Characteristics of Oil palm (Elaeis guineensis) and Nipah (Nypa fruticans) silages

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SUMMARY

An experiment was conducted to study the chemical characteristics of silages produced from oil palm (Elaeis guineensis) fronds (OPF) and nipah (Nypa fruticans) fronds (NF). Fresh fronds were chopped mechanically and packed separately in tightly closed containers, and left in the shed for various time intervals. Chemical analyses showed that fresh OPF had significantly ($P<0.05$) higher dry matter (DM) and neutral detergent fiber (NDF), but significantly ($P<0.05$) lower ash, lignin, soluble sugars and buffering capacity than that of NF. The crude protein (CP) content 0 ffresh fronds were similar, in the range of 4.7-5.3 %. However, after ensiling for 90 days, the CP content of OPF silage was significantly ($P<0.05$) higher (6.8 %) than that of NF silage (%4.0). On day 30 and 90, OPF silage showed lower pH (4.1 and 4.3, respectively) than NF silage (4.8 and 4.6, respectively). At both incubation periods, the lactic acid contents of OPF silage (53.6 and 52.8 g/kg DM, respectively) were significantly ($P<0.05$) higher than that of NF silage (16.8 and 17.8 g/kg, respectively). The buffering capacity of OPF silage was greatly increased from 57.7 m-eqU/I00g DM at day 0 to 93.3 m-equ/100g DM at day 90, whereas, the buffering capacity for NF silage decreased from 75.0 m-equ/100g DM at day 0 to 51.7 m-equ/l00g DM at day 90.

It was concluded that OPF produced a better quality silage than NF, and that the high ash and lignin contents as well as the buffering capacity of NF may cause the poor quality of the silage produced from NF.

N.B. *Buffering capacity, lactic acid, palm fronds, silage.*

INTRODUCTION

During the last few decades, silage making has been a common practice by livestock producers especially in the temperate countries. Plant materials like grass and maize are ensiled through anaerobic fermentation as a means of feed conservation. In Malaysia, silage making is a novel practice and it is still at the experimental stage, most probably due to limited supply of such plant materials. It has been estimated that about 18 million tons dry matter (DM) of pruned fronds are available annually as crop residues in Malaysia (Hussin *et al.*, 1986, Shafie, 1995). These fronds should be given due consideration as an alternative source of feed materials for ruminants, either fed fresh or ensiled, and in doing so, would give added-value to crop residues. The abundant supply of palm fronds from the plantation industries would ensure a continuous supply of plant materials for silage making and hence, continuous supply of feed materials for animal production. Chemical changes that occur during ensiling as well as factors which influence the quality of silages formed have not been fully investigated in both oil palm and nipah fronds. Hence, the objective of the present experiment was to study the chemical composition of. Both fronds and the quality of the silages produced.

MATERIALS AND METHODS

Tile Fronds:-

Oil palm fronds (OPF) and nipah fronds (NF) were collected from nearby plantations. The whole fronds which consisted of the leaflet, petiole and midrib were chopped to 10-15 em long using a mechanical chopper and mixed before packing. Three fres samples of each frond were taken for chemical analyses.

The Ensiling Technique:-

About 10 kg of freshly chopped OPF and NF were packed into plastic bags separately, and the contents compressed manually to exclude as much air as possible before tying the bags tightly with a string. T he bags were placed individually in closed buckets (30 cm high with diameter of 30 em) and kept in the shade. Forty-two buckets were prepared for each frond for ensiling .

Sampling and Analytical Techniques:-

Sampling of silage in triplicates was carried out on alternate days during the first two weeks and then on day 18, 22, 26, 30, 44, 58 and 90. The samples were used for the determination of pll, lactic acid, buffering capacity and chemical composition. The temperature was measured in situ immediately after opening the bag. Since the effiuent produced was very little, pH of each sample was detenuined following the method described by Playne and McDonald (1966), where 10 gm sample from each bag were mixed with distilled water, blended and filtered. The filtrate was used for the detenuination of pH using a pH-meter fitted with a glass electrode. The detenuination of lactic acid was done by colorimetric technique (Nahm, 1992). The buffering capacity expressed as milli-equivalents of alkali needed to increase the pH from 4 to 6 per 100 gm DM was detenuined according to the method of McDonald and Henderson (1962) and Playne and McDonald (1966).(Choose 1 reference).

The chemical analyses conducted on the fronds were according to AOAC procedures (1984). The soluble sugar content was detenuined according to the procedure described by Dubois *et al*. (1956).

Statistical analysis:-

The data were statistically analyzed as a factorial experiment by analysis of variance (ANOV A) to detenuine the influence of frond type, time and the interaction between the main effects on the characteristics of the silage. The means of all parameters measured were statistically compared using Students t-test (Steel and Torrie, 1980 after separation of the interacting factors in case of a significant interaction.

RESULTS AND DISCUSSION

Table 1 shows the chemical composition and other parameters (temperature, pH, lactic acid content and buffering capacity) of fresh samples of OPF and NF. The results show significant differences between fronds in most of the parameters measured. The dry matter (DM) content of OPF (32.5%) was significantly ($P<0.05$) higher than that of NF (27.1 %). These values were higher than that of fresh grass (15%) (McDonald *et al.*, 1966). The fronds were fibrous in nature with high amount of lignin, where the lignin content of NF (17.8%) was significantly ($P<0.05$) higher than that of OPF (14.6%). The protein and soluble sugar contents of both fronds were rather low, but NF contained significantly higher soluble sugar than that of OPF.

Both OPF and NF fronds showed similar amounts of mineral contents, except for Mg which was twice as much for NF. The Cu contents were very low; hence animal fed these plant materials should be safe from Cu intoxication.

As shown in **Table 1,** the temperature, pH and lactic acid contents were similar in both fronds. The temperatures of OPF and NF at day 0 (30.0 and 29°C, respectively) in the present experiment were similar to that recommended by Zhang *et al.,* (1997) as the favorable temperature for proper fermentation. The initial buffering capacity of OPF (57.7 m-equ/lOOg DM) was observed to be significantly lower ($P<0.05$) than that of NF (75.0 m-equ/lOOg PM). The high buffering capacity of fresh NF indicated its higher resistance to acidification as suggested by Mclfonald *et al.,* (1991) who observed a difficulty in ensiling Lucerne because of its

Table 1. Chemical Composition, Mineral Contents, Temperatures, pHs, Lactic Acid Contents and Buffering Capacity (BC) of Fresh (Day 0) Oil Palm (OPF) and Nipah Fronds (NF).

Parameter	OPF	NF	SE
DM (%)	32.5^{a}	27.1^{b}	1.4
Ash (%)	5.0^{b}	10.0^{a}	0.51
OM (%)	95.0^{a}	90.0^{a}	0.55
CP (%)	5.3^{a}	4.7^{b}	0.31
EE (%)	1.0^{a}	0.8^{a}	0.21
NDF (%)	75.9^{a}	64.1^{a}	1.06
ADF (%)	59.5^{a}	59.0^{a}	0.95
Lignin (%)	14.6^{a}	17.8^{a}	0.88
NSC (%)	12.8^{a}	20.4^{a}	1.07
SS (%)	3.3^{b}	4.6^{a}	0.39
CA (%)	0.8^{a}	0.9^{a}	0.08
P (%)	0.5^{a}	0.5^{a}	0.07
Cu (%)	0.002^{a}	0.002^{a}	0.0003
Mg (%)	0.1^{b}	0.2^{a}	0.0005
Fe (%)	0.02^{a}	0.02^{a}	0.0008
Temperature °C	30.0^{a}	29.0^{a}	0.16
pH	4.2^{a}	4.2^{a}	0.03
Lactic acid (g/kg DM)	14.4^{a}	11.8^{a}	1.15
BC (M-equ/100g DM)	57.7^{b}	75.0^{a}	5.20

Means in the same row with different superscripts are significantly different ($P<0.05$).

EE = ether extract. SS = soluble sugar. NSC = non structural carbohydrate.

SE = Standard error. M-equ = milli-equivalents. BC = buffering capacity.

high buffering capacity value. Thus, larger quantities of acids will be needed during ensiling to lower the pH of NF material by one unit compared to that of OPF. This is of particular importance during the early stages of ensiling. Similarly, Evers and Carroll (1998) suggested that the high buffering capacity of shrimp waste might have prevented the rapid lowering of the pH of the silage. Generally, the buffering capacity of NF observed in the present study was higher than the values reported by Lin et al., (1992) for alfalfa (40.1 m-eqU/I00g DM) and by Jones (1970) for clover (42.0 m-eqU/I00g DM).

Characteristics of OPF and NF silage:-

A significant interaction between frond types and period of ensiling was observed; hence comparisons between the two fronds were done separately for the different periods of ensiling. **Table 2** shows the chemical composition and the characteristics (temperature, pH, lactic acid content and buffering capacity) of silage measured at day 30 and 90. Results from these two periods were presented as changes during other ensiling periods were similar.

Figure 1 shows the changes in CP contents of OPF and NF silages at various days of ensiling. The amount of CP of OPF increased while that of NF decreased during the first week of ensiling. Differences in CP content between the two silages became apparent after 40 days. At 90 days **(Table 2)** the amount of CP of OPF silage was significantly ($P<0.05$) higher (6.8%) than that of NF silage (4.0%). The increased in CP content in OPF during ensiling indicates an increased number of fermenting microorganism in the silage. As expected, the soluble sugar contents of both OPF and NF decreased during ensiling, which indicates its utilization by the microbes present. Both NDF and lignin contents of OPF and NF silages remained high, although OPF silage showed a small decrease in NDF and lignin content at 90 days compared to the values observed at 0 day.

At day 30 and 90, the temperatures of OPF and of NF did not differ significantly ($p<0.05$). The temperatures were in the range of 26 - 28°C. Lower temperatures (20-24°C) of non-insulated silos have been reported by McDonald *et al.*, (1966). The pH values of OPF silage at day 30 and 90 (4.1 and 4.3, respectively) were significantly (P<O.OI) lower than those of NF silage (4.8 and 4.6, respectively). The pH values of OPF silage were comparable to a Ph of 4.2 for grass silage observed in commercial farms (Steen *et al.*, 1998).

Figure 2 shows the changes in lactic acid concentration of OPF and NF silages at different days of ensiling. There was a rapid increase in lactic acid concentration in OPF silage and the amount became relatively stable after 1 week of ensiling. In the case of NF silage, there was only a small increase in lactic acid content. As shown in **Table 2,** the lactic acid content of OPF was significantly ($P<0.01$) higher than that of NF at both periods of ensiling. The lactic acid contents for OPF silage at day 30 ‘0 was 53.6 g/kg DM, while the amount at day 90 was 52.8 g/kg DM, much higher than the amount observed at day 0 (4.4 g/kg DM), while the lactic acid concentrations for NF silage were 16.8 and 17.8 g/kg DM, respectively. Since lactic acid is primarily responsible for proper production and preservation of silage (Wolford, 1984; Evers and Carroll, 1998), the results of the present study indicate that OPF was better fermented than NF. However, the lactic acid contents of OPF silage were considerably lower than that of grass silage which was in the range of 66.0 – 112.0 g/kg DM (Rooke, 1995; Dawson and Mayne, 1998 and Steen *et al.*, 1998). The Ph range for these silages were 4.0 – 4.2.

Figure 3 shows the changes in the buffering capacity of both OPF and NF silages at different ensiling periods. The buffering capacity of OPF silage at day 4 and 6 increased by 41.6% and 52.0%, respectively, while the increase in NF silage was only 16.0% and 19.1%, respectively. The increase in the buffering capacity of fermented material during the first few days of ensiling had been reported earlier (Greenhill, 1964; Playne .and McDonald, 1966). These authors observed that the buffering capacity values on the third day of ensiling were two times greater than that of the initial plant material. Similarly, Lancaster (1975) reported that the buffering capacity of ryegrass clover silage reached its peak value at day 11 and remained relatively constant thereafter. The increased in buffering capacity during ensiling was attributed tot he production of excessive a mounts of cations as a result of the rapid breakdown and dissimilation of organic acid salts (Playne and McDonald 1966) The changes in buffering capacity during the early stage of ensiling may be useful in predicting the outcome of the conservation process of a plant material.

Table 2. Chemical Composition, Temperatures, pHs, Lactic Acid Contents and buffering Capacity (BC) of oil palm (OPF) and Nipah Fronds (NF) silage at 30 and 90 days.

Parameter	**Day 30**			**Day 90**		**SE**
DM (%)	**31.3 ^{a}**	**28.1 ^{a}**	**0.96**	**32.5 ^{a}**	**25.9 ^{b}**	**0.96**
CP (%)	**5.8 ^{a}**	**4.7 ^{a}**	**0.27**	**6.8 ^{a}**	**4.0 ^{b}**	**0.16**
EE (%)	**1.2 ^{a}**	**0.8 ^{b}**	**0.08**	**2.0 ^{a}**	**0.9 ^{b}**	**0.17**
Ash (%)	**5.7 ^{a}**	**10.4 ^{a}**	**0.28**	**6.1 ^{b}**	**10.8 ^{a}**	**0.34**
NDF (%)	**73.0 ^{b}**	**63.6 ^{a}**	**3.00**	**70.3 ^{a}**	**66.1 ^{a}**	**2.90**
Lignin (%)	**12.3 ^{a}**	**19.8 ^{a}**	**2.37**	**12.8 ^{a}**	**15.0 ^{a}**	**1.4**
SS (%)	**1.6 ^{b}**	**2.4 ^{a}**	**0.64**	**1.2 ^{b}**	**2.2 ^{a}**	**0.22**
Temperature ^{o}C	**26.8 ^{a}**	**27.5 ^{a}**	**0.22**	**28.0 ^{a}**	**27.3 ^{a}**	**0.17**
pH	**4.1 ^{b}**	**4.8 ^{a}**	**0.10**	**4.3 ^{b}**	**4.6 ^{a}**	**0.07**
Lactic acid (g/kg DM)	**53.6 ^{a}**	**16.8 ^{b}**	**0.74**	**52.8 ^{a}**	**17.8 ^{b}**	**0.63**
BC (M-equ/100g DM)	**91.7 ^{a}**	**75.7 ^{a}**	**10.70**	**93.3 ^{a}**	**51.7 ^{b}**	**12.40**

$^{a\text{-}b}$ Means in the same row with different superscripts are significantly different ($P<0.05$)

SE = Standard error.

(Figures - place in separate pages for submission)

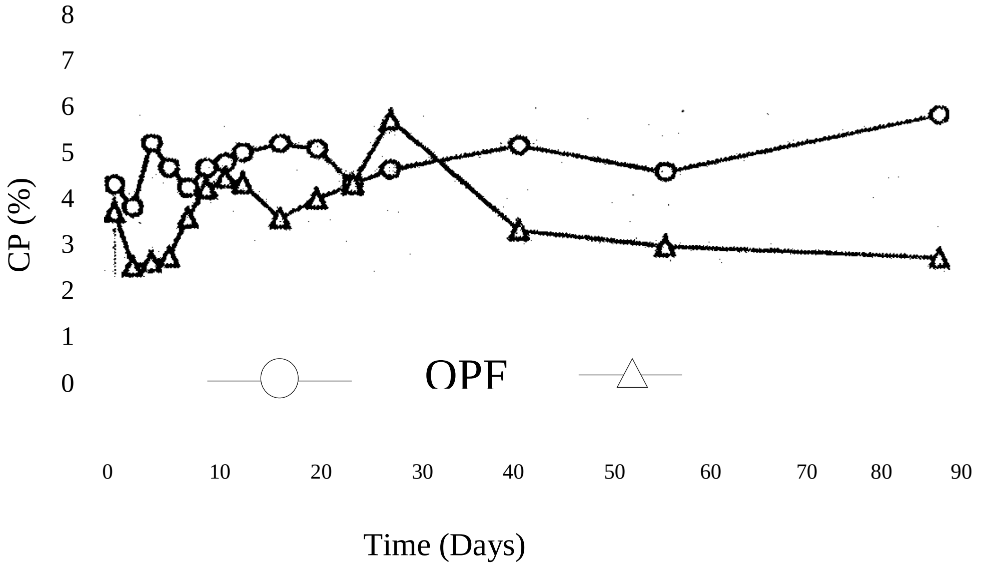

Figure 1: The crude protein (CP) contents of oil palm frond (OPF) and nipah fronds (NF) silage at different days of ensiling.

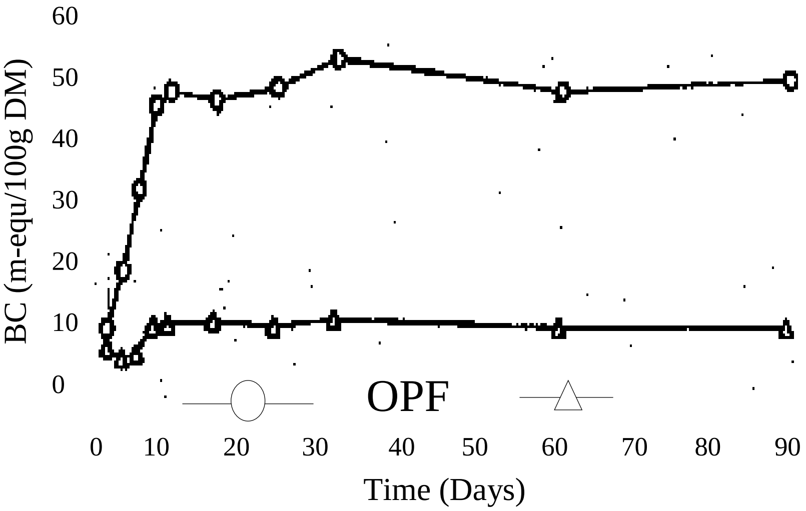

Figure 2: Lactic acid contents of oil palm frond (OPF) and nipah fronds (NF) silage at different days of ensiling

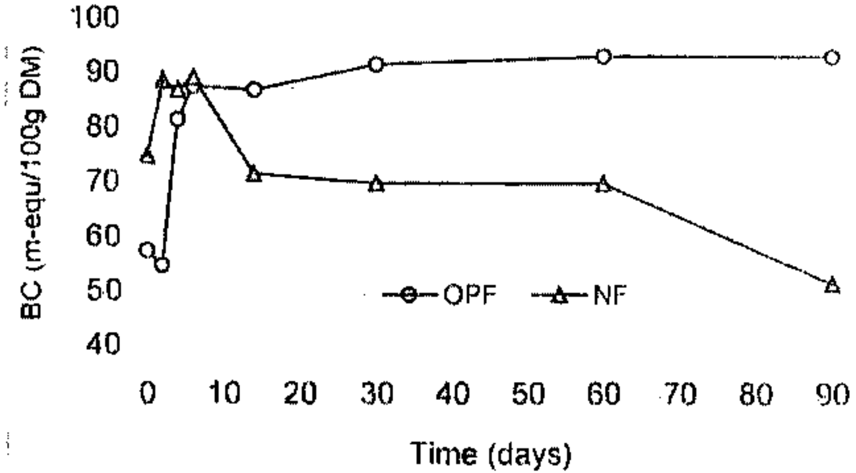

Figure 3: The buffering capacity (Be) of oil palm frond (OPF) and nipah fronds, (NF) silage at different days of ensiling

The high buffering capacity of fresh NF was considered as of one of the main reasons for the poor ensilability of this frond. The reason (s) for the high buffering capacity of NF was not really known, but the high ash content (which reflects the mineral content) may influence the buffering capacity values. Evers and Carroll (1998) suggested that the high amount of calcium carbonate in the initial shrimp waste might caused a high buffering capacity of the material and hence a difficulty in ensiling.

The chemical analysis of the fronds showed that the lignin content of the unfermented NF (17.8%) was significantly ($P<0.05$) higher than that of OPF (14.6%). Highly lignified plant material is expected to be less fermentable, as lignin could interfere with the availability of the carbohydrates and other nutrients for the fermenting organisms (McDonald *et al*., 1995). It has also been suggested that lignified cuticle layers of poor quality roughages could form barriers that limit microbial attachment and affect the quantity of fermentable tissue during ensiling (Akin, 1989). Thus, the high buffering capacity and lignin content of fresh NF could be the main reasons for its poor ensilability, even though it initially contained a higher level of soluble sugar than that of 0 PF. However, the content of soluble sugar may not be a key factor in ensiling, as Laettemae (1997) observed that legumes. Could easily be ensiled in spite of their low levels of water-soluble carbohydrates.

CONCLUSION

The results of the present study indicate that OPF formed a better silage than NF and that the initial buffering capacity and lignin contents may greatly influence the quality of the silage formed.

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