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EVALUATING THE POSSIBILITY OF RECYCLING BANANA WASTE AS A FEED FOR RUMINANTS:
I- CHEMICAL COMPOSITION, RUMEN-LIQUOR PARAMETERS, DIGESTIBILITY COEFFICIENTS, AND FEEING VALUES BY LAMBS

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ABSTRACT

Three underground trenches with the capacity of 6 tons (2 tons each) were used for making silage from banana wastes. Rice straw was added to banana wastes at the rate of 1:2, while molasses was added at the rate of 5%. The first kind of silage (T_2) was made without any additive. In the second silage (T_3), urea was added at the rate of 3%, while in the third silage (T_4), EM_1 (biological treatment) was added at the rate of 1%. Whereas T_1 was a control. The rations were fed *ad libitum* of silage, while concentrate feed mixture consisted 70% from the requirements. Twenty lambs (crossbreed Finnish rams, Finnish x Rahmani) having 4 months of age and averaging 22 $\pm$ 0.5 kg live body weight were used in this experiment. Lambs were divided into four similar groups according to their live body weight (5 animals in each). The results of this study revealed that banana waste silage with urea before ensiling increased CP and ash, but limited increased CF and EE, and decreased contents of OM and NFE. Making silage decreased CF and EE, but increased CP, NFE, and ash in BWES. Addition of urea and effective microorganism affected silage. Ruminal pH values decreased at 3 hours after feeding (5.73 T_1, 5.9 T_2, 6.47 T_3 and 5.8 T_4). The treatment with urea increased pH values compared to other treatment. The highest level of ammonia-N concentration (mg/100 ml) produced in rumen was (16.42 T_3) compared with T_2 (15.64) and T_4 (14.86). These levels decreased after 6 hours of feeding, being T_1 (13.25), T_2 (10.17), T_3 (12.51) and T_4 (9.38). The concentration of volatile fatty acids 3 hours after feeding was the highest in T_3 and T_4 (13.82 and 11.68 meq, respectively). At 6 hours after feeding, TVFA's tended to increase in T_3 and T_4 compared to T_2 (16.00, 12.00 and 10.17 meq, respectively). Digestibility coefficients of DM increased significantly in T_4 and T_3 compared to T_2 (67.10, 65.91 and 63.16%, respectively. Digestibility coefficients of OM increased significantly in T_4 & T_3 compared to T_2 (68.11, 66.89 and 64.10%, respectively). Digestibility coefficients of CP, CF, EE and NFE increased significantly in T_4 and T_3 compared to T_2, being 64.58, 66, 66 & 87%; 56.91, 55.33 & 52.39%; 82.14, 81.53 & 78.28%; and 70.95, 68.16, 65.03%, respectively. These data indicated good silage of T_4 compared to T_2. T_4 contained more DM, OM, CP, CF, EE and NFE (67.10, 68.11, 64.58, 56.91, 82.14 and 70.15%, respectively), compared to T_1 (DM, OM, CP, CF, EE and NFE being 70.47, 71.52, 68.44, 53.94, 8.81 and 74.52%, respectively). No significant differences between T_3 & T_4 were found, except for CF. Significant differences were found between T_1,, T_4 and T_2 compared to T_3 & T_4. The nutritive value as TDN increased insignificantly between T_3 and T_4 (63.29 and 64.98%) but increased significant between T_3 & T_4 compared to T_2 (63.29, 64.98 and 60.11%, respectively). There were significant decreases in TDN of T_2, T_3 & T_4 compared to T_1 (60.11, 63.29, 64.98 and 67.77%, respectively). The nutritive value as DCP differed insignificantly between T_3 & T_4 (10.46 and 10.18%, respectively), but both (T_3 and T_4) increased significantly

compared to T_2 (10.46, 10.18 and 9.52%, respectively). Significant decreases were found between T_2, T_3 and T_4 compared to T_1 (9.52, 10.46, 10.18 and 11.15% DCP, respectively). From the foregoing results it could be concluded that EM_1 as an additive for making silage of banana waste was effective. Ensilage of banana wastes with urea or EM_1 reduced the tannins level and CF content but increased OM, CP, NFE and nutritive value; as well as nutrients digestibility comparing with the banana waste silage without additives, (even comparing with the control, e.g. for CF and EE). So, it is to recommend using banana waste silage with EM_1 (or urea) in feeding ruminants.
Keywords: Banana waste, Silage quality, Chemical composition, Rumen liquor, Digestibility coefficients, Feeding values, Lambs.

INTRODUCTION

In Egypt, animal feed resources are limited which do not allow increasing livestock population to a level satisfies human demands. Moreover, feed shortage is also unevenly divided between summer and winter. Where in winter season; berseem is the major forage crop covering 45.91 and 124.52% of yearly animal requirements of energy and protein, respectively (Abou-Selim and Bendary, 2005). While in summer season, the available feeds are mainly concentrates and straws which cover 39% and 22% of the local animal requirements of energy and protein, respectively (El-Serafy, 1991). Encouraging results obtained confirm that using crops wastes in animal diets could participate in reducing the shortages of animal feeds and subsequently increase milk and meat production. Many efforts have been carried out to evaluate available waste products for feeding animals (Abdelhamid, 1988). Banana leaves and pseudo stems have chemical analysis close to clover composition and can play an important role to cover some nutrient requirements of the animals (Abd El-Gawad *et al*., 1994). Highest live weight gain was achieved when diet was supplemented with banana, this suggests that fodder supplement with green banana can improve cattle nutrition in the humid tropics (Ibrahim *et al*., 2000). Wastes of banana trees are one of the solutions, which may share in solving this problem. The annual cultivated area from banana plants in Egypt is about 39.00 feddans (Ministry of Agriculture and Reclaiming land, 2003). The wet materials (leaves and pseudo stems) are about 40 tons per feddan. The total wet material is about 1.400.000 tons which is estimated to be about 89.000 tons dry matter. The main shortcoming of banana wastes as sole animal feed lies in their low digestible energy and protein contents and its containing of antinutritional compounds (Tannin). Biological treatments such as white rot fungi (Abdelhamid *et al*., 2006 & 2007), as *Trichoderma viride* (El-Ashry *et al*., 2003 and Abdelhamid *et al*., 2009a, b & c) and *Penicillium funiculusms* (El-Ashry *et al*., 2003) were used to improve the nutritive value and digestibility of poor quality roughages. Also, yeast treatment was used to improve rumen digestibility of nutrients especially crude fiber, in term of elevation rumen fermentation and more activation of rumen microorganisms (Dawson, 1992). The main objective of this study was to determine the influence of incorporation of different kinds of silage made from banana plant wastes on chemical composition, silage quality, rumen fermentation, nutrients digestibility, and nutritive value by ram lambs.

MATERIALS AND METHODS

This work was carried out at Sakha Animal Production Station, Animal Production Research Institute, Agric. Research Center and Animal Production Department, Faculty of Agriculture, Al-Mansourah University during 2007/2008 for about 26 weeks.

Silage preparation:

Three under ground trenches with capacity of 6 tons (2 ton each) were used for ensiling the fresh banana plant leaves and stems which collected after harvesting immediately from Giza governorate (El-Waraq), then (banana by-products) were chopped (20 – 25 cm) by a hand machine and sun dried for a period of 7 – 10 days to reach a moisture content of about 65 – 70%. The silage was prepared by filling successive layers of the chopped materials and heavily trodden before adding the next layer. However, each layer was consisted of the banana wastes and chopped rice straw (2:1). Molasses was added at the rate of 5%. The first trench had no additives, but urea was added at 3% (dissolved in water) to the second and microorganisms (EM1) were added at 1% from weight silage in the third trench. Molasses and urea were purchased from Nobaria Animal Production Station, whereas rice straw and berseem hay were taken from Sakha Animal Production Station.. After filling the trenches with the materials they were pressed well then covered by thin layer of polyethylene sheet (180 µm). Soil and straw layers of approximately 20 cm thickness were covered the polyethylene sheet then tires to get anaerobic conditions for 8 weeks. Effective microorganisms (EM_1), from EM research organization (EMRO), Jaban and Ministry of State for Environmental affairs contained photosynthetics bacteria (*Rhadopseudomonas plustris* and *Rhodobacters phacrodes*), lactic acid bacteria (*Lactobacillus plantaru, Lactobacillus case* and *Streptococcus lactis*), yeasts (*Saccharomyces cerevisiae*) and *Actinonycetes* (Microhiza) according to El-Dosyki *et al*. (2002). For determination of silage quality after 8 weeks, the bunkers were opened and the color and odor were examined directly. Representative samples were taken from each kind of silage material before and after ensiling for chemical analysis and pH values determination.

Experimental animals and feeding system:

To study the effect of feeding lambs on the tested three different types of silage on growth performance, twenty crossbred ram lambs (3/8 Finnish Landrace x 5/8 Rahmani) having 4-5 months of age and averaging 22 $\pm$ 0.5 kg live body weight were used in this experiment. Lambs were divided into four similar groups according to their live body weight (5 animals in each). Lambs in all groups were fed diets which contained the same amount of concentrate feed mixture (CFM). The dietary treatments were: T1) concentrate feed mixture (CFM) of lactation (17% CP) + berseem hay (BH) as a control; T2) CFM + banana waste silage (BWS) without additives (banana waste 2:1 rice straw + 5% molasses); T3) CFM + BWS with urea 3%

+ 5% molasses (BWUS); and T4) CFM + BWS with effective microorganisms 1% (EM_1 + 5% molasses, BWES). Feeding of all groups was on the basis of 4% DM of their live body weight, concentrate ratio in diet of all groups was 70% from NRC (1985) requirement silage *ad libitium*. Amount of CFM were adjusted biweekly according to the actual live body weight. The experimental feeding period lasted from weaning up to 180 days (about 26 weeks). Freshwater and Calphos Block (from Turkey) were available all times and feeds were offered twice daily at 8 a.m and 4 p.m. Block Bilesimi consisted of (mg/Kg) 20.000 Ca, 10.000 P, 30.000 Mg, 500 Fe, 40 Co, 500 Cu, 100 I, 4.000 Mn, 2.5 Zn, 1.000 S, 20 Se, 33.7 Na, 50.000 iu vit. A, 10.000 iu vit. D, and 20 vit. E.

Digestibility trials:

At the end of the experimental period three ram lambs weighing about 45 kg LBW and aging 10 months were taken randomly from each dietary treatment and placed in metabolic cages. Animals in all groups were fed the same diets for a period of 2 weeks as preprimary period followed by 7 days as a collection period. In the digestibility trials, the animals were fed 1000 g silage and 800 g concentrate feed mixture. The daily feces excreted were collected and weighed then 10% of the daily feces were taken and dried for 24 hours at 65ºC to determine the daily dry matter excreted. Composite fecal samples were taken and stored for chemical analysis. Rumen liquor samples were taken from three animals of each digestibility trial at the end of the collection period of the three digestion trials. Sample from rumen liquor were taken before morning feeding (zero time) and at 3 and 6 hours after morning feeding (post-feeding). Samples were taken using rubber stomach tube. Immediately after rumen liquor collection, ruminal pH values were measured by pH meter, then rumen liquor of each animal was strained through four layers of cheese cloth and stored at -20ºC until chemical analysis for concentration of total volatile fatty acids (TVFA's) and ammonia-N (NH_3-N). The pH values were measured as soon as the rumen liquor was collected before adding the preservatives using a pH meter. Ruminal ammonia-N was determined according to the procedures outlined by Conway (1957). Total VFA's were determined according to the method of Warner (1964) using Markam micro-distillation apparatus.

Chemical analysis:

Dry matter, crude protein, ether extract, crude fiber and ash of feeds and faces were analyzed according to the methods of A.O.A.C. (1990). Tannins content were determined by the method of A.O.A.C. (1980).

Statistical analysis:

The obtained data were statistically analyzed using general linear models procedure adapted by SPSS (2004) for Windows for user's guide. Least significant differed according to Duncan (1955) within program SPSS was done to determine the degree of significance between means.

RESULTS AND DISCUSSION

Chemical composition:

The chemical composition of fresh banana waste, rice straw, banana waste silage, banana waste urea silage and banana waste EM_1 silage (BWF, RS, BWS, BWUS and BWES) is shown in Table (1). The present results showed that BWF had 7.2 DM, 81.46 OM, 7.54 CP, 31.62 CF, 1.22 EE, 41.08 NFE and 18.54% ash. Data indicated that BWUS contained the highest content of CP, EE and ash. It was noticed that the addition of urea before ensiling caused an increase in both CP and ash and limited increase in CF and EE, while lowest contents of OM and NFE in BWUS may be due to the addition of rice straw and molasses. The obtained results agree with those reported by many authors (Hassan *et al*., 2005 and Mohsen *et al*., 2006), who found that chemical composition of banana waste fresh had 7.40 DM, 84.55 OM, 6.36 CP 32.69 CF, 0.78 EE, 44.72 NFE and 15.45% ash on dry matter basis. It could be seen from Table (2) the chemical composition of CFM, BH, BWS, BWUS and BWES indicated that making silage decreased CF and EE but increased CP and NFE, and ash in BWES. It was noticed that the addition of urea and effective microorganisms improved CP, CF and NFE contents of the silages. The obtained results agree with Mohsen *et al*. (2006), who found that silage making decreased CF and cell wall components, but increased EE and ash contents. Also, Biomin (2008) mentioned that inoculant led to higher production of lactic acid and therefore lower pH value, decreased butyric fermentation or inhibition of the clostridia fermentation and a higher recovery of energy in the ensiled matter.

Fermentation characteristics of silages:

At the end of the fermentation period (8 weeks) and as shown in Table (3), the present results showed that pH values were 4.25 BWS, 4.45 BWUS, and 4.35 BWES. Ammonia-N (%) of total N was 2.29 BWS, 5.22 BWUS, and 1.4 BWES. Total volatile fatty acids (% of DM) was 1.53 BWS, 2.14 BWUS, and 1.36 BWES. These results agree with those of Mahmoud (2005), who found that at the end of the fermentation period (6 weeks), pH values reached 4.3, 4.52 and 4.01 and total VFA concentration reached 2.15, 3.10 and 2.36 (mM/100 ml) for the control, ureated, inoculant silages, respectively. Whereas ammonia-N concentration reached 16.81 (mg/100 ml) for banana waste silage treated with urea, while that inoculated had 10.88 (mg/100 ml) and the control silage had 10.36 (mg/100 ml), which correlated with the pH values of silage. However, all silages tested were normal colored, moist, odor and solid. The highest acceptable pH value in silage is 5.0 (Meyer *et al*., 1980) and up to 8% ammonia, make the stage good (Abdelhamid, 1991). Additionally, increasing ammonia and pH value in a silage are indicators for poor quality silage (Flynn, 1988 and Woolford, 2007). Total bacterial count was 5.7 x 10^8 BWS, 2.9 x 10^6 BWUS, and 8.3 x 10^7 (CFU) BWES (Table 3). Aflatoxin examination revealed no aflatoxin was found in silages. Although the normale total bacterial count (Abdelhamid, 1991), urea addition led to lower count followed by EM_1 comparing with BWS. However, the absence of aflatoxins may be due to lower fungal count which may be attributed to the presence of urea (Abdelhamid *et al*. (1994) and microorganisms, and/or low pH values for the good ensilage conditions. Moreover, Oliveira and Furlong (2008) found that the extract of banana reduced the production of aflatoxin B_1. However, Abdelhamid *et al*. (2001) found aflatoxin B_1 contamination in silage (.452 ppb) may be for aeration which enable molding and spoilage (Cullison, 1982).

Table (1): Chemical composition of tested feedstuffs before ensiling.

Item	BWF	RS	BWS	BWUS	BWES
DM %	7.20	89.26	34.20	34.10	33.95
Composition of DM %					
OM	81.46	32.02	76.98	76.41	77.43
CP	7.54	3.23	6.59	11.38	7.70
CF	31.62	33.65	32.32	32.50	32.69
EE	1.22	1.41	2.33	2.68	2.60
NFE	41.08	43.73	35.72	29.85	34.44
Ash	18.54	17.98	23.02	23.59	22.57

BWF: Fresh banana waste, RS: Rice straw,
BWS: Banana waste silage, BWUS: Banana waste silage with urea,
BWES: Banana waste silage with EM_1

Table (2): Chemical composition of feedstuffs of the experimental silages.

Item	CFM	BH	BWS	BWUS	BWES
DM %	92.15	92.40	31.90	31.80	32.70
Composition of DM %					
OM	93.24	87.86	77.19	77.80	75.37
CP	17.05	14.57	7.09	9.49	8.81
CF	6.73	22.66	31.17	29.78	27.33
EE	2.95	2.10	2.82	2.27	2.15
NFE	66.51	48.53	36.11	36.26	37.08
Ash	6.76	12.14	22.81	22.20	24.63

CFM: Concentrate feed mixture, BH: Berseem hay,
BWS: Banana waste silage, BWUS: Banana waste silage with urea,
BWES: Banana waste silage with EM_1

Aflatoxins impair liver and kidney function, delay blood clotting, increase susceptibility to bruising, and interfere with cellular humoral immune system (Diekman and Green, 1992) as well as suppression of cellular immunity (Qureshi *et al*., 1998). So, inhibition of DNA, RNA and protein synthesis via a variety of different mechanisms appears to be directly or indirectly responsible for the immunosuppressive action of many mycotoxins (Corrier, 1991). Studies have linked human exposure to aflatoxins to increased prevalence of infection (IARC, 2002). Prenatal exposure to aflatoxin produced a delay of early response development, impaired locomotors coordination, and impaired learning ability in the offspring of rats exposed to aflatoxin during middle pregnancy, and the early gestational exposure appears to produce more effects than latter exposure (Kihara *et al*., 2000). Aflatoxins cross the human placenta. It is associated with growth impairment in young children (IARC, 2002). Its chronic symptoms include liver and kidney damage; reduced growth, anemia, bruising and immune suppression (Herman and Trigo- Stockli, 2008). The biochemical effects of aflatoxins included carbohydrate metabolism, lipid metabolism, vitamin assimilation, protein synthesis, mitochondrial respiration, endocrine system, and skeletal system (Verma, 2007) as well as DNA damage (El-Barbary, 2008). Mycotoxins are found frequently in different feedstuffs (Abdelhamid, 1993a,b & 2009a and Swamy, 2009). And threat not only plant crops, but also animal and human health (Abdelhamid and Saleh, 1996; Abdelhamid, 2004 & 2005; and Abdelhamid *et al*., 1999). El-Shanawany *et al*. (2005) isolated numerous fungal genera (*Aspergillus, Penicillium, Fusarium* and *Gibberella*) as well as many mycotoxins, particularly aflatoxins, which showed the highest incidence rates in silage samples from Assiut and Sohag governorates. However, moldy silage is frequently asked questions (Albert Govt., 2008). The mycotoxin problem could be overcome by good farming and nutrition (Abdelhamid, 1995 & 2000; and Taylor-Pickard, 2008).

Table (3): Fermentation characteristics of different kinds of silages.

Item	BWS	BWUS	BWES
The pH value	4.25	4.45	4.35
Ammonia-N,% of total N	2.29	5.22	1.40
Total volatile fatty acids, % of DM	1.53	2.14	1.36
Total count of microorganisms, cfu/g	5.7×10^8	2.9×10^6	8.3×10^7
Aflatoxin, ppb	-	-	-
Tannins (g/100 g) before ensiling	0.90	0.95	0.91
after ensiling	0.95	0.85	0.75

BWS: Banana waste silage,
BWUS: Banana waste silage with urea,
BWES: Banana waste silage with EM_1

Tannins tended to decrease after fermentation (Table 3), being 0.90 BWS, 0.95 BWUS, and 0.91% BWES before ensiling, but became 0.95 BWS, 0.85 BWUS and 0.75% BWES after ensiling. These results may be due to the addition of urea and effective microorganism. Generally, the results obtained agree with those reported by Viswanathan *et al*. (1989) that the mean composition of banana stalk of tannin content was only 0.74% as tannic acid equivalent. These data indicated good silage fermentation, and inoculant with EM_1 was proved to be the best silage compared to the other two silages. Anyhow, tannins are frequently found in many forages and agroindustrial wastes and may harm the livestock animals by high consumption as unconventional feed resources (Abdelhamid and El-Ayouty, 1988 and Abdelhamid, 1991, 2003, 2008 & 2009b).

Calculated composition of the experimental diets:

It could be seen from Table (4) that the percentages of CP were 16.29, 15.14, 15.69, and 15.76; OM percentages were 91.60, 90.16, 90.46, and 90.45; and percentages of CF were 11.59, 11.42, 10.88, and 9.94 in T_1, T_2, T_3 and T_4, respectively. These data indicated decreases of CF, EE and ash of T_2 and T_3 compared to T_2 and increased OM, CP, and NFE of T_2 and T_3 compared to T_2. These data are related to the chemical composition of the dietary ingredients (Tables 1 and 2), since banana waste silages were contained lower OM, CP and NFE and higher CF, EE and ash than berseem hay.

Table (4): Chemical composition of the experimental diets.

Item	Dietary treatment			
	T_1	T_2	T_3	T_4
DM %	92.23	67.68	68.89	71.90
Composition of DM %				
OM	91.60	90.16	90.46	90.45
CP	16.29	15.14	15.69	15.76
CF	11.59	11.42	10.88	9.94
EE	2.69	2.93	2.83	2.83
NFE	61.03	60.68	61.06	61.92
Ash	8.40	9.84	9.54	9.55

T_1: Control, T_2: Banana waste silage,
T_3: Banana waste silage with urea 3%, T_4: Banana waste silage with EM_1

Digestibility coefficients:

It could be seen from Table (5) that the digestibility coefficients of DM increased significantly ($P < 0.05$) in T_4 and T_3 compared to T_2, being 67.10, 65.91 and 63.16%, respectively. Digestibility coefficients of OM increased also significantly ($P < 0.05$) in T_4 and T_3 compared to T_2, being 68.11, 66.89 and 64.10%, respectively. Digestibility coefficients of CP, CF, EE and NFE increased significantly ($P < 0.05$) in T_4 and T_3 compared to T_2, being 64.58, 66.66 and 62.87% CP; 56.91, 55.33 and 52.39% CF; 82.14, 81.53 and 78.28% EE; and 70.95, 68.16, and 65.03% NFE, respectively. These data indicated significantly comparable digestibility of all nutrients particularly CF and NFE of T_4 compared to T_1. Data indicated that T_4 contained more digestible DM, OM, CP, CF, EE and NFE being 67.10, 68.11, 64.58, 56.91, 82.14 and 70.15%, respectively, compared to T_1 (digestibility coefficients of DM, OM, CP, CF, EE and NFE were 70.47, 71.52, 68.44, 53.94, 80.81 and 74.52%, respectively). The results revealed significant differences ($P < 0.05$) among treatments, with no significant ($P > 0.05$) differences between T_3 and T_4, except in crude fiber, being 55.33 and 56.91, respectively. The obtained results agree with those reported by many authors. Choung and Lee (1989) studied the effect of physico-chemical treatment of banana by-products through ammoniation by 3%. They found that DM digestibility increased, being 68 vs. 53.50% compared with the untreated banana. Mohamed (2001) reported that banana by-products treated with bacteria (*Celluomonas cellosea*) increased digestion coefficients of DM, OM, CP, EE and CF but decreased NFE compared to untreated. Banana by-products treated with fungus (*Phanerochaete chrysoporium*) plus bacteria increased the digestion coefficients of DM, OM, CP, EE and CF, but decreased NFE compared to untreated. Banana by-products treated with 4% urea increased the digestion coefficients of all nutrients than those for the untreated, except NFE which showed insignificant differences.

In addition, Shoukry *et al*. (1992) found that ensiling banana by-products after treatment with 3% urea had resulted in an increase in digestibilities of DM, OM, CP, CF, and NFE while digestion of EE was decreased. Hassan *et al*. (2005) found that silage making decreased CF and cell wall components but increased ash and EE contents. Also, Mohsen *et al*. (2006) found that silage making decreased CF and cell wall components but increased EE and ash contents. Inoculant increased the apparent digestibility of all nutrients followed by silage treated with urea as compared to untreated control silage. Abd El-Ghani (1999) indicated that the differences between cows fed control and ration contained 15% banana plant wastes in nutrients digestibility coefficients were significant. Digestion of DM, CP, EE and NFE decreased significantly with increasing the percentage of banana plant in the ration. However, the addition of concentrate to a silage basal diet improved digestibility. In addition, the quality of silage positively and significantly affected both DM and OM digestibility of silage (Abdelhamid and Topps, 1991). Moreover, Abdelhamid *et al*. (2009a & b) reported an improved digestibility of DM and OM of fungal treated agricultural by-products.

Table (5): Digestibility coefficients and nutritive value of the tested rations.

Item	Dietary treatments			
	T_1	T_2	T_3	T_4
Digestibility coefficient (%):				
DM	$70.47^{a} \pm 0.46$	$63.16^{c} \pm 0.90$	$65.91^{b} \pm 0.62$	$67.10^{b} \pm 0.98$
OM	$71.52^{a} \pm 0.47$	$64.10^{c} \pm 0.91$	$66.89^{b} \pm 0.63$	$68.11^{b} \pm 0.99$
CP	$68.44^{a} \pm 0.75$	$62.87^{c} \pm 0.89$	$66.66^{ab} \pm 0.45$	$64.58^{bc} \pm 0.67$
CF	$53.94^{bc} \pm 0.58$	$52.39^{c} \pm 0.59$	$55.33^{b} \pm 0.62$	$56.91^{a} \pm 0.59$
EE	$80.81^{b} \pm 0.21$	$78.28^{c} \pm 0.46$	$81.53^{ab} \pm 0.36$	$82.14^{a} \pm 0.35$
NFE	$74.52^{a} \pm 0.50$	$65.03^{c} \pm 1.32$	$68.16^{bc} \pm 0.82$	$70.95^{b} \pm 1.26$
Nutritive value (%)as fed:				
TDN	$62.50^{a} \pm 0.46$	$40.69^{c} \pm 1.10$	$43.65^{bc} \pm 2.36$	$46.70^{b} \pm 0.85$
DCP	$10.28^{a} \pm 0.11$	$6.44^{c} \pm 0.09$	$7.21^{bc} \pm 0.41$	$7.32^{b} \pm 0.20$
Nutritive value (%)on DM basis:				
TDN	$67.77^{a} \pm 0.59$	$60.11^{c} \pm 0.97$	$63.29^{b} \pm 0.98$	$64.98^{b} \pm 0.65$
DCP	$11.15^{a} \pm 0.12$	$9.52^{c} \pm 0.09$	$10.46^{b} \pm 0.19$	$10.18^{b} \pm 0.02$

a, b and c: Means with different superscripts in the same row are significantly different at (P < 0.05).

Nutritive value on DM basis:

The nutritive value (Table 5) as TDN did not differ significantly ($P > 0.05$) in T_3 from T_4, being 63.29 and 64.98%, respectively, but increased significantly ($P < 0.05$) in T_3 and T_4 compared to T_2, being 63.29; 64.98 and 60.11%, respectively and decreased significantly ($P < 0.05$) in T_2, T_3 and T_4 compared to T_1, being 60.11, 63.29, 64.98 and 67.77%, respectively. Also, the nutritive value as DCP did not differ significantly ($P > 0.05$) in T_3 than T_4 (10.46 and 10.18%), but there were significant ($P < 0.05$) increases for T_3 and T_4 compared to T_2, being 10.46, 10.18 and 9.52%, respectively. Yet, significant ($P < 0.05$) decreases were found in T_2, T_3 and T_4 compared to T_1, being 9.52, 10.46, 10.18 and 11.15%, respectively. The obtained results agree with those of Choung and Lee (1989), who studied the effect of physico-chemical treatment of banana by-products through ammoniation by 3%. They found an improvement of nutritive value of the by-products due to the treatment. Mohamed (2001) reported that banana by-products treated with bacteria (*Celluomonas cellasea*) reflected feeding values expressed as TDN, SV, and DCP which increased significantly than those for untreated. The banana by-products treated with fungus (*Phanerochaete chrysoporium*) plus bacteria gave feeding values as TDN and SV not significantly differed from those for the untreated, but DCP value was significantly higher than the untreated roughage. The banana by-products treated with 4% urea reflected feeding values as TDN, SV and DCP higher significantly ($P < 0.05$) than the untreated. Hassan *et al*. (2005) found that animals fed on banana waste silage with bacteria and banana waste silage with EM_1 had significantly higher nutritive value. Mohsen *et al*. (2006) evaluated the effect of feeding diary cows on banana (*Musa acuminate* L.) waste silage alone or treated with urea 3% or inoculant mixed bacteria. Silage making resulted the highest feeding values for banana waste silage bacteria (63.69% TDN and 9.30% DCP) and the lowest values for banana waste silage (60.94% TDN and 8.8% DCP). However, urea treated or fungal treatment of agricultural by-products led to higher feeding values (TDN, SV and DCP) than the control (Abdelhamid *et al*., 1991b and 2009b), respectively.

Rumen fermentation:

Changes in ruminal pH values with time after feeding presented in Table (6) show that values of pH were higher before feeding (7.07 T_1, 7.10 T_2, 7.10 T_3 and 6.63 T_4), and decreased to reach their lowest values almost at 3 hours after feeding (5.73 T_1, 5.90 T_2, 6.47 T_3 and 5.80 T_4). The 4^{th} and 2^{nd} diets (T_4 and T_2) caused lower pH values than T_3 at 3 and 6 hours post-feeding, but significantly equal to T_1 at 3 hours post-feeding. Ammonia-N concentrations are shown in Table (6). The highest levels of ammonia-N produced in rumen was for ration containing banana treated with urea (T_3) at all sampling times, and did rot differ significantly ($P > 0.05$) than T_1. This may be due to the urea addition to this silage. The increased ruminal NH_3-N concentrations were related too to the elevated values of ruminal pH with T_3. The ammonia-N concentrations tended to decreased after six hours of feeding and the lowest concentration was noticed with the T_4 (14.08 T_1, 10.17 T_2, 12.51 T_3 and 9.38 T_4 mg/dl). The concentration of volatile fatty acids at zero time (before feeding), 3 and 6 hours after feeding are shown in Table (6). There were significant differences among treatments. The highest ($P < 0.05$) level of volatile fatty acids was recorded almost after six hours of feeding (13.25 T_1, 10.17 T_2, 16.00 T_3 and 12.00 T_4 meq/dl). The trend of changes in ruminal pH values positively rotated to NH_3-N and negatively to TVFA's concentrations. But NH_3-N levels related negatively to TVFA's concentrations. These relations were confirmed before by El-Kady (1997). However, the obtained results agree with those reported by many authors. Jankovsky *et al.* (1992) reported that when Merino sheep were fed on fresh banana leaves and pelleted Lucerne, concentration of VFA in rumen fluid was increased at 48 hr and then maintained a new value corresponding to that associated with the subsequent diet.

Also, El-Kady (1997) determined pH values in the rumen fluid of sheep feed banana by-products (Fresh or silage) as the only source of ration. He found that pH values were 7.6 vs. 6.4, respectively, and ammonia-N was

11.68 vs. 10.92% when fresh and silage materials were fed, respectively. Additionally, Abdel-Ghani (1999) found that total VFA's decreased with increasing the percentage of banana plant wastes in the ration. Mohamed (2001) fed ruminants on banana by-products with urea 3%, bacteria and bacteria plus fungi and showed that ruminal pH ranged from 6.79 (Treated with 3% urea) to 7.5 (treated with bacteria plus fungi) to 6.69 (Treated with 3% urea) 3 hrs after feeding and from 7.42 (treated with fungi) to 6.54 (untreated control) 6 hrs after feeding. The minimum pH values were observed at 3 hrs post feeding tended to increase again at 6 hrs. This trend was observed with all banana by-product treatment. These results indicated that there was significantly higher effect for treatment with bacteria plus fungus than those for urea treatment on pH values, being 7.5 vs. 6.79 at zero time. There were in significant differences between the untreated bacteria and fungi treatment. He found also that reminal NH_3-N ranged from 22.68 to 11.90 (mg/100 ml) before feeding, from 26.97 to 15.40 (mg/100 ml) at 3 hrs after feeding, and from 25.57 to 12.83 (mg/100 ml) at 6 hrs after feeding. The maximum NH_3-N values were observed at 3 hrs post feeding and tended to decrease after wards. The least value for NH_3-N was obtained for untreated by-products. At 3 hrs after feeding, the highest figures were recorded for biological treatment, being 26.97 (mg/100 ml), and the lowest values were found for urea. Bacteria and bacteria plus fungi treatments produced the highest figures, being 23.80 and 25.57 (mg/100 ml) and the least figures were found for untreated, urea, and acid plus urea treatments, being 14.00, 13.23 and 12.83 (mg/100 ml), respectively, at 6 hrs after feeding.

Kholif *et al*. (2001) found that ruminal pH and ammonia nitrogen were not affected by biological treatment. However, TVFA's, total nitrogen, protein nitrogen and true protein nitrogen were significantly ($P < 0.05$) increased by biological treatment compared with control. Moreover, Hassan *et al*. (2005) reported that silage making significantly increased ($P < 0.05$) total VFA's in EM_1 banana waste silage than other experimental rations. In addition, Mohsen *et al*. (2006) registered that total VFA's were significantly ($P < 0.05$) increased in banana waste silage treated with bacteria than other silages. Abdelhamid *et al*. (2003) concluded that microbial fermentation was not adversely affected by dietary treatments reflecting normal ranges of pH values, concentrations of VFA's and NH_3-N in ruminal liquor of calves. Yet, Abdelhamid *et al*. (2007) registered higher ruminal values of pH, TVFA's and ammonia-N of lambs fed the control diet than those of animals fed the biological treated mixtures.

From the foregoing results it could be concluded that EM_1 as an additive for making silage of banana waste was effective. Ensilage of banana wastes with urea or EM_1 reduced the tannins level and CF content but increased OM, CP, NFE and nutritive value; as well as nutrients digestibility comparing with the banana waste silage without additives, (even comparing with the control, e.g. for CF and EE). So, it is to recommend using banana waste silage with EM_1 (or urea) in feeding ruminants.

Table (6): Effect of treatment and sampling time on ruminal pH, and TVFA's and ammonia concentrations in rumen liquor of growing lambs fed the experimental diets (means ± SE).

Item	Sampling time (hr)	Experimental group			
		T_1	T_2	T_3	T_4
pH value	**0**	7.07 ± 0.03^a	7.10 ± 0.06^a	7.10 ± 0.06^a	6.63 ± 0.12^b
	3	5.73 ± 0.13^b	5.90 ± 0.12^b	6.47 ± 0.27^a	5.80 ± 0.10^b
	6	6.30 ± 0.06^a	5.70 ± 0.17^b	6.30 ± 0.12^a	5.80 ± 0.06^b
NH_3-N (mg/100 ml)	**0**	18.77 ± 0.98^a	16.54 ± 0.99^a	17.98 ± 0.81^a	12.91 ± 1.18^b
	3	14.08 ± 0.78	15.64 ± 0.98	16.42 ± 0.78	14.86 ± 1.80
	6	14.08 ± 0.35^a	10.17 ± 0.32^b	12.51 ± 0.78^a	9.38 ± 0.40^b
TVFA's (meq/100 ml)	**0**	16.67 ± 0.83^a	10.13 ± 0.63^b	12.67 ± 1.45^b	11.58 ± 0.87^b
	3	13.03 ± 0.78^a	8.70 ± 0.15^b	13.82 ± 0.86^a	11.68 ± 0.72^a
	6	13.25± 0.52^{ab}	10.17 ± 0.73^b	16.00 ± 2.00^a	12.00 ± 1.32^{ab}

a, b and c: Means with different superscripts in the same row are significantly different at (P < 0.05).

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تقييم إمكانية تدوير مخلفات الموز كعلف للمجترات. - التركيب الكيماوى – قياسات سائل الكرش – معاملات الهضم – والقيم الغذائية فى الحملان.

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تم عمل ثلاثة كومات من السيلاج كل كومة مقدارها ٢ طن من مخلفات نبات الموز الكامل، وتم إضافة قش الأرز إلى المخلف بنسبة ١:٢، والمولاس بنسبة ٥% لكل معاملات السيلاج، **السيلاج الأول:** كان بدون إضافات، **السيلاج الثانى:** كان بإضافة اليوريا بنسبة ٣%، **السيلاج الثالث:** كان بإضافة الكائنات الحية الدقيقة EM_1 بنسبة ١%. استخدم فى التجربة عشرين حولى خليط (٨/٣ فلندى × ٨/٥ رحمانى) عمر ٤ شهور بمتوسط وزن ٢٢ كجم، وقد قسمت الحوالى إلى أربع مجموعات متشابه طبقا للوزن (٥ حيوانات فى كل مجموعة) وذلك لدراسة التحليل الكيماوى، خواص تخمرات السيلاج، معاملات الهضم، والقيم الغذائية. وغُذيت الحوالى فى كل المجموعات على نفس المركزات، وقد قسمت إلى أربع مجموعات تجريبية طبقاً لنوع العلف **المجموعة الأولى** غُذيت على دريس البرسيم وقد اعتبرت كمجموعة مقارنة، **المجموعة الثانية** غُذيت على سيلاج الموز المعامل بالمولاس ٥%، **المجموعة الثالثة** غُذيت على سيلاج الموز المعامل بالمولاس ٥%، واليوريا ٣%، أما **المجموعة الرابعة** فقد غُذيت على سيلاج الموز المعامل بالمولاس ٥%، ومعامل ميكروبيولوجيا بـ EM_1 ١%. وغُذيت كل المجموعات على أساس نسبة العلف المركز إلى العلف المائى بنسبة ٧٠% من الاحتياجات الغذائية فى صورة علف مركز والمخلف للشبع – طبقاً للاحتياجات الغذائية **(NRC,**

(1985 ويتم التعديل طبقاً للتغير فى وزن الجسم، وقد استمرت فترة التغذية لمدة ستة شهور (١٨٠ يوماً). وفى نهاية التجربة أجريت تجارب الهضم لتحديد القيم الغذائية للعلائق المختبرة، كما تم جمع عينات سائل الكرش. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:-

احتواء السيلاج المضاف إليه اليوريا قبل السيلجة على أعلى نسبة من البروتين والرماد والدهن وزيادة محدودة من الألياف وانخفاض فى المادة العضوية والكربوهيدرات. السيلجة أدت إلى نقص فى الألياف الخام والدهن وزيادة البروتين الخام والكربوهيدرات، وذلك بإضافة اليوريا ٣% والكائنات الحية الدقيقة EM1. سجل السيلاج المحتوى على اليوريا ٣% والكائنات الحية الدقيقة (EM1) زيادة معنوية فى معاملات هضم المادة الجافة و المادة العضوية والبروتين الخام والألياف الخام والدهن والكربوهيدرات مقارنة بالسيلاج غير المعامل. سجل السيلاج المحتوى على الكائنات الحية الدقيقة (EM1) أفضل النتائج مقارنة بالكنترول فى معاملات هضم المادة الجافة والمادة العضوية والبروتين والألياف والدهن والكربوهيدرات مقارنة بالكنترول. لا توجد اختلافات معنوية بين المعاملة الثالثة (سيلاج باليوريا ٣%) والمعاملة الرابعة (سيلاج بالكائنات الحية الدقيقة EM1). توجد اختلافات معنوية بين الكنترول والمعاملة الرابعة (السيلاج بالكائنات الحية الدقيقة EM1)، وبين المعاملة الثانية (السيلاج بدون إضافة) مقارنة بالمعاملة الثالثة (سيلاج باليوريا ٣%) والمعاملة الرابعة (سيلاج بالكائنات الحية الدقيقة). سجل السيلاج المحتوى على اليوريا ٣% والسيلاج المحتوى على الكائنات الحية الدقيقة زيادة غير معنوية فى مجموع المواد الغذائية المهضومة، بينما سجل زيادة معنوية مقارنة بالسيلاج غير المعامل. سجل السيلاج المحتوى على اليوريا ٣% والسيلاج المحتوى على الكائنات الحية الدقيقة والسيلاج بدون إضافة زيادة معنوية مقارنة بالكنترول فى مجموع المواد الغذائية المهضومة. سجل السيلاج المحتوى على ٣% يوريا والسيلاج المحتوى على الكائنات الحية الدقيقة زيادة غير معنوية فى المهضوم من البروتين الخام ، بينما سجل زيادة معنوية فى المهضوم من البروتين الخام مقارنة بالسيلاج غير المعامل. سجل السيلاج المحتوى على اليوريا ٣% والسيلاج المحتوى على الكائنات الحية الدقيقة والسيلاج بدون إضافة زيادة معنوية فى المهضوم من البروتين الخام مقارنة بالكنترول. قيمة الأس السالب لتركيز أيون الهيدروجين فى الكرش انخفضت بعد ثلاث ساعات من التغذية وذلك فى جميع المعاملات سواء الكنترول، سيلاج بدون إضافة، سيلاج باليوريا، سيلاج بالكائنات الحية الدقيقة. المعاملة باليوريا أدت إلى زيادة هذه القيم فى الكرش مقارنة بباقى معاملات السيلاج الأخرى. كانت أعلى قيمة لتركيز الأمونيا بعد ثلاثة ساعات من التغذية على السيلاج المعامل باليوريا، تلاها السيلاج بدون إضافة، ثم السيلاج بالكائنات الحية الدقيقة، وانخفض بعد ستة ساعات من التغذية مقارنة بالكنترول. كانت أعلى قيمة للأحماض الدهنية الطيارة بعد ثلاثة ساعات للسيلاج المعامل باليوريا والسيلاج المعامل بالكائنات الحية الدقيقة على التوالى، وكان تركيز الأحماض الدهنية الطيارة بعد ٦ ساعات من التغذية أعلى فى كل من السيلاج باليوريا والسيلاج بالكائنات الحية الدقيقة مقارنة بالسيلاج بدون إضافة.

وعلى ضوء النتائج المتحصل عليها من الدراسة يمكن استخلاص أن: نظراً لارتفاع محتوى هذه المخلفات من الرطوبة يمكن استخدام تلك المخلفات فى المناطق التى توجد بها زراعات الموز عن طريق الاستفادة منها بتحويلها إلى سيلاج بطرق مختلفة، وهذا يؤدى إلى زيادة قابلية الحيوانات على التغذية عليها بعد خفض محتوها من بعض العوامل المضادة للتغذية مثل التانينات بالكمر، فتوصى الدراسة بكمر أو سيلجة مخلفات نبات الموز الكامل، إما بإضافة اليوريا ٣% أو الكائنات الحية الدقيقة (EM1) والمولاس ٥% والقش والمخلف الموز بنسبة ٢:١ لاستفادة الأغنام من سيلاج هذه المخلفات.

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