A SURVEY OF SILAGE QUALITY ON NORTHLAND DAIRY FARMS

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Abstract

A survey was made on 31 dairy farms of the botanical and chemical composition of pasture being ensiled and of the chemical composition of the resultant silages.

Despite the wide range in grass (37-100%) and legume (0-50%) components, drymatter content (20-56%), soluble carbohydrate (4-19%) and neutral detergent fibre (NDF) (43-69%) contents, NDF was the only component significantly correlated with dry matter digestibility (range 53-76%) ($r = -0.77$; $P > 0.01$).

Wilting time ranged from 2-47 hours except in seven of the silages which were not wilted. Four silages were not covered with polythene but were similar in chemical composition to other silages when sampled in summer. Phosphorus (P) (.15-.42% DM) and nitrogen (N) (1.0-2.2% DM) in silage were below published requirements for cows in mid lactation in more than 75% of the silages. It is suggested that either or both of these minerals may limit milk production from cows fed a predominantly silage ration during summer. Ensiling of less-mature pasture is advocated to ensure a more digestible feed which is likely to contain adequate levels of P and N.

INTRODUCTION

There is a trend in Northland towards increasing use of pasture silage as a supplementary feed for dairy cows in summer. A strong relationship has been demonstrated between the quality of the pasture ensiled and silage quality (Coop 1943; Demarquilly and Jarrige 1970), and between quality of pasture ensiled and milk production from cows fed the resultant silage (Castle et al. 1980; Gordon 1980). Demarquilly and Jarrige(1970) concluded that "the digestibility of silage is largely dependent on the digestibility of the parent material". The digestibility of the parent material is governed less by plant species (Wilson and Collins 1980) than maturity at harvest (Coop 1943; Gordon 1980). Wilting has little effect on silage nutritive value but results in less effluent loss from the stack (Sears and Goodall 1947), higher dry matter (DM) intakes by sheep and cattle (Marsh 1979) and, in many instances, improved animal performance.

Many assessments have been made of silage quality but on two aspects little or no information is available. These are the range of composition and maturity of pasture ensiled on farms, and the mineral composition of silages in relation to mineral requirements of cows in summer. This paper describes the results of a survey made on some Northland dairy farms of pasture composition and of the quality of resulting silages.

EXPERIMENTAL

Thirty one dairy farms distributed throughout the Dargaville, Whangarei, Bay of Islands and Kaitaia districts were included in the survey. Twenty eight silages were made in early summer and three from predominantly kikuyu pastures in autumn of the 1978-79 season.

SAMPLING

Three samples were taken from each farm:
(i) pasture just prior to forage harvesting.
(ii) material as it was being dumped from the forage harvester.
(iii) silage which had been conserved for at least six weeks.
With one autumn-made silage, only conserved silage was taken. Sample(i) was analysed for botanical composition. Sample (ii) was collected over 60-90 minutes, thoroughly mixed and sub-sampled. Duplicate samples of (iii) were taken by either of two methods. If silage was being fed out, the exposed face was cut back and two 20cm wide slices taken through the depth of the stack. Samples from an undisturbed part of a stack were taken throughout its depth with a 5cm diameter coring device. Each replicate sample was mixed and a 2-3 kg subsample taken. Samples (ii) and (iii) were sealed in plastic bags from which air had been expelled, placed in an insulated box and covered with dry ice. These were placed in a deep freeze within 4 hours and remained frozen until required.

ANALYSES

Cut ***pasture:*** DM content was determined by oven drying. Remaining herbage was freeze-dried prior to analysing the following:
(1) neutral detergent fibre (van Soest and Wine 1967).
(2) soluble carbohydrate (Haslemore and Roughan 1976).
(3) predicted in *vivo* dry matter digestibility (Roughan and Holland 1977).
(4) N, P, K, S, Ca, Mg, Na by routine laboratory procedures.

Silage: Frozen blocks of compressed silage were finely cut on a bench saw prior to analysing:
(1) DM content by toluene distillation (Dewar and McDonald 1961).
(2) pH in extracts obtained by treating 25 g silage with 100ml distilled water.
(3) ammonia-N as a percentage of total N by microdiffusion (Conway and Byrne 1933) on filtrate derived from soaking 20g of thawed silage in 80g of water.
(4) fibre digestibility and mineral composition on freeze-dried material by methods already described.

Where appropriate results are expressed as a percentage of DM (toluene distillation method).

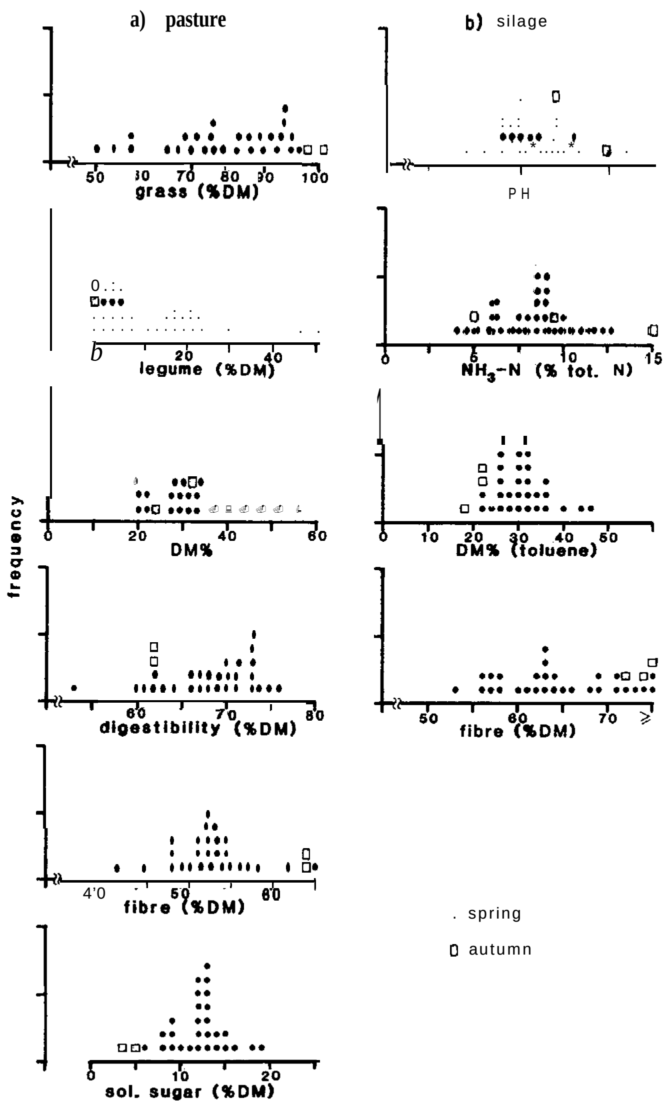

FIG. 1: *Frequency distribution of some a) pasture, cut pasture and b) silage variables. Each point represents the mean value of samples taken from a pasture or a silage stack.*

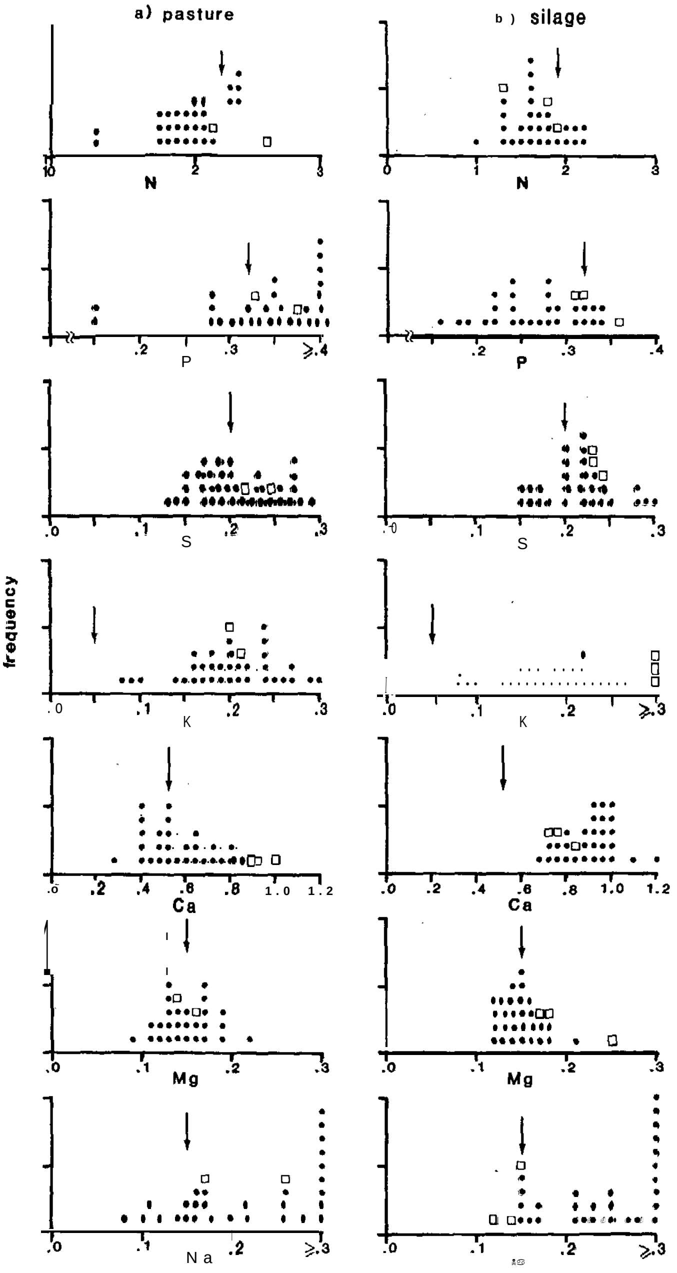

FIG. 2: *Frequency distribution of minerals in a) cut pasture (% DM) and b) silage (% toluene DM). Each point represents the mean value of samples taken from a pasture or a silage stack. Arrows indicate ARC (1980) minimum nutrient requirements for a lactating cow.*

RESULTS AND DISCUSSION

PASTURES

Silage making was later than usual by 2-3 weeks because of slow spring growth. Most were collected in mid-late November, some in December and one in January. Autumn silages were made in April. Pastures generally contained a high grass content although some high-legume pastures occurred on newly developed land or on drought-prone soils. Perennial ryegrass, which has a high fermentation potential (Wilson and Collins 1980), was the predominant grass in spring while kikuyu, a subtropical grass, was essentially the sole component in autumn silage.

CUT HERBAGES (Figs la and 2a)

Cutting and storage: Fourteen silages were made with flail-type harvesters and the rest with double or fine-chop machines. Eight were ensiled in concrete-lined bunkers with the rest being made in unlined pits or in free-standing stacks. All but four stacks were covered with polythene film which was generally well weighted down with tyres.

Dry mutter content: Wilting time ranged from 0-47 hr. But where ensiling took place over 2-3 days on individual farms there would have been a large variation in wilting time and in DM content. None of the wilted spring-cut pastures contained less than 25% DM. This is the level below which effluent losses occur (see Marsh 1979). Six wilted pastures had a DM content greater than 40%. Such pastures are difficult to compact properly and resulting silages are often poorly preserved (Barry *et al.* 1980).

Nutritive value: The ranges in digestibility, neutral detergent fibre and soluble carbohydrate contents (53-76%, 43-69%, 4-19% respectively) of the pastures indicate that some pastures were too mature to make highly digestible, high quality silages suitable for lactating cows. Autumn-cut pasture was particularly notable for the low soluble carbohydrate and high fibre contents. These were similar to one very mature spring-made silage. Digestibility was related to changes in fibre content ($r = -.077$; $P < 0.01$). Therefore to obtain a high quality silage, crop yield should be sacrificed and the pasture cut in a less stalky state than is generally done at present.

Minimum. mineral levels in herbage DM required by a 500kg cow producing 15 1 milk/ day have been estimated from ARC (1980) data and are indicated by an arrow in Fig. 2. Many of the pastures were deficient in one or more minerals.

SILAGES (Figs lb and 2b)

Dry mutter content: The mean DM content (31%) determined by toluene distillation was similar to, and correlated with, the DM content of cut herbage (33%; $r = 0.75$; $P < 0.01$). That only 56% of the variation in silage DM content was accounted for by variation in pasture DM content might be explained by two factors; (i) loss of moisture from silages made with wet pasture and (ii) because the sample of cut pasture may not have been representative of the total crop ensiled. Recently Haslemore and Holland (1981) found a wide variation between small samples taken from one face of a silage stack in DM, volatile fatty acid and ammonia-N contents. 'Total N, soluble N, DM digestibility and silage pH were relatively uniform across the sampled profile of the stack. They stress the need for care in sampling stacks and in interpreting silage data. In our survey, which used a different sampling method, between-stack variances were highly significantly greater than within-stack variances for most variables measured. Therefore we are confident that our results give a good indication of the true range in components of the silage stacks.

Fermentation characteristics: The mean silage pH (4.6) is consistent with values of many wilted silages (Marsh 1979) and with wet silages which have not been sealed quickly(Wilson 1980). Some well preserved wilted silages with pH 5.0 have also been reported (Marsh 1979). Haslemore'and Holland (1981) found a significant correlation between pH and DM content of each silage. However our results did not show a similar correlation probably because other factors such as the level of soluble sugars interact with DM content in determining silage acidity. Interestingly, uncovered silages did not have an unusually high pH (4.44.5) and in only one was ammonia-N (as % of total N) higher than the average. Ammonia-N (as % of total N) is an indicator of amino acid breakdown (McDonald and Wittenbury 1973) and secondary clostridial fermentation. Silages of high nutritive value generally have a low ammonia-N content. The mean ammonia-N content in this survey was 8.4%. Both this, and the highest value (17.9%), were lower than expected in relation to other published results (e.g. 7.8-24.6%, McDonald and Edwards 1976).

Minerals: The mean phosphorus(P) content of silage (0.27%) was 23% lower while that of sodium (Na) (0.28%) and calcium (Ca) (0.89%) were 24% and 68% higher respectively than in cut herbage. The mean content of other minerals was similar in both cut herbage and silage. The reason for this divergence of some means cannot be readily explained. Despite these discrepancies there were significant ($P < 0.01$) although not strong, correlations between each of N, P, K, S and Na in cut herbage and the respective silages.

Eighty four percent of silages did not contain adequate P to meet the requirements of a dairy cow in mid lactation (ARC 1980). During the period when silage is fed to dairy cows in summer, pasture growth is invariably slow. In such situations P concentrations in pasture are similarly low (Betteridge unpublished data). Thus cows being fed pasture and silage in summer are likely to be in negative P balance. This deficit in P intake can be met by drawing on bone reserves (Little ***et al.,*** 1978) but this may not be at a rate sufficient to maintain high milk production.

Many silages contained less than 12% crude protein (1.9% N) although the N:S ratio (range 5.2-10.5) was apparently adequate for animal production (Tisdale 1977). It is not clear in the literature at what point limiting N or S concentrations have more effect on animal production than the N:S ratio *per* se. But as N in silage is poorly utilised by ruminants (Barry et *al.,* 1980a, b) the low level of N in many silages might accentuate the inherently poor metabolism of this nutrient. Magnesium and Na were also marginally deficient in several silages.

Kikuyu silage: Although each kikuyu pasture was -wilted, the DM content of the resultant silage was low. This was probably because kikuyu was rapidly growing in a moist environment at the time it was cut. The generally adequate mineral content of the kikuyu silages also reflects the vegetative growth phase of the pasture at harvest. The high pH of these silages would be the result of the low soluble sugar content of kikuyu pasture whereas with spring-made silages the high pH values would more likely be the result ofwilting. The high ammonia-N levels in one of the kikuyu silages supports the suggestion of poor preservation.

There was no significant correlation between the legume content of the pasture and fermentation characteristics or mineral content of the silages, even though legumes do not always make good silage (McDonald and Whittenbury 1973).

CONCLUSION

If pasture silage is to be fed to lactating dairy cows it must be made from leafy pasture, since poor quality mature pasture cannot be improved by the ensiling process. In general a reduction in yield would be needed to obtain a pasture of high digestibility and good mineral status. In our survey many pastures did not fulfill these criteria.

Wilted silage generally results in higher silage DM intakes and subsequent increased milk production compared to unwilted silage, but excessive wilting, as occurred in some instances in this survey, can lead to poor preservation and a reduced silage intake.

Polythene covers had no apparent effect on any of the silage variables we measured when compared with the four uncovered stacks. But a higher proportion of surface wastage could be expected where covers are not used.

Whereas kikuyu silage generally had an adequate mineral concentration, the low level of soluble sugar in pasture is not likely to produce a well preserved silage capable of leading to high animal performance.

With the exception of N, none of the literature we have seen relating to silage nutritive value refers to mineral composition. Whether the low mineral status in many of the spring-made silages is peculiar to Northland is not known. Neither is it known whether cows fed silages low in one or more of these minerals will increase their milk production if the minerals are fed as a supplement. However we speculate that some of the poor animal production responses from silzge feeding may be due in part to inadequate mineral nutrition of the animals.

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REFERENCES

Agr. Res. Council, 1980. *In* The Nutrient Requirements of Ruminant Livestock. Commonwealth Agricultural Bureaux, England.
Barry, T. N,; Cook, J. E.; Wilkins, R. J., 1978 a. *Jl. Agr. Sri. Camb. 91:* 701-15.
Barry, T. N.; di Menna, M. E.; Webb, P. R.; Parle, J. N., 1980. *Jl Sci. Fd. Agr. 31: 13346.*
Barry, T. N.; Mundell, D. C.; Wilkins, R. J.; Beever, D. E., 1978b. *Jl. Agri. Sci. Camb. 91:* 717-25.
Castle, M. E.; Retter, W. C.; Watson, J. N., 1980. *Grass Fge. Sci. 35:* 219-25.
Conway, E. J.; Byrne, A., 1933. *Biochem. Jl. 27:* 419-29.
Coop, I. E., 1943. N. Z. *Jl Sci. Tech. 24A: 303-16.*
Demarquilly, C.; Jarrige, R., 1970. *Proc. IX Int. Grld. Cong.* pp 733-7.
Dewar, W. 4.; McDonald, P., 1961. *Jl Sri. Fd. Agr. 12: 790-S.*
Gordon, F. J., 1980. *Anim. Prod. 31:* 3541.
Haslemore, R. M.; Holland, R., 1981. N.Z. *Jl exp. Agric. 9: 85-9.*
Haslemore, R. M.; Roughan, P. G., 1976. *Jl Sci. Fd. Agric.* 27: 1171-8.
Little, D. A.; Siemon, N. F.; Moodie, E. W., 1978. *Aust. Jl exp. Agric. An. Husb. 18:* 514-19.
McDonald, P.; Wittenbury, R., 1973. In The Chemistry and Biochemistry of Herbage. I I I pp 33-60 Ed. Butler, G. W. and Bailey, R. W. London: Academic Press.
McDonald, P.; Edwards, R. A., 1976. *Proc. Nutr. Soc. 35:* 201-11.
Marsh, R., 1979. *Grass Fge. Sci. 34:* 1-10.
Roughan, P. G.; Holland, R., 1977. *Jl Sci. Fd. Agric. 28:* 1057-64.
Sears, P. D.; Goddall, V. C.; 1947. N.Z. *Jl Sci. Tech. 28A:* 289-304.
Van Soest, P. J.; Wine, R. H., 1967. *Jl Ass. Off. Anal. Chem. 50:* 50-3.
Tisdale, S. L., 1977. Sulphur in forage quality and ruminant nutrition. *The Sulphur Inst. Tech. Bull. 22:*
Wilson, R. K., 1980. *Ir. Jl Agric. Res. 19:* 160-3.
Wilson, R. K.; Collins, D. P., *1980. Ibid 19:* 75-84. K.; Collins, D. P., *1980. Ibid 19: 75-84.*