Production of a Good Quality Silage from Crop Residues for Ruminant Feeds

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Introduction

Silage fermentation is widely accepted as an important method of feed conservation for ruminants (1). It is produced from a controlled anaerobic fermentation of a plant material. Ensiling can preserve a wide range of crops and in the United States, alfalfa and corn are the two major silage crops (2) It has been estimated that about 18 million tonnes of dry matter of pruned pronds are available annually as crop residues in Malaysia. These materials, such as nipah (*Nipa fruticans*) (NF) and oil-palm fronds (*Elaeis guineensis*) (OPF) have the potential use as feed materials for ruminants after certain processing such as ensiling. A number of studies had been conducted using OPF in the form of silage as a feed material (3,4,5). The results showed that OPF silage could be used successfully as a component of the diet for beef and milk production. On the other hand, NF, although contain higher percentage of crude protein and ether extract when compared to OPF (6), produced poorer silage. The reasons for the differences in the quality of silage are not well understood. Chemical changes that occur during ensiling as well as factors (such as protein, carbohydrate and lignin contents of the fronds), which influence the production of good silage, have not been fully investigated in both OPF and NF. Good silage is produced when the pH is around 4 as a result of lactic acid fermentation. As silage is preserved by lactic acid fermentation, only homofermentative bacteria are beneficial, while others would cause inefficient fermentation or silage deterioration. The objectives of this project were to study the biochemical and microbial changes that took place during ensiling of OPF and NF and determine methods to improve the quality of the silages formed as well as their nutritive values as a feed material for ruminant.

Materials and Methods

Nipah (NF) and (OPF) fronds were chopped (10-15 cm long) mechanically and packed separately in 10 kg batches in plastic bags. Each bag was placed in a bucket and the materials were compressed manually to exclude as much air as possible. The bags were tied and the buckets sealed and left under shade. A total of 42 bags were prepared. Samples of fresh fronds were analysed for chemical composition and observation on anatomical structures. Silages at 2-day intervals during the first two weeks and thereafter at regular intervals for three months were sampled for the determinations of pH and chemical composition (in triplicates). Temperature was measured *in situ*. The chemical composition, the buffering capacity (BC), the concentrations of soluble sugar and lactic acid were measured. The effects of adding 3 % urea and molasses at various concentrations (10, 20, 30%) on the quality of both silages were also investigated. The epiphytic microflora of fresh and ensiled fronds were determined at 2, 4 and 6 weeks in another batch of fronds. The MRS medium was used for enumerating lactic acid producing bacteria (LAB) which includes *lactobacilli, pediococci, streptococci and leuconostoc*, the violet red bile agar medium for *Enterobacterioceae* and malt agar for yeast and fungi. Nutritive value of the silage was determined by nylon bag study *in situ* using rumen fistulated sheep. Rumen parameters were determined in fistulated sheep fed each silage treated with 30 % molasses. A feeding trial was conducted with 24 lambs to study their growth performance when fed molasses treated silage-based diet for 63 days.

Results and Discussion

Fresh NF and OPF contained 4.7 and 5.3% crude protein, 64 and 76 % neutral detergent fibre, 4.6 and 3.3 mg/g soluble sugar, 10 and 5% ash, 17.8 and 14.6 % lignin, 6.0 and 1.4 % tannic acid, respectively. Anatomical investigations showed that the two types of fronds were different in their structures. In OPF, the hypodermic layer consisted of two layers of thin-walled cells, while in NF, the outermost layer of the hypodermis was made up of thick-walled cells. In addition, lignified palisade cells were present below the epidermis on NF, but were absent in OPF. The initial pH was 4.2 for both fronds. During ensiling, pH for nipah was significantly ($p < .05$) higher than that of OPF. pH value for NF increased to 5.3 at 30 d, while the pH value for OPF was maintained around 4.3. The high pH value observed for NF indicates poor ensibility as a result of lower concentration of lactic acid (0.7 g/kg dry matter) when compared to that of OPF (1.5 g/kg dry matter) (7). Lactic acid production was considered low when compared to that of grass or maize silage (53-59 g/kg dry matter). The BC was also significantly ($p < .05$) higher in NF (78.3 meq/100g) than that of OPF (58.3 meq/100g). The initial BC of a material has a considerable effect on its ensibility. The addition of molasses at 10 and 20 % (100g and 200g/kg dry matter, respectively) and urea (30 g/kg dry matter) did not improve the quality of NF silage. The addition of urea to both fronds resulted in higher pHs values (7.2-7.6). However, the addition of 30 % molasses improved the quality of silage produced from NF where pH values and lactic acid production were comparable to that of OPF silage. The epiphytic microflora detected were the LAB (produced lactic acid and thus instrumental in silage fermentation), *streptococci* and *Enterobacteriaceae*. Fungus and yeast were not detected. In OPF silage, the LAB counts increased from 5.16 Log_{10} cfu/g DM on day 0 to 7.76

Log_{10} cfu/g DM on day 28. In NF silage the LAB counts decreased from 5.48 to 4.80 Log_{10} cfu/g DM on day 0 and 28, respectively. The counts for the other groups of bacteria either remained unchanged or declined in both silages. The high counts of LAB in OPF silage would account for the high lactic acid production (0.8 mmol/g DM) and low pH value (3.83), compared to that of NF silage (0.13 mmol/g DM lactic acid and pH 4.7) at day 28 of ensiling. Digestibility studies by *in situ* (nylon bag technique) showed that about 42% DM loss were observed in both silages treated with 30% molasses, while studies by *in vivo* showed that digestibility of silage + concentrate was about 60%. The rumen ammonia nitrogen concentration of sheep fed OPF silage was significantly ($p<.05$) higher than in sheep fed NF silage. The daily weight gain was 170-178 g/d for lambs fed molasses treated silage, and 124 -167 g/d for lambs fed untreated silage (8).

Conclusions

The results indicated that OPF produced better silage than NF with or without the addition of molasses. However, the quality of silage produced from NF had improved and comparable to that of OPF after the addition of 30 % molasses. Although OPF and NF were observed to be different in several constituents of their chemical composition, the most significant difference relevant to the fermentation process during ensilage was the buffering capacity of the fresh materials, which was found to be higher in NF. This frond also contained higher concentrations of *lignin* and *tannic* acids, which might also have some effect on the fermentation process. Nevertheless, the two types of fronds can be considered a potential feeding material for ruminants, especially after ensiling and molasses treatment.

Benefits from the study

The research findings contribute information on the factors affecting OPF and NF silage production and the treatment required to improve the silage formed. Ensiling techniques could be easily adapted for small-scale production of silage by small holders. Once formed, the silage could be stored for a consistent supply of feed to the animals. Oil palm fronds could be ensiled untreated, but NF required soluble carbohydrate (like molasses) addition to improve the fermentation process. The findings would enhance the utilisation of crop residues as feed materials for ruminants. Hence, it gives added value to crop residues as well as improve animal production.

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None.

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