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# ENHANCEMENT OF THE NUTRITIVE VALUE OF BAGASSE USING CHICKEN MANURE

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**ABSTRACT**

The study investigated the effects of chicken manure droppings on the nutritive value of sugar cane bagasse upon fermentation. It was hypothesized that the use of the two low cost residues (bagasse and chicken manure) in an animal feed could present a great nutritional potential to livestock farmers. Five treatments were made in duplicates, containing zero (control), 2.5, 5, 7.5 and 10% chicken manure. The measurements included pH changes, organic matter digestibility as well as proximate analyses of Crude protein (CP), Neutral Detergent Fiber (NDF), Crude fiber (CF). Fat and ash content of bagasse were determined before and after fermentation for 21 days. A further investigation involved in-sacco digestibility determination. Data was obtained by insertion of nylon bags containing various rations into a fistula of rumen fistulated animal and removed at 3, 6, 12, 24, 48 72 and 96 hours. The bagasse used in had a moisture content which averaged 48 %.± 3.0 with an initial pH of 6.9 ±0.15. There was variation on the composition of the manure dependent on the source amongst all the parameters assessed. The broiler manure had the highest crude protein content and this differed significantly ($p< 0.05$). Substantial amounts of Ca were found to be present in the chicken layer manure. Fermentation of bagasse for a period of 21 days improved bagasse digestibility from 35% to an average of 81%. All rations analyzed after fermentation showed significant ($p<0.05$) decline in NDF content compared with before fermentation. The 10% chicken manure assay analyzed before fermentation showed a higher value of ash compared with after fermentation. The *in vitro* dry matter digestibility progressively increased significantly ($p< 0.05$) with the increase of chicken manure level in the diet. The organic matter before fermentation was determined to be 59.2±2.1 compared to 45±1.8 after fermentation which was significant ($p<0.05$). The dry matter digestibility was observed to increase significantly ($p<0.05$) with addition of chicken manure in the formulated diet which peaked at 50.26 at 10 % manure. Addition of chicken manure had an incremental increase in the crude protein degradability which differed significantly ($p<0.05$) from 2.5% to 10%. The findings suggest that microbial fermentation of bagasse using chicken dropping improves its digestibility to the extent that it can be utilized as an alternative livestock feed.

**Key words:** Fermentation, Bagasse, Chicken, Manure, Digestibility

## INTRODUCTION

Intensive chicken farming leads to solids disposal problems worldwide. While animal waste is commonly applied to farmland as a fertilizer, it is known to be more valuable as a feed nutrient [1]. Due to the high fiber and non-protein nitrogen content of the wastes, ruminants are best suited for utilization of the wastes [2]. Poultry Manure has a potential use as a ruminant feed in addition to its traditional use as fertilizer. It has been shown that poultry manure/litter is more valuable as a feed ingredient than as a fertilizer. In fact, the economic value of poultry manure/litter as a feed ingredient in balanced diets for several classes of ruminants is up to four times greater than its value as a fertilizer [3, 4]. In addition to offering an economic advantage, using poultry manure/litter as animal feed is environmentally friendly. Many of the nutrients in the broiler litter are redistributed on pastureland as cattle manure. The utilization of the waste through ruminant animals could thus become a convenient option of disposing the waste [3].

Lignocellulosic biomass such as sugarcane bagasse is mainly used for production of ethyl alcohol, sugar and spirits [4]. Sugarcane bagasse is a by-product resulting from juice extraction [4]. Many sugar milling factories in Kenya and around the world release large quantities of bagasse as part of their byproducts, some even dispose it as a waste. Traditionally, past research has more or less focused on utilization of bagasse for production of energy, fabrication boards, and paper manufacture as well as for production of insulation material [5]. In addition; one major potential use of bagasse is as feedstuff for cattle [6]. However its low digestibility limits its use in the raw state. The study investigated the possible use of chicken manure and bagasse residues upon fermentation as an animal feed.

## MATERIALS AND METHODS

The experiments were undertaken at the food chemistry and animal science laboratories, Egerton University. Manure was obtained from the Tatton farm Egerton University, Njoro in Kenya. Sugarcane bagasse was sourced from the Muhoroni sugar factory in Kenya. All chemical analyses were carried out in triplicate for the manure samples as per the AOAC method, 1984 [7].

**Preparation of the formulation rations***:* A basal diet (BD) containing 85% baggasse 10% molasses, 5% sorghum grains was formulated. Graded levels of chicken manure obtained from broilers (0, 2.5, 5, 7.5 and 10%) were added to the BD as percentage of diet weight to make five dietary treatments. Molasses was mixed with water in the ratio of 1:2 and added to each dietary treatment. Each diet was then mixed, put in a plastic bag compressed to remove air and closed. The bags were stored for 21 days away from sun light to ferment under incubation of 23$^{o}$C. The procedure was repeated for chicken manure obtained from layers manure (0, 2.5, 5, 7.5 and 10%). At the end of the fermentation period the pH of each treatment was measured. Chemical Analyses, dry matter, crude protein, neutral detergent fiber, degradability and acid detergent fiber were performed before and after fermentation**.**

Acid detergent fiber (ADF) was determined by the method of Goering & Van Soest [8]. Neutral detergent fiber (NDF) was determined by the method of Robertson & Van Soest [9]. Organic matter digestibility was determined according to the two-phase technique by Tilley & Terry [10]. Crude protein (CP) was determined using a Micro-Kjeldahl method. All nitrogen results were expressed as a protein equivalent using conversion factors.

A 600kg rumen fistulated Fresian bull was used for the insertion of the samples. The bull was acclimatized for one week before the beginning of the research. This aimed at stabilizing the rumen environment (temperature of 39$^{o}$C, pH of 5.5-7.1) reducing shock to micro organisms and achieving definite proportion of the rumen microorganisms. The bull was fed on a pure ration of hay with 10% molasses added to improve palatability and provide energy for rumen microorganisms to utilize the NPN. The times of feeding were spread through out the day to ensure continuous supply of feed in constant bits without periods of starvation or over feeding. The animal was housed in a clean well lit and airy environment with brief periods of exercise during the day to fulfill its psychological requirements.

**Degradability:** Samples were prepared and subjected to in sacco degradability measurements as described by Michalet-Doreau and Ould-Bah [11]. Data was obtained by insertion of nylon bags into the rumen of the fistulated animal and removed at 3, 6, 12, 24, 48 72 and 96 hours. Dry matter and N disappearance were measured in triplicate from the fistulated animal according to Ørskov and McDonald [12]. At the end of each incubation period, the percentage in sacco DM disappearance was calculated. Samples were taken out of the bags and stored in polyethylene vials for later analyses of nitrogen according to the AOAC [13].

**Statistical analysis:** A one way ANOVA with treatments in a 2 X 5 factorial were used [14]. Treatment effects were two experimental periods and five concentrations of chicken layers manure (0, 2.5, 5, 7.5 and 10%). An analysis of variance was performed for the treatments and significant differences were identified by means of Tukey's T–test.

## RESULTS

Table 1 gives the determined composition of various animal manure. There was variation dependent on the source amongst all the parameters. The broiler manure had the highest crude protein content and this differed significantly ($p< 0.05$). Substantial amounts of Ca were found to be present in the chicken layer manure compared to the other three sources.

The effects of fermentation on the nutritive value of bagasse are given in Table 2. All rations analyzed after fermentation showed significant ($p<0.05$) decline in NDF content compared with before fermentation. From the table, the 10% chicken manure assay analyzed before fermentation showed a higher value of ash compared with after

fermentation. This trend was also similar for the crude protein. The in vitro dry matter digestibility progressively increased significantly ($p< 0.05$) with the increase of chicken manure level in the diet.

The 5% percent chicken manure assay analyzed before fermentation showed higher values of fat content compared with that analyzed after fermentation with chicken manure respectively (Table 2). The 10% chicken manure assay showed the lowest value of fat content compared with the same assay analyzed before fermentation. The fat content of control (zero chicken manure assay), 5 and 7.5% manure assays were all found to change only slightly before and after fermentation with chicken manure.

The 2.5% percent chicken manure after fermentation was found to show a higher value of crude fiber compared with before fermentation respectively. But control (zero chicken manure) after fermentation was found to show the lowest value compared with that before fermentation respectively. The crude fiber content of all the rations before and after fermentation as evident from Table 2, did change significantly ($p< 0.05$).

The bagasse used in the present study had a moisture content which averaged 48 %.± 3.0 with an initial pH of 6.9 ±0.15. The effects of fermentation on the pH value of bagasse are shown in Table 3. The 10% percent chicken manure assay analyzed after fermentation showed the least change i.e. unfermented and fermented. The 2.5% ration was found to have changed the most in acidity level.

The organic matter before fermentation was found to be 59.2± 2.1 compared to 45±1.8 after fermentation which was significant ($p < 0.05$). From table 4, the dry matter digestibility was observed to increase significantly ($p < 0.05$) with addition of chicken manure in the formulated diet which peaked at 50.26 at 10 % manure. There was a gradual decline in the neutral detergent fiber digestibility with a significant ($p<0.05$) decline occurring in the 5% and 10% NDF digestibility. The dry matter degradability increased significantly ($p<0.05$) in the 7.5 % and 10% manure, peaking at 46.4 % DM (Table 5).

Addition of chicken manure had an incremental increase in the crude protein degradability which differed significantly ($p<0.05$) from 2.5% to 10% (Table 5).

**DISCUSSION**

Non structural carbohydrates (NSC) or non-fibrous carbohydrates are found inside cells of plants and are water-insoluble [4]. NSC includes starches, sugars and fructans and organic acids for ensiled feeds. They are more rapidly degradable in the rumen relative to the structural (cell wall) carbohydrates [4]. Crude fiber fermentability has been identified as one of the limiting factors in utilization of high fiber content feeds such as bagasse. One of the ways of using sugar cane as animal feed is as ensilage. The ensilage process is a technique that consists in preserving foddering plants through acid fermentation adequacy, in which lactic acid bacteria convert soluble

sugars into lactic acid [15]. Sugar cane is an unbalanced food, rich in energy and poor in crude protein (about 2 to 3%) (16). Due to low crude protein content of sugar cane, diets based on cane forage require a large quantity of supplemental nitrogen. The economics of feeding sugar cane could thus be improved by using a less expensive source of crude protein, like urea or ammonia [16].

In the present study chicken manure was used as an inexpensive source of nitrogen and also a microbial source. Fermentation of bagasse for a period of 21 days was found to improve bagasse digestibility by approximately 30%. The NDF% decreased from 84.63 to 57.23 at 10% supplementation. A possible explanation could be that increase in chicken manure had an incremental increase on the lactic acid generated during fermentation which improves overall digestibility resulting in a lowered NDF. The cell wall content as represented by NDF represents the most important fraction of dry matter for forages inclusive of bagase. The low nitrogen content of bagasse is a clear indicator of a need to supply fermentable nitrogen. The addition of chicken manure at various proportions is thus important. Apart from improving the NPN component of bagasse it facilitates the fermentation process. This is because chicken manure is a good source of the fermenting micro-organism (*Fibrobacter succinogenes*), provided it is processed well to destroy potentially harmful microorganism [17]. The manure also contributes to the desirable acidity. While urea degrades/decomposes to ammonia and carbon dioxide through the action of urease the chicken manure acts as a microbial growth factor by providing the source of *Fibrobacter succinogenes*. This microbe has a role in the breakdown of urea into uric acid and thereby contributes to the desirable acidity [17, 18].

The findings from the present study provide information on the effect microbial fermentation on the nutritive value of bagasse using chicken manure at different concentrations. In Kenya there are no specifications for poultry manure as animal feed and it is unclear where such specifications have been enacted elsewhere. The determined levels in the present study were however within the suggested limits of an earlier investigation [19].

In light of threat of a bird flu pandemic, the issue of using poultry droppings as animal feed could raise safety concerns and would have to be addressed adequately. Two serious obstacles to the feeding of poultry excreta to livestock are pathogenic organisms and medicinal drugs. However poultry waste can be rendered free of pathogens by autoclaving, fumigation and dry heat alone or in combination with formaldehyde [20]. Furthermore, other methods of processing such as ensiling and deep stacking have been proposed as possible ways of enhancing the safety of the poultry excreta [20].

Coprophagy, or feeding on manure, is not new in animal nutrition. For example, livestock feeding on a farm has frequently involved a system of beef cattle followed by hogs and subsequently chickens [18]. Under such a program the nutrition of the hogs and chickens is based on manure. The current interest in manure as a feedstuff is mostly due to the problem of waste disposal from intensive livestock and poultry

operations. Apart from this problem it has been recognized that large amounts of nutrients are wasted. The re-use of manure could be one way of creating edible protein from waste material which is often disposed of uneconomically and also creates a nuisance. The amount of excreta produced is considerable: a 2kg hen produces an average of 0.8 kg a week, a 650-kg cow 150 kg, an 80 kg pig 40 kg and a 45 kg pig 22 kg. Manure has served as a substrate for both yeast and algae used as feedstuffs, and it has been tried as a substrate for maggots used as a poultry feed the authors are however of the view that the simplest way to use it is as a direct feed [18].

## CONCLUSION AND RECOMMENDATION

This study indicates that the additions of chicken manure enhances the protein and mineral content, increases the dry matter digestibility and protein degradability. The use of these two low cost residues resulting in an animal feed seems to present a great nutritional potential to livestock farmers. It might be of future use to carry out research to determine the effect of feeding bagasse to dairy animals on the composition and safety of milk.

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**Table 1: Composition of animal manure *(n=3)* dry matter basis**

| *Manure parameter* | *Broiler manure* | *Layers manure* | *Cow manure manure* | *Pig* |
|---|---|---|---|---|
| Moisture | 10.06±0.9[a] | 9.91±0.9[a] | 14.2±1.2[b] | 11.5±0.9[c] |
| Crude Protein (CP) | 30.0±1.7[a] | 26.0±1.2[b] | 11.5±1.1[c] | 22.6±0.8[d] |
| Crude fiber | 15.2±2.5[a] | 11.5±1.8[b] | 10.8±1.6[c] | 13.8±1.1[d] |
| Fat | 1.8±0.9[a] | 1.6±0.4[a] | 1.4±0.7[a] | 6.2±1.4[a] |
| Ash | 12±1.1[a] | 29±3.4[b] | 17.1±1.7[c] | 12.2±2.2[a] |
| Calcium | 2.6±0.3[a] | 5.5±1.3[b] | 1.0±0.1[c] | 3.8±0.2[d] |
| Phosphorus | 2.5±0.4[a] | 3.7±1.1[b] | 2.4±0.8[a] | 3.6±0.8[b] |
| Sodium | 0.2±0.1[a] | 0.5±0.3[b] | 0.1±0.1[a] | 0.4±0.2[c] |
| Potassium | 2.1±0.4[a] | 3.4±0.8[b] | 0.8±0.2[c] | 1.9±0.5[d] |

[abcd] Means in the same row with no common superscript $p < 0.05$)

Errors are ± standard deviation of triplicate determinations.

**Table 2: Effects of 21 days fermentation on the nutritive value as dry matter basis of bagasse before fermentation (BF) and after fermentation (AF)**

| *Fermentation traits* | *Treatments* | | | | |
|---|---|---|---|---|---|
| | *Basal medium supplemented with manure (%)* | | | | |
| | **Control (0%)** | **2.50%** | **5%** | **7.50%** | **10%** |
| NDF% BF | 84.63±4.9[a] | 84.95±4.0[a] | 73.23±5.1[a] | 71.01±4.8[a] | 57.23±3.3[a] |
| NDF% AF | 82.94±3.4[a] | 80.02±4.3[b] | 65.01±4.8[b] | 60.25±5.1[b] | 40.26±2.9[b] |
| Ash% BF | 3.94±0.8[a] | 5.01±1.1[a] | 5.68±0.9[a] | 5.89±1.2[a] | 5.93±1.4[a] |
| Ash% AF | 3.62±0.4[a] | 4.82±0.8[a] | 5.65±1.0[a] | 3.84±0.6[b] | 4.58±0.7[b] |
| CP% BF | 5.32±0.2[a] | 6.13±0.5[a] | 7.54±0.4[a] | 7.22±0.3[a] | 9.01±0.9[a] |
| CP% AF | 3.01±0.1[b] | 6.00±0.4[a] | 6.97±0.3[a] | 6.08±0.5[b] | 7.05±0.7[b] |
| FAT% BF | 0.09±0.04[a] | 0.08±0.01[a] | 0.16±0.02[a] | 0.05±0.01[a] | 0.04±0.02[a] |
| FAT% AF | 0.08±0.01[a] | 0.07±0.03[a] | 0.15±0.05[a] | 0.04±0.03[a] | 0.03±0.01[a] |
| CF% BF | 30.91±0.3[a] | 34.01±0.5[b] | 33.33±0.4[b] | 30.73±0.2[c] | 32.85±0.4[c] |
| CF% AF | 22.74±0.1[b] | 30.52±0.4[b] | 27.4±0.2[b] | 24.22±0.1[b] | 25.25±0.3[b] |

Errors are ± standard deviation of triplicate determinations.

Crude protein (CP %), Neutral Detergent Fiber (NDF %), Crude fiber (CF %)

[ab]Means in the same column within the same fermentation trait with no common superscript differ ($p < 0.05$).

**Table 3: Effects of fermentation on the pH value (dry matter basis) of bagasse**

| ***Ph readings*** | ***Treatments*** | | | | |
|---|---|---|---|---|---|
| | **Control (0%)** | **2.50%** | **5%** | **7.50%** | **10%** |
| 1. *p*H-reading BF | 6.94 ±0.15 | 6.79± 0.02 | 6.52±0.03 | 6.29±0.15 | 6.16± 0.02 |
| *p*H-reading AF | 6.56±0.02 | 5.09± 0.17 | 5.55±0.11 | 5.78±0.03 | 5.98± 0.04 |
| *P<0.05* | | * | * | * | * |

Errors are ± standard deviation of triplicate determinations.

BF = Before fermentation

AF = After fermentation

**Table 4: Effects of fermentation on the dry matter degradability (DM*dig%*), Neutral detergent digestibility (NDF), of the bagasse formulation**

| ***Parameter*** | ***Treatment*** | | | | |
|---|---|---|---|---|---|
| | **Control (0%)** | **2.50%** | **5%** | **7.50%** | **10%** |
| DM*dig%* | 33.94 ±3.15 | 46.79± 0.02 | 48.52±3.03 * | 48.29±4.15* | 60.26± 3.02 * |
| NDF*dig%* | 30.96±3.02 | 29.29± 2.17 | 24.55±2.11 * | 20.78±0.03* | 15.98± 1.04 * |

Errors are ± standard deviation of triplicate determinations.

*Means before and after fermentation differed significantly ($p < 0.05$).

**Table 5: Effects of fermentation on dry matter degradability (DM *deg%) and* Crude protein (CP*deg*), of the bagasse formulation**

| ***Parameter*** | ***Treatment*** | | | | |
|---|---|---|---|---|---|
| | **Control (0%)** | **2.50%** | **5%** | **7.50%** | **10%** |
| DM*deg%* | 32.6±3.15 | 32.9±1.15 | 33.15±2.15 * | 41.4±3.15 * | 46.4±3.15 * |
| CP *deg%* | 58.2±2.55 | 69±3.15* | 72±2.45* | 87.6±1.15* | 96.2±1.55* |

Errors are ± standard deviation of triplicate determinations.

*Means before and after fermentation differed significantly ($p < 0.05$).

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