determined by potentiometer measurement (pH meter) of the extract [17]. Chemical analysis were followed by in-vitro dry matter digestibility (IVDMD) determination. Representative samples of one kg were taken from each of the silages. These were dried in an oven at 65 °C for 72 hours. The dried materials were ground to pass through 1 mm sieve in a Wiley mill and stored in polyethylene bags until required for chemical analysis and in-vitro dry matter digestibility determination [18]. Dry matter, crude protein, ether extract and ash content were determined using methods of AOAC manual [18]. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin were determined according to [19] .Condensed tannin (CT) was determined according to the method developed by [20]. Caffeine was extracted as in[21] and the concentration was measured using HPLC at 274nm.

2.3. In-Vitro Dry Matter Digestibility (IVDMD)

One gram dried and ground sample taken from each treatment silages were used for the determination of IVDMD according to procedures of [22]. The rumen fluid was obtained from an annulated steer fed on a roughage diet. DM residue was determined after 96 hours of digestion, followed by ashing of the residue to determine IVDMD.

2.4. Data Analysis

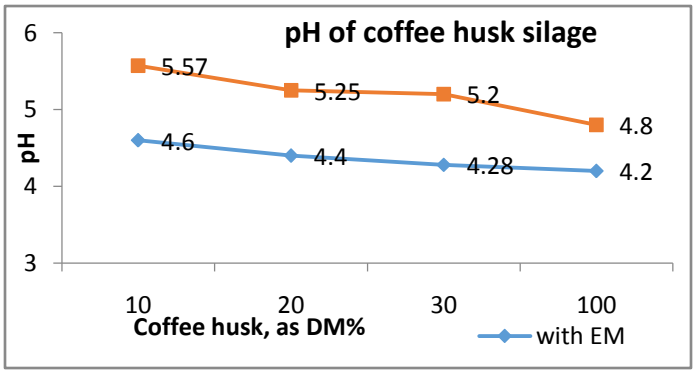
Statistical software [23] was used to analyze the data.Differences between treatment means were separated by Least Significant Difference (LSD) when the F value showed significant differences.

3. Results and Discussion

3.1. Silage Quality

The pH values, chemical composition and in-vitro dry matter digestibility of the treatment silages are shown in Table 2. The results of the visual appraisal (smell and color) showed that T2, T3 and T4 shows goodquality silages by use of EM as biological inoculants. These results in agree with that of [1] who reported that the dark brown appearance and color of coffee pulp silages are an indicator of silage which have undergone adequate anaerobic fermentation.According to Table 2 and Figure 1, the pH values recorded from all the treatment silages ranged between 4.2and 5.5. The mean pH value of the silage treatments produced by ensiling coffee husk and coffee husk in combination with chopped grass hay with the use of EM as biological inoculant was significantly lower (P<0.01) than those ensiled without the use of EM. The range of pH values obtained from the treatment silages containing EM (4.2-4.5) was lower and narrower than the pH range obtained from the treatment silages without EM (4.8-5.5), showing that the use of EM as biological inoculant in silage preparation facilitates the fermentation of fibrous feed materials. It is accepted that a pH value of 4.5 is an indicator for the occurrence of adequate anaerobic fermentation during silage preparation [24]. Low pH values (<4.5) are believed to increase chemical hydrolysis of the ensiled fibrous polysaccharides [25]. According to the results of the current study, pH values of 4.2 and 4.8 were recorded from T4 and T8 respectively. The pH value (4.2) obtained fromT4 which have EM as biological inoculants was found to be in agreement with the acidity limits (4.2) of good silage characteristics as in [1]; [24]; [26].

Fig. 2. pH value of EM ensiled coffee husk silage



3.2. Chemical Composition

Chemical composition of the treatment silages are shown in Table 2. T8 had statistical low significantly (P<0.05) total ash content (8.15%). the total ash contents increased because of dilution of coffee husk with different levels of chopped grass hay and due to the effect of EM (P<0.001). the treatment silages inoculated with EM shows an increment in the total ash content due to the influence of three different factors that are the presence of molasses reported to havehigh levels of minerals, fermentation losses in organic matter, and the presence of mold in the top surface of the silos.Likewise, there was a tendency to increase/or improvement in the crude protein content (CP)T1, T2, T3 and T4 as a result of EM inoculation (P<0.001). The crude protein increase as the coffee husk inclusion rate increased. The highest percentage composition of crude protein (12.3-13%) was obtained from T3 and T4 respectively.

Table 2. Chemical composition and in-vitro dry matter digestibility of the coffee husk and hay combination treatment silages

Variable	With EM				Without EM					Effects		
	T1	T2	T3	T4	T5	T6	T7	T8				
Treatments												
CH%	10	20	30	100	10	20	30	100	SE	EM	CH	EM*CH
pH	4.56^{dc}	4.41^{de}	4.28^{e}	4.22^{e}	5.57^{a}	5.25^{b}	5.25^{b}	4.81^{c}	0.07	<.0001	0.0002	0.0336
DM	90.95^{d}	90.70^{e}	90.74^{e}	91.19^{c}	91.40^{b}	90.89^{de}	91.14^{c}	91.66^{a}	0.08	<.0001	<.0001	0.2136
Ash	8.53d^{e}	8.90^{b}	8.75^{cb}	8.54^{de}	8.67^{cd}	8.47^{e}	8.49^{e}	8.15^{f}	0.05	0.0001	0.0004	0.0011
CP	11.1^{abcd}	11.7^{abc}	12.3^{ba}	13.0^{a}	9.25^{c}	9.90^{cd}	10.4^{bcd}	10.9^{abcd}	0.69	0.0066	0.1701	0.9963
EE	2.61^{bc}	2.99^{ba}	3.26^{a}	3.47^{a}	1.81^{d}	2.32^{cd}	2.37^{c}	2.47^{bc}	0.15	<.0001	0.0087	0.7716
NDF	60.16^{de}	58.65^{e}	54.92^{f}	50.39^{g}	68.30^{ab}	66.24^{bc}	65.02^{c}	61.32^{d}	0.82	<.0001	<.0001	0.2182
ADF	45.84^{d}	47.27^{cd}	45.84^{d}	41.63^{e}	53.91^{a}	53.60^{a}	52.32^{ab}	49.53^{bc}	0.60	<.0001	0.0101	0.8036
H-cellul.	14.32^{ba}	11.38^{bcd}	9.08^{cd}	8.76^{d}	14.39^{ab}	12.64^{abc}	12.70^{abc}	11.80^{abc}	0.52	0.0497	0.432	0.4863
Lignin	9.26^{c}	8.71^{d}	8.22^{e}	7.06^{f}	10.46^{b}	10.21^{b}	9.10^{c}	8.27^{e}	0.38	<.0001	<.0001	0.1179
Caffeine	0.03^{ef}	0.04^{ed}	0.10^{c}	0.18^{b}	0.06^{de}	0.07^{d}	0.18^{b}	0.75^{a}	0.01	<.0001	<.0001	<.0001
CT	0.23^{f}	0.34^{e}	0.37^{de}	0.45^{c}	0.35^{e}	0.43^{cd}	0.61^{b}	2.10^{a}	0.02	<.0001	<.0001	<.0001
IVDMD	55.11^{b}	54.77^{b}	55.45^{b}	48.16^{c}	53.50^{b}	54.12^{b}	49.21^{c}	37.75^{d}	1.04	0.0003	<.0001	0.0077

Data expressed as % DM basis except pH and DM. abcd means with different superscripts letter are different at P<0.05. CoH= coffee husk, CP=Crude Protein, EE=Ether Extract, NDF=Neutral Detergent Fiber, ADF=Acid Detergent Fiber, H-cellul. =Hemi-cellulose, CT= Condensed Tannin, IVDMD=In-vitro Dry matter Digestibility

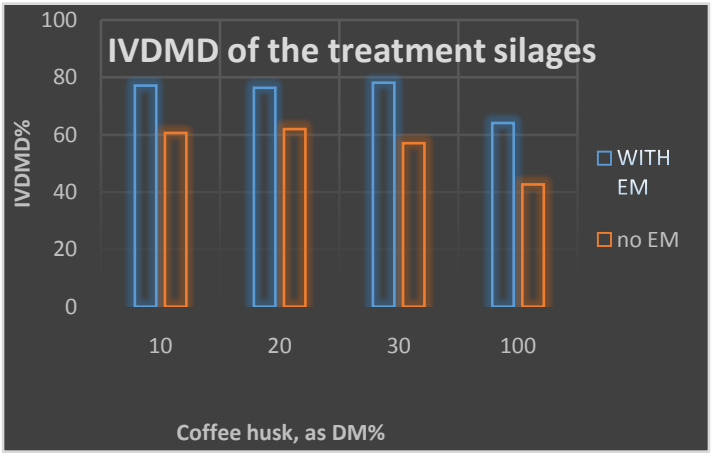
The improvement in crude protein content of the treatment silages produced with the use of EM is attributed to bacterial growth during anaerobic fermentation. The microbes which found in the EM efficiently utilize the carbohydrate found on the coffee husk so that the natural microbes synthesis protein by breaking down the carbohydrate and generates energy to synthesis protein and these tends to leads in reduction in the concentration of cellulose. The percentage composition of fat or ether extract (EE) of T4 (100% coffee husk) tended to increase with EM inoculation (P<0.001) by the mechanism the microbial growth whichhave a tendency increase the fat content from their metabolism product which eventually resulted in higher fat contents of the ensiled silage. The cell wall component (NDF, ADF and hemicellulose) of the treatment silages with increased proportion of coffee husk designating that the chopped grass hay is higher in cell wall components than that of the wet processed coffee pulp [11]. Thetreatment silage NDF, ADF, lignin (P<0.001) and hemicellulose content significant decrease (P<0.05) respectively as the result of EM inoculation but significant increase in NDF (P<0.001), ADF (P< 0.01), lignin (P< 0.001) and hemicellulose (P<0.05) due to dilution with chopped grass hay. T4 silage composition of NDF and ADF were (50.39 and 41.63%) were significantly lower (P<0.05) than that of T8 silages (61.32 and 49.53%) respectively. Which enhanced and lowered in the NDF and ADF content by EM inoculation by 18 and 16 % respectively. A decrease in NDF and ADF content of the silage could be attributed by first addition of molasses in the silage (in these study it was used as a starting additive for EM multiplication and activation) increase the number of anaerobic bacteria, including the lactic acid bacterium; therefore, the NDF and ADF degradation of silage increases. Second a decrease take place because of lower ADF content of the molasses or the additives [27]. This infers that microbes or (EM) uses the cellulose content of the coffee husk better than, other nutrients; especially lacticacid bacteria: *Lactobacillus plantarum; L.casei; Streptococcus Lactis* which are the major dominant in the EM compositionwhich could utilize extensively the cellulose. Application of EM inoculates on in fibrous feed stuffs increase the quality of the silage by decreasing silage fibrous (NDF and ADF) content [9]. Lignin is resistant to both mammalian and microbial enzymatic degradation and renders the other cell wall components of feed materials, particularly cellulose and hemicelluloses indigestible based on degree of lignification. The EM treated treatmentsilage were have lower hemicellulosescontent (8.76%) when compare to T8 (11.80%) which are statistically significantly difference (P<0.05) by 26%. The lignin content of the treatment silage decline in both with and without EM inoculants treatment silage as the inclusion rate of coffee husk increase (P<0.001). The lignin content of T4 are lower than that of T8 by 7.06 % which is significantly lower at (P<0.05). The lower pH of the silage, increase the hydrolysis of the fibrous content of the treatment silage increase. The result agrees to the finding of [25]which find out a lower pH levels increase chemical hydrolysis of some polysaccharides, which can reduce the fiber content of the ensiled forage.Moreover, the NDF, ADF, hemicellulose and lignin percentage increase with an increase in the inclusion of chopped grass hay. These are due to the coffee husk have been lower fiber content than the most tropical hay. However, the caffeine and condensed tannin content of the treatment silages were increase as the level of coffee husk increase. Table 2 shows that caffeine and condensed tannin content of T4 showed significant decrease (P< 0.001) after ensiled with EM as well as grass hay at (P<0.001) and the interaction effect of the two factors were significant (P< 0.001). The content of caffeine and condensed tannin are of interest in terms of the potential use of coffee husk as animal feed. According to the results of current study0.75% of caffeine was turn out to be from T8 (100% coffee husk) ensiled without EM and 0.18% recorded from T4 (100% coffee husk) ensiled with EM, which was significantly lowered by 76% (P<0.05) when compare to silage ensiled without EM. In addition to this there wassignificant reduction in caffeine content of coffee husk ensiled without EM due to dilution with chopped grass hay alone at (P<0.001). Similarly, there is high significant interaction effect between EM and hay inclusion rate on the caffeine and condensed tannin that lower the anti-nutritional factors at (P<0.001). Three factors appear to be important relative to caffeine and effects observed in various animals: the relatively high concentration of nitrogen in caffeine; its known effect of stimulating increased activities and its diuretic effect [1]; [4]; [11]. As show in table 2 the pure coffee husk ensiled without EM had 2.10% condensed tannins which were significantly reduced by 79% as a result of efficient microbial utilization on tannin at (P< 0.05). There was significant reduction of condensed tannin content of dry coffee pulp using EM and mixing with chopped hay (P<0.001). Caffeine degradation has been observed in fungal species like Stemphyllium sp. Penicillium spp. such as Penicillium. Commune and Aspergillus spp. (*A. tamari*, *A. niger,* and *A. fumigates*) showed appreciable growth when caffeine was used as the sole source of nitrogen. *A. tamari* and*Penicillium commune*, showed good caffeine degrading ability (about 60%) whereas others had less than 20% caffeine degradation [28].Bioremediation of coffee husk to reduce the caffeine content has been studied more in fungal systems. Among the microbial community present in coffee pulp, only a few species like Aspergillus, Penicillium and Rhizopus could degrade caffeine. According to [29] a fungal strain called Aspergillus spp. also had ability to grow on a coffee husk and degradation of tannins (65%) were obtained. Tannins are known to confer astringency to food stuffs and complex proteinsby binding to plant proteins sometimes cell wall carbohydrates decreases thedigestibility and decreasing nitrogen utilization by the animals [30]. As in [31] showed that a strain of *Lactobacillus plantarum* was able to degrade up to 90% of the tannin present in coffee pulp. In other, studies the presence of *Lactobacillus plantarum*, which is one of the major microorganisms in believed to produce an enzyme tannase which can degrade tannin [32]; [33]. This was expected because tannin can only degrade by

the small number of the lactic acids bacteria's and others from natural micro flora of the coffee byproduct [11]. The caffeine and condensed tannin content on T8 was higher than those reported by [34] Leifa et al. (2000). These differences may confirm not only chemical variability of the coffee byproduct but due to location (soil type, altitude), coffee strains (species and varieties), culture management and differences in extraction and analyzing methodology (specially for the ANFs) [35]. Polyphenols and tannins also bind with polysaccharides or are absorbed by cellulose, which could affect the extraction and as a result, the incorrect determination of these components in coffee husk. As in [36] more than 20 bacteria strains were isolated from soil collected under coffee plants, observing predominance of Pseudomonas species which was also the most efficient caffeine degrader. Also as in [37] isolates of bacteria, yeast, and fungi were obtained, and bacteria were the predominant microorganisms and fermentative bacteria, cellulolytic bacteria, yeast and filamentous fungi were identified among 626 microorganisms. Some bacterial and fungal strains such as *Bacillus coagulans, Pseudomonas aeruginosa, P. putida, Penicilliumrouquifortii, Penicilliumcurtosum*, and Pleurotus spp. have been also stated to have the capacity of degrading caffeine [38]. The microbes present in EM and coffee husk are capable of caffeine and tannin degrading, the capability to degrade these compounds however depends on the type of microbes used or found in the micro flora of coffee husk.

3.3. In-vitro Dry Matter Digestibility of coffee husk (IVDMD)

One of the principal factors used to determine the nutritivevalue of feed is the quantity the animals consume whenthey have free access. The limitation to the use of coffee pulp as animal feed is the reluctance of animals to eat it when it is supplied as the main feed ingredient. It is generally agreed that low feed intake, protein digestibility and nitrogen retention are the major factors limiting the use of coffee husk as animal feed. The low intake of coffee husk is due to its low palatability and probably to adverse effects on digestion and metabolism.

Fig. 3. In-vitro Dry Matter Digestibility of coffee husk (IVDMD**)**



According to the table 2 and fig 3.T3 and T1 and T4 were statistical significantly at (P< 0.001) due to the use of EM. However, the IVDMD (48.1 and 37.7%) recorded for T4 and T8 respectively and it was found to be lower than the minimum recommended degradability (50%) for poor quality roughages [39].Nevertheless, IVDMD of T4 silage were very close the recommended degradability for animal feed stuffs and it shows somehow improvement by 30% using EM. On the other hand [11] find out wet processed coffee pulp have better digestibility(64.1%) than dry processed coffee husk and its degradability were amended by 50% due to the inoculation with effective microorganisms. The increased in in-vitro dry matter digestibility of the coffee husk silages ensiled with EM could also be attributed to the decreased percentage composition of the ADF, lignin and related anti-nutritional factors of coffee husk treated with EM. The yeasts and bacterial species present in the EM may have had positive effects in feed degradability and resulted in the corresponding in-vitro dry matter digestibility of the treatment silages. Especially the role of yeast in the EM solution had important because yeasts have been reported to utilize feeds with high structural components [40]. These microbes may have stimulated the activity of beneficial microbes, especially the cellulolytic organisms. All the available evidences tend to indicate that the low digestibility of coffee pulp and coffee husk are partially attributed to the presence of anti-nutritional factors in coffee husk including caffeine, condensed tannins and some polyphenoles. The anti-nutritional effects of tannins are associated with their ability to combine with dietary protein, cellulose, hemicellulose, pectin and mineral retarding their digestion and utilization [5]. Tannins impair the digestive process by complex with enzymes and endogenous protein. Toxicity has also been reported form ingestion of tannins [41]. Nitrogen availability is certainly affected by formation of protein complex by tannins. Tannins are known to affect food digestibility and decrease nitrogen utilization of the animals.

4. Conclusions

There was a reduction in the fibrous component and anti-nutritional factors of coffee husk when it ensiled with EM. Reduction in the anti-nutritional factors of coffee husk in turn resulted in significant improvement in the feed degradability. Inclusion of coffee huskwith the available local feed stuffs into livestock feeding system with the use of effective microorganism (EM) has significant economic and environmental implication in coffee growing areas.

Acknowledgments

Authors kindly appreciatedand hugely indebted Woljeejii Agro-Industry PLC for the research work grant support and also toMiss Anne LeLacheur, MissMeronTesfageorgis, NetsanetBeyeroand Dr Gordon W.Price for their unhindered support, encouragement and with thought provoking comments and insightful suggestions. My gratitude also goes for to the stuff of department of Animal Science, Jimma University, Ethiopia.

5. Reference

[1]. Solomon D, 1991. The value of coffee pulp alone and in combination with other feeds in sheep nutrition in Ethiopia. J. Small Ruminant Research 5(3): 223-231

[2]. Alemayehu T, Esayas K and Kassu K, 2007. Coffee development and marketing improvement plan in Ethiopia. pp. 375-387. Proceeding of national workshop four decades of coffee research and development in Ethiopia, Addis Ababa, Ethiopia.

[3]. Pandey A, C. R. Soccol C R, Nigam P, Brand D, Mohan R and S. Roussos S, 2000. Biotechnological potential of coffee pulp and coffee husk for bioprocesses. Journal of Biochemical Engineering. 6:153-162

[4]. Bressani R, 1979. By-products of coffee berries. PP. 5-24. In: Brahan, J.E. and R. Bressani (eds). Coffee pulp: composition, technology and utilization. Guatemala City: Intern. Dev. Res. Center. Ottawa, Canada.

[5]. McSweeney C S Palmer B D McNeill M and Krause D.O, 2001. Microbial interaction with tannin: consequence for ruminants. Animal feed science and technology, 91:83-93

[6]. Donkoh, A., C. C. Atuahene, A. G. Kese, and B. M. Asante, 1988. The nutritional value of dried coffee pulp (DCP) in broiler chickens' diets. J.Anim. Sci. Technol. 22:139-146.

[7]. Gordon F.J, 1989. An evaluation through lactating cattle of a bacterial inoculant as an additive for grass silage. Grass and Forage Science 44:169-179.

[8]. Steen R.W J, 1989. Evaluation studies in the development of a commercial bacterial inoculant as an additive for grass silage. 3. Responses in growing cattle and interaction with protein supplementation. Grass and Forage Science 44:381-390.

[9]. HigaT and Wididana G.N. 2007. The Concept and theory of Effective Microorganism: A New Dimension for Nature Farming. pp. 20-22. In J.F. Parr, S.B. Hornick, and M.E. Simpson (eds). Proceedings of the 2nd International Conference on Kyusei Nature Farming. U.S.Department of Agriculture, Washington, D.C, USA.

[10]. EMROSA (Effective Microorganisms research organization of South Africa) 2006. Users manual. Emrosa, inc. South Africa.

[11]. Yonatan K, Solomon D and Taye T, 2011. Chemical composition and in-vitro digestibility of coffee pulp ensiled with effective microorganism in Ethiopia. Livestock Research for Rural Development. Volume 23, Article #155. Retrieved March 29, 2014, from http://www.lrrd.org/lrrd23/7/kass23155.htm

[12]. Higa T, Parr J, 1994. Beneficial and effective microorganisms for a sustainable agriculture and environment. International Nature Farming center, Atami, Japan, pp. 16

[13]. Asia-Pacific Natural Agriculture Network-APNAN, 1995. EM application manual. (First Eds.) Retrieved from http://www.agriton.nl/apnanman.html

[14]. Chantsawang S and Watcharangul P, 1999. Influence of EM on quality of poultry production. Pp.133-150. Y D A. Senanayake, and U R. Sangakkara (eds). Proceedings of the 5th International Conference on Kyusei Nature Farming, Thailand, 1998, APNAN, Thailand.

[15]. Konoplya E F and Higa T, 2000. EM application in animal husbandry-Poultry farming and its action mechanisms. Paper presented at the International Conference on EM Technology and Nature Farming, October 2000, Pyongyang DPR Korea.

[16]. Wondmeneh E., Adey M. and Tadelle D, 2011. Effect of effective microorganisms on growth parameters and serum cholesterol levels in broilers. African Journal of Agricultural Research Vol. 6(16), pp. 3841-3846. http://www.academicjournals.org/AJAR

[17]. Playne M.J and McDonald P, 1996. The Buffering constituents of herbage and of silage. J. Sci. Food Agric. 17:264-268.

[18]. AOAC, 1990. Official Method of Analysis. 15th edition. Association of Official Analytical Chemists Washington, DC. USA. 66-88p.

[19]. Goering H K and Van Soest P.J, 1970. Forage fiber analysis. Agricultural Handbook No. 379. Agricultural Research Service, USDA, Washington DC. 20 p.

[20]. Maxon, E.D., L.W. Rooney, 1972. Evaluation method for tannin analysis in sorgum grain. Ceralchem, 49:749

[21]. Abebe B, Kassahun T, Mesfin R and Araya A, 2008. Measurement of caffeine in coffee beans with UV/spectrometer. Journal of Food Chemistry, 108: 310-315

[22]. Tilley J M A and Terry R A 1963 A Two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassland Soc. 18:104

[23]. SAS Institute Inc, 2000. Statistical analysis

Software version 9.2, Cary, NC: SAS Institute Inc. USA.

[24]. Mannetje L. 1999. Silage Making in the Tropics with Particular Emphasis on Smallholders. Proceedings of the FAO Electronic Conference on Tropical Silage September 1-15 December 1999, Food and Agricultural Organization of the United Nations, Rome, Italy.

[25]. Bolsen K K, Ashbell G and Weinberg Z.G. 1996. Silage fermentation and silage additives. Asian-Aust. J. Anim. Sci, 92:483-493

[26]. McDonald P, Henderson A. R and Heron S.J.E, 1991. The Biochemistry of silage. 2nd(eds). halcombe Publications, Marlow, Bucks, England.340p.

[27]. Bingal, H.T and E. Baytok, 2003. The Effect of some silage additives in sorghum silage on the silage quality and ruminal degradability of nutrients. I. The effects on silage quality. Turk J. Vet.Anim.Sci, 27:15-20

[28]. Gokulakrishnan, S. Chandraraj, K. Sathyanarayana and N. Gummadi, 2005. Microbial and enzymatic methods for the removal of caffeine. Journal of Enzyme and Microbial Tech. 37:225–232.

[29]. Wong, Y.S and X. Wang, 1991. Degradation of tannins in spent coffee grounds by Pleurotussajorcaju. World J.microbiology and Biotechnology, 7:573-574

[30]. Bressani R, 1987. Anti-physiological factors in coffee pulp. PP.83-88. In: Brahan, J.E. and R. Bressani (eds). Composition, technology and utilization. Guatemala City: Institute of Nutrition of Central America and Panama.

[31]. Menezes H C F.S. Samann F S, Clifford M N and Adams M.R, 1994. The Fermentation of fresh coffee pulp for use in animal feed. Pp.52-61. Proceedings. In: COLLOQUE International sur la chimie du coffee du CACAO, 15. Montpellier, 1993, Paris: association scientific international on coffee.

[32]. Osawa R, KuroisoK,Goto S and Shimizu A, 2000. Isolation of tannin-degrading lactobacilli from humans and fermented foods. Journal of .Applied and Environmental Microbiology 66: 3093–3097

[33]. Vaquero I, Marcobal A and Munoz R 2004.Tannase activity by lactic acid bacteria isolated from grape must and wine. International Journal of Food Microbiology, 96(2):199-204

[34]. Leifa F, A. Pandey and CR. Soccol, 2000. Solid State Cultivation an Efficient Method to use Toxic Agro-Industrial Residues. Journal of Basic Microbiology, 40(3): 97-187

[35]. Clifford, M.N., J.R.Ramirezmenezes, 1991. Tannins in wet processed coffee beans and coffee pulp. J.Food Chemistry, 40:35-42.

[36]. Yamaoka-Yano, D.M. and P. Mazzafera, 1998. Degradation of caffeine by Pseudomonas putida isolated from soil. Allelopathy Journal, 5: 23-34

[37]. Silva, C.F., R.F. Scwan, E.S. Dias and A.E. Wheals, 2000. Microbial diversity during Maturation and Natural Processing of coffee cherries of coffee Arabica in Brazil. International Journal of Food Microbiology, 60: 251-260

[38]. Aquiahuatl M, Raimbaukt M, Roussos M and Trejo-Hernandez M, 1988. Solid State Fermentation of coffee pulp. pp. 13-26. In: M.Raimbault (eds). Solid State Fermentation and Bioconversion of Agro-industrial Raw materials, vol 2. ORSTOM, Montpellier.

[39]. Aramble M J and Tung R S, 1987. Evaluation of saccharomyces cerevisiae growth in the rumen ecosystem. PP. 29-32. In: 19th Biennial Conference on rumen Function, Chicago, Illinois.

[40]. Maurya M S, 1993. Effect of Feeding Live Yeast Culture (Saccharomyces cerevisiae) on rumen fermentation and nutrient digestibility in goats. A PhD Thesis. Indian Veterinary Research Institute, Deemed University, Izotnager. India.

[41]. McSwenney, C.S. and R.L. Mackie, 1997.Gastrointestinal detoxification anddigestive disorder in ruminant animals. PP. 583-634. In R.L.Mackie, B.A.White (eds). Gastrointestianl Microbiology. Vol. 1. Chapman and Hall, New York.