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SAFETY OF ENSILING POULTRY LITTER WITH SUGAR CANE TOPS

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An experiment was conducted to consider the possibility of ensiling sugarcane tops with or without poultry litter. Sugarcane top was ensiled alone or with poultry litter in the ratio of 100:0, 90:10, 80:20, 70:30 and 40:60, dry basis, respectively. Each mixture was prepared by weighing known amount of each component for the respective mixture. Silos were prepared by firmly packing the respective treatment into 1 kg capacity plastic bucket, double lined with polyethylene bags. After 45 days, silages were opened; all silages had desirable aromas and no mould growth was observed. Addition of broiler litter to sugarcane tops increased ($P<0.05$) crude protein and ash contents linearly from 5.8 to 14.8%, dry basis. Low pH for all the silages (4.65 to 3.75) and higher concentration of lactic acid (3.25 to 11.24, dry basis) indicated completion of desirable fermentation. Results indicated that ensiling is effective and feasible way of the eliminating pathogenic organism present in the poultry waste. It may be concluded from the present study that poultry litter and sugarcane tops can be ensiled safely for feeding ruminants.

Keywords: Ensiling, sugarcane tops, pathogens, poultry litter

INTRODUCTION

Sugarcane is an important cash crop and grown in wide cultivated area of Pakistan. Besides sugar production, sugarcane produces numerous valuable byproducts like, alcohol used by pharmaceutical industry, ethanol used as a fuel, bagasse used for paper, and chip board manufacturing and press mud used as a rich source of organic matter and nutrients for ruminants (Naseeven, 1986 and Ferreiro and Preston, 1976). Sugarcane tops consists of 3 distinct parts, the green leaves (blades), the bundle leaf sheath and variable amounts of immature cane. Tops with immature cane have reasonable amount of water soluble carbohydrates for fermentation (Martin and Bozoglu 1996).

Poultry litter consists of bedding material, excreta, wasted feed, feathers, bacterial biomass, and soil (Goetsch *et al.*, 1998) Poultry wastes are higher in nutritional value than other animal wastes (Hopkins and Poore, 2001) and are source of crude protein and minerals (Ruffin and McCaskey, 1990) Due to the high fiber and non-protein nitrogen contents of the wastes, ruminants are best suited for utilization of the wastes (Bhattacharya and Taylor, 1975).

There have always been concerns about presence of pathogenic bacteria in broiler litter. Processing is necessary for destruction of pathogens, improvement of storage and handling characteristics, and maintenance or enhancement of palatability (CAST, 1978). Processes that have been used include dehydration (Fontenot and Ross, 1980), ensiling alone or with other ingredients (Goering and Smith, 1977) and deep stacking, (Chaudhry *et al.* 1998).

However, ensiling broiler litter is an effective and widely used method for eliminating pathogens and it can be ensiled with crop residues. The present study was conducted with the objectives to: i) study the fermentation parameters in sugarcane poultry litter silage and ii) determine the safety of broiler litter to be used as a feed ingredient when ensiled with sugarcane tops.

MATERIALS AND METHODS

Saw dust containing poultry litter was collected from commercial broiler house shortly after removal of birds and transported to experimental station. Sugarcane tops were collected from sugarcane field at National Agricultural Research Centre, transported to animal farm station, chopped to the size of 1.5 cm length. Sugarcane tops were ensiled alone or with poultry litter in the ratio of 100:0, 90:10, 80:20, 70:30 and 40:60, dry basis, respectively. Each mixture was prepared by weighing known amount of each component for the respective mixture. Silos were prepared by firmly packing the respective treatment into 1 kg capacity plastic bucket, double lined with polyethylene bags. After sealing the bag and container the silos were kept in the store for a period of 45 days. There were six silos for each treatment. Samples of individual components, each mixture were taken aseptically, composited and sub-sampled separately for microbial study and proximate analysis. Samples of microbial study and fermentation characteristic were processed immediately while other samples were frozen for later analysis.

Total (Anonymous, 1967) and fecal (Millipore Corp., 1973) coliform were determined on initial samples of each component, each mixture and ensiled mixtures. The aseptic samples collected for microbial analysis were prepared by homogenizing 25 g of sample with 225 ml of distilled water in a blender at full speed for 1 min. The homogenate was filtered through four layers of cheesecloth and the filtrate was used for determination of pH (electrometrically), Lactic acid, water soluble carbohydrates and microbial analysis. Lactic acid was quantitatively converted into acetaldehyde by concentrated sulfuric acid. The resulting acetaldehyde was determined by its color reaction with p-hydroxydiphenyl in the presence of cupric ion at λ_{max} 560 nm according to the method of Barker and Summerson, (1941), as modified by Pennington and Sutherland (1956). Water soluble carbohydrates were quantitatively measured by reacting with phenol reagent in an acidic medium, the color compound formed between carbohydrates and sulfuric acid was then measured spectro-photometrically at λ_{max} 490 according to the method of Dubois *et al.* (1956) as adapted by Johnson *et al.* (1966).

Samples of all components of silos, pre and post ensiled material for each silo were analyzed for nitrogen on wet samples (AOA 2000 method). Dry matter was determined by drying in duplicate, 200 g samples of each material in forced draft oven at a maximum of 60 °C for 48 h. Following equilibration with atmospheric moisture, the duplicate dried samples were composited, ground to pass a 1 mm sieve and subjected to analysis for DM, ash, (AOAC, 2000), NDF (Van Soest and Wine, 1967), ADF, cellulose and lignin (Van Soest and Wine, 1968).

Statistical Procedures

Data was treated with analysis of variance with general linear model procedure of SAS (1982). Orthogonal polynomials were run to test the treatment effect. The contrasts were: i) sugarcane tops alone vs mixtures containing broiler litter and sugar cane tops, ii) within broiler litter containing mixtures the contrast were mixture containing 40% broiler litter vs other broiler litter containing mixtures, iii) mixture containing 40% broiler litter vs mixtures containing 20 and 30% broiler litter, and iv) mixture containing 10% broiler litter vs mixture containing 20 and 30 % broiler litter.

RESULTS AND DISCUSSION

Chemical and biological analyses

Chemical composition of the ingredients is presented in Table 1. Broiler litter contained 25% crude protein, dry basis, higher than the values reported by Chaudhry *et al.* (1998) but lower than the values reported by Harmon *et al.* (1975). Ash contents of broiler litter were similar to the values reported by Abdelmawla *et al.* (1988). These differences in composition could be attributed by number of factors like, bedding material, the number of batches of birds housed on the litter, broiler house management, method of litter removal, and moisture content (Fontenot *et al.* 1990).

Table 1. Chemical composition of the ingredients[ab]

Items	Proiler litter	Sugarcane top
DM g kg^{-1}	910	289
CP g kg^{-1}	281	60
Ash g kg^{-1}	201	85
Cell wall Constituent		
NDF[c] g kg^{-1}	343	650
ADF[d] g kg^{-1}	254	401
Cellulose g kg^{-1}	315	351
Hemicellulose g kg^{-1}	68	214
Lignin g kg^{-1}	90	127

[a]Each value represents the mean of six samples.
[b]Dry matter basis.
[c]Neutral detergent fiber.
[d]Acid detergent fiber.

Crude protein content for sugarcane tops was 5.95 % (Table 1) lower than the values reported by (Pate and Coleman, 1975). Neutral detergent fiber, ADF, cellulose, hemicellulose and lignin values present in sugar tops were 65%, 40%, 35%, 21% and 13 %, respectively. These values are similar to the values reported by Kevelenge *et al.* (1983[a]).

Chemical composition of pre- and post ensiled mixture is presented in table (Table 2). Dry matter, crude protein and ash content of initial and ensiled mixture were lower for sugarcane tops alone and increased linearly ($P<0.05$) with increasing level of poultry litter, due to higher dry matter, crude protein and ash content in the broiler litter. The slight decrease in dry matter content for each mixture after ensiling could be attributed by the respiration of plant cell and action of microbes in the ensiled mixture (Viljoen, *et al.* 1926).

Table 3 presents the results of microbial analysis. Total number of colony forming units (CFU) for untreated broiler litter was 9.35×10^7 units g^{-1} DM. Colony forming unit for initial mixtures with or without poultry litter varies from 0.002×10^3 to 11.17×10^3 and *Salmonella, Shigella* and *Proteus* were present. Following ensiling all samples of broiler litter becomes negative for *Salmonella, Shigella* and *Proteus.* Complete elimination of microorganisms has been reported by Casewell *et al.* (1975) when broiler litter was ensiled

Table 2. Composition of initial mixtures of poultry litter and sugarcane top[a]

Items	Sugarcane tops : poultry litter[bc]					SEM[d]
	100 : 0	90 : 10	80 : 20	70 : 30	60 : 40	
Pre-ensiled						
DM[ef] g kg^{-1}	290	351	413	475	538	0.04
CP[ef] g kg^{-1}	58	82	104	126	148	0.14
Ash[ef] g kg^{-1}	85	96	108	120	131	0.12
Post-ensiled						
DM[ef] g kg^{-1}	279	339	402	461	522	0.05
CP[ef] g kg^{-1}	61	84	107	129	151	0.11
Ash[ef] g kg^{-1}	86	95	108	121	132	0.12

DM = Dry matter, CP= Crude protein,
[a]Each value represents the mean of six samples.
[b]Proportion on wet basis.
[c]Dry matter basis except for DM.
[d]Standard error of means.
[e]sugarcane tops vs litter containing mixture differ (P<0.01)
[f]Linear effect of waste treatment significant (P<0.05)

Table 3. Total and colony forming units (CFU), *Salmonella, Shigella and Proteus* of initial and ensiled mixtures

Fermentation characteristic of poultry litter and sugarcane top mixture[a]					
Pathogens	Sugarcane tops: poultry litter[b]				
	100:0	90:10	80:20	70:30	60:40
Total CFU[c] (10^3)					
Pre-ensiled	.002	0.918	3.25	9.93	11.17
Post-ensiled	-	-	-	-	-
Fecal CFU[c] (10^3)					
Pre-ensiled	.01	0.67	0.79	0.93	1.18
Post-ensiled	-	-	-	-	-
Salmonella[d]					
Pre-ensiled	+	+	+	+	+
Post-ensiled	-	-	-	-	-
Shegella[d]					
Pre-ensiled	+	+	+	+	+
Post-ensiled	-	-	-	-	-
Proteus[d]					
Pre-ensiled	+	+	+	+	+
Post-ensiled	-	-	-	-	-

[a]Six samples per treatments.
[b]Proportion on wet basis.
[c]CFU, g^{-1} dry basis.
[d]Qualitative study; (+) indicates presence. (-) indicates absence of respective organisms.

with 40% moisture. Similar findings have been reported by Chaudhry *et al.* (1993). Some *lactobacilli* species produce sufficient hydrogen peroxide to inhibit coliform and *Salmonella* organisms (Dahyia and Speck, 1969). Bacteria isolated from ensiled animal waste inhibit the growth of coliform bacteria, *Salmonella*, *Streptococci* and *Staphylococci* by mechanisms of other than acid production (McCaskey and Anthony, 1979). Ensiling results in complete elimination of pathogen due to; i) low pH, ii) presence of antibiotic like substances produced by lactic acid bacteria, and iii) the ability of organic acids to pass over the cell membranes of micro-organisms thus lowering the organism's internal pH to destructive levels (Raa and Gildberg 1982).

Sugarcane tops contained 8% water soluble carbohydrates (table 4). Roxas (1985) reported similar values of water soluble carbohydrates and suggested that sugar tops contains sufficient amount water

Table 4. Fermentation characteristic of poultry litter and sugarcane top mixture[a]

Items	Sugarcane tops: poultry litter[b]					
	100 : 0	90 : 10	80 : 20	70 : 30	60 : 40	SEM[c]
pH						
Pre-ensiled[de]	6.5	6.85	6.9	7.0	7.0	0.02
Post-ensiled[de]	5.12	5.15	5.04	5.01	4.38	0.05
Lactic acid						
Pre-ensiled	0.0	0.0	0.0	0.0	0.0	
Post-ensiled[de]	3.25	6.51	7.15	9.15	11.24	0.16
WSC[f]						
Pre-ensiled[de]	8.25	5.85	6.3	6.4	6.5	0.21
Post-ensiled[de]	4.35	1.25	1.9	1.75	2.8	0.18

[a]Each value represents the mean of six samples.
[b]Proportion on wet basis.
[c]Standard error of means.
[d]sugarcane tops vs litter containing mixture differ (P0.01)
[e]Linear effect of waste treatment significant (P<0.05)
[f]water soluble carbohydrates

soluble carbohydrates needed for desirable fermentation. After ensiling pH and water soluble carbohydrates of sugarcane tops silage decreased from 6.5 to 4.3 and 8.2 to 4.3, respectively (Table 4). McDonald (1981) reported that generally silages with pH of 3.7 to 5 are of good quality. Within litter containing mixture the pH decreased for all the ensiled mixture and values varies from 4.17 to 3.73. However, the lowest values were found for the mixture containing 30% poultry litter. Usually there are two types of fermenting bacteria involved in ensiling process; i) fiber digesters and ii) those that specialize in digesting starch and more soluble carbohydrates. The second group tends to be adventitious, producing lactic acid at the expense of cellular efficiency. Rapid production of lactic acid reduces pH and thus renders the environment more favorable for their growth because low pH is inhibitor to the slower fermenting organisms dependent on cellulose and hemicellulose (Jung, 1985).

Water soluble carbohydrates decreased for the all ensiled mixture and concentration of lactic acid increased (P<0.05) with increase of poultry litter in the mixture. Highest values were found for the mixture containing 40% poultry litter but pH of the respective mixture was not lowest. It may be due to higher buffering capacity of broiler litter (Georing and Smith 1977). We found desirable level of lactic acid ≥ 6%, dry matter basis, indicating completion of desirable fermentation in all the mixture containing poultry litter.

Results indicated that ensiling of sugar cane tops with or without poultry waste showed feasible way of preserving the animal feed for scarcity period. Sugarcane tops have enough fermentable carbohydrates to generate rapid fermentation. Moreover ensiling is an effective means of eliminating pathogens.

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