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STUDIES ON ENSILAGE OF GREEN PANIC/GLYCINE MIXED PASTURE

By S. J. BARKER, B.Agr.Sc., and M. S. LEVITT, B.Sc.

SUMMARY

A green panic/glycine pasture mixture was used in a series of ensiling experiments carried out in 1,000 lb capacity silos.

Silage quality was dependent mainly on maturity of the pasture and the amount of molasses added. Without additive the more immature pasture gave the poorer silage. The amounts of molasses required for lactic acid dominant silage were very high, being 120 lb/ton when dead pasture was included in the harvest rather late in the growing season and 200 lb/ton when harvest included only young, leafy pasture early in the season.

Sub-optimum molasses (40 to 160 lb/ton depending on maturity of the pasture), wilting and salt at 3% gave smaller improvements to silage quality but without lactic dominance; small molasses additions (80 lb/ton for the most immature pasture) gave no improvement over control.

Molasses and salt combined in sufficient amounts produced lactic dominant silage from the most immature pasture and was associated with greatest reduction in the high dry-matter losses.

Length of cut and small differences in maturity of the pasture had small and inconsistent effects.

I. INTRODUCTION

The need to conserve fodder which is in excess of the immediate requirements of grazing cattle is generally recognized. Mawson (1953) suggested that fodder conservation was essential for dairying to prosper on the Atherton Tableland of north Queensland and that silage was the most suitable means. Ensilage appears to be the most applicable method in the wet season, when the excess fodder is available.

Maize is ensiled to a small extent but its nutritional value is limited by its low protein content. There is a need for conservation of a well-preserved, high-protein feed which can be fed back when the quality and quantity of pasture for dairy cattle decline in winter. Kyneur (1960) has reported the suitability of the legume glycine (*Glycine javanica* cv. Tinaroo) to the environment. It forms a successful permanent pasture association with green panic (*Panicum maximum* var. *trichoglume*), which is widely grown in the district. Techniques for ensiling a green panic/glycine mixed pasture were investigated.

II. MATERIALS AND METHODS

Pasture.—A permanent mixed pasture of green panic and glycine growing at Kairi Research Station on the Atherton Tableland was harvested in the summer of each year from 1961 to 1965. In three of these years estimates of dry-matter pasture yields before harvesting were made by weighing pasture cut from 30 × 20 sq lk quadrats and estimates of the legume content by weighing after hand sorting. In the other two years these estimates were made by visual appraisal.

Treatments.—The following treatments were applied in 1961:—

Length of cut: 18 in. and 9 in.

Molasses: 0, 40 and 80 lb/ton of green material.

These were combined factorially to give six treatments. Eighteen inches was the average length of cut given by a commercial flail harvester and 9 in. was the average length obtained after feeding this material through a rotating blade maize harvester.

The 1962 treatments were:

Time of harvest: Grass in one-quarter head and grass in full head.
Length of cut: 18 in. and 1 in.
Molasses: 0 and 80 lb/ton of green material.

These were combined factorially to give eight treatments. The time interval between harvests was 2 weeks. Eighteen inches was again the average length given by a flail harvester and 1 in. was the average length given by a commercial cutter-bar harvester with rotating chopper blades.

In 1963, the treatments were the same as in 1962 except the second harvest, short cut molasses treatment, which had molasses applied at 120 lb/ton instead of 80 lb/ton.

The treatments in 1964 were:

No additive: Control.

Molasses: 80, 120 and 160 lb/ton of green material.

Salt: 1%, 2%, 3% of green material.

Wilted: To 31% dry matter.

These were imposed singly to give eight treatments. Wilting was achieved by spreading the chopped pasture on a concrete floor in the sun for 5 hr during the middle of the day and turning at $\frac{1}{2}$ hr intervals.

The 1965 treatments were:

No additive: Control.

Molasses: 80, 120 and 200 lb/ton.

Molasses and salt: 80 lb/ton + 1% salt.
80 lb/ton + 2% salt.
120 lb/ton + 1% salt.
120 lb/ton + 2% salt.

Where molasses was used as an additive it was diluted with an equal volume of water, and where salt (NaCl) was used it was added in the solid form. One time of harvest and one length of cut (1 in.) were used for all treatments in 1964 and 1965.

Silos and filling.—The experimental silos were concrete pipes 8 ft long and 3 ft in diameter. Each one was set into a concrete base dished to the centre, where an outlet allowed effluent to be drained off through a pipe and collected.

Pasture was weighed into the silos in 50 lb lots and then trampled. Where treatment involved the use of additive the appropriate amount was applied to each 50 lb lot. Using this procedure, each silo was filled with about 1,000 lb of green material as quickly as possible to keep temperature rise to a minimum. In 1962, heights of the packed pasture were recorded to calculate their densities.

The silos were left unsealed but covered by a roof to keep out rain. They were opened each year at a convenient time some 4 months after ensiling.

Methods of analysis.—In all years except 1961, samples were taken from the material being ensiled and from different layers of silage for dry-matter determinations. The samples, of about 500 g, were dried in a convection oven at 105°C for 48 hr. Where effluent was produced, it was collected at intervals, its volume measured and a sample stored at 4°C for subsequent dry-matter determinations. From these measurements, the loss of dry matter due to ensiling could be calculated. No corrections could be made for the loss of volatile constituents during drying.

Chemical analyses were carried out by the methods described by Levitt, Taylor, and Hegarty (1962) on a sample of silage weighing about 6 lb taken from the middle of each silo.

Nitrogen was determined on samples of wet silage using a macro Kjeldahl procedure.

Palatability.—A 60 lb sample was taken from the section of each silo from which the 6 lb sample was taken for chemical analysis. This was offered to dairy cattle by cafeteria presentation and relative palatability judged by the observed acceptance of each silage.

III. RESULTS

Yield of pasture, proportion of legume and moisture content for all harvests are given in Table 1.

TABLE 1

YIELD AND LEGUME CONTENT OF THE PASTURE AND MOISTURE CONTENT AT ENSILING

Year	Harvest	Yield of Dry Matter (lb/ac)	Legume Content (% dry weight)	Moisture Content (% total weight)	
1961	One only	3,000*	50*	Short Cut	Long Cut
1962	First	3,200	16	80·0	74·0
	Second	3,400	14	75·0	75·0
1963	First	2,000	11	79·9	75·0
	Second	2,500	14	76·4	77·6
				Wilted	Non-wilted
1964	One only	4,000	42	69·0	78·3
1965	One only	2,000*	60*	84·0	

* Estimated by visual appraisal.

All silages had a mouldy layer about 1 ft thick on the top and a smaller layer of poor quality silage beneath this. The remainder of the silage from which the samples were taken appeared uniform.

(a) 1961 Experiment

The pasture was harvested late in the season (April 20). It had been deferred 3 months before harvest and consisted of a large proportion of dead and senescent material, but the legume content was high.

There was little difference in silage between treatments. All silages had good pH values of just above 4·0 but lactic was not the dominant acid. A small increase in lactic acid content with the use of molasses is shown by treatment mean figures presented in Table 2. Volatile acids were a fairly high percentage of the total nitrogen.

TABLE 2

SILAGE QUALITY TESTS

Treatment	pH	Volatile Acids as Acetic (% dry weight)	Residual Acids as Lactic (% dry weight)	Volatile Bases (% total N)
1961				
No additive (mean of 2)	4·08	7·3	2·2	28·0
Molasses (mean of 4)	4·06	6·7	3·3	26·4
1962				
No additive (mean of 4)	4·98	..	..	..
Long cut, molasses at 80 lb/ton (mean of 2)	4·44	..	..	..
Short cut, molasses at 80 lb/ton (mean of 2)	4·12	..	..	..
1963				
No additive (mean of 4)	4·98	6·7	1·4	31·3
Molasses at 80 lb/ton (mean of 3)	4·72	5·6	2·4	20·4
Molasses at 120 lb/ton	4·02	2·8	8·1	10·8
1964				
No additive	5·17	12·7	2·3	47·9
Molasses at 80 lb/ton	5·14	8·0	1·3	30·6
Molasses at 120 lb/ton	4·66	6·8	2·1	20·8
Molasses at 160 lb/ton	4·74	6·4	3·5	19·3
Salt at 1%	5·27	8·5	1·9	40·5
Salt at 2%	5·20	7·0	1·4	33·3
Salt at 3%	4·86	5·2	3·6	21·4
Wilted	4·97	6·1	4·6	21·4
1965				
No additive	5·33	9·6	2·8	32·1
Molasses at 80 lb/ton	5·30	11·4	2·6	36·5
Molasses at 80 lb/ton, salt at 1%	5·48	8·1	2·2	33·0
Molasses at 80 lb/ton, salt at 2%	5·38	11·4	1·7	47·4
Molasses at 120 lb/ton	4·66	8·9	6·3	20·0
Molasses at 120 lb/ton, salt at 1%	4·70	5·8	5·3	17·2
Molasses at 120 lb/ton, salt at 2%	4·21	3·5	7·9	11·2
Molasses at 200 lb/ton	3·92	3·2	13·4	8·0

Stock-food analyses (Table 3) show high protein content of the silage from mature pasture. This was apparently due to the high legume content. Mean treatment values in Table 3 show a small increase in nitrogen-free-extract with the use of molasses. No difference in palatability between treatments could be detected.

(b) 1962 Experiment

The first harvest was earlier (March 7) than in the pervious year. The pasture had been lightly grazed 4 weeks before harvest. There was less dead and senescent material and less legume than in 1961.

Densities of the packed pasture were 17 to 20 lb/cu ft for long-cut material and 24 to 27 lb/cu ft for short-cut material.

TABLE 3

STOCK FOOD ANALYSIS AND DRY-MATTER LOSSES

Treatment	Moisture (% total weight)	Crude Protein (% dry weight)	N.F.E. (% dry weight)	Dry-matter Losses (% original weight)*	
				Effluent	Unaccounted
1961					
No additive (mean of 2) ..	77·3	14·1	28·8	..	..
Molasses at 40 lb/ton (mean of 2)	78·7	14·5	29·0	..	..
Molasses at 80 lb/ton (mean of 2)	77·6	13·8	32·2	..	..
1962					
First harvest (mean of 4)	79·9	12·8	..	0·5	38
Second harvest (mean of 4)	77·3	11·8	..	0	30
1963					
No additive (mean of 4) ..	80·7	12·5	31·4	1·3	36
Molasses at 80 lb/ton (mean of 3)	79·7	12·0	38·3	1·7	31
Molasses at 120 lb/ton ..	78·5	11·0	41·7	0	29
1964					
No additive	85·5	21·0	21·8	3·0	46
Molasses at 80 lb/ton ..	82·1	16·8	30·1	4·0	46
Molasses at 120 lb/ton ..	80·8	15·9	35·6	7·5	33
Molasses at 160 lb/ton ..	80·0	15·6	36·8	4·5	34
Salt at 1%	80·8	17·8	24·0	3·3	25
Salt at 2%	81·1	16·7	23·5	2·8	29
Salt at 3%	78·2	15·2	27·0	0	21
Wilted	72·0	18·4	30·2	0·7	42
1965					
No additive	87·4	26·1	17·1	0	37
Molasses at 80 lb/ton ..	86·5	25·9	25·8	0	34
Molasses at 80 lb/ton, salt at 1%	84·6	22·2	26·1	0	30
Molasses at 80 lb/ton, salt at 2%	82·9	21·3	26·8	0	19
Molasses at 120 lb/ton ..	85·2	23·1	36·7	4·0	34
Molasses at 120 lb/ton, salt at 1%	81·5	20·3	24·4	1·7	14
Molasses at 120 lb/ton, salt at 2%	79·1	18·4	38·2	1·0	11
Molasses at 200 lb/ton ..	81·8	18·8	45·7	0	24

* Original dry-matter weight inclrded that of the pasture and that of any additive applied.

Good pH values of slightly above 4·0 (Table 2) were recorded for silage from short-cut pasture that had been supplied with molasses. Long-cut treatments with molasses were variable and time of harvest had no effect on pH.

Fermentation losses tended to be lower for the second harvest (Table 3). Chemical analysis could not be related to density of the packed pasture. Cattle showed some preference for the short-cut treatments with molasses and for one long-cut treatment with molasses.

(c) 1963 Experiment

Seasonal and maturity effects were similar in this year to those of the previous year but the total yield was less.

Silage made with molasses at 120 lb/ton was very sweet smelling. Its lactic acid content was three times as high as its volatile acid content and its volatile base content much lower than that of the other treatments (Table 2).

Molasses at 80 lb/ton gave variable results in lowering pH and increasing lactic acid concentration. Time of harvest and length of cut had no clear effects on quality.

Stock-food analyses (Table 3) show slightly higher nitrogen-free-extract and slightly lower fermentation losses with the use of molasses. There was a marked preference by stock for silage made with molasses at 120 lb/ton.

(d) 1964 Experiment

An early harvest (January 21) was carried out after a light grazing 2 months previously. There was no obvious dead pasture but some was senescent.

Quality tests (Table 2) indicate very poor control silage. Molasses at 160 lb/ton was insufficient to induce lactic acid dominance but there was some improvement in quality over control as shown by lower pH, higher lactic acid and lower volatile bases. Molasses at 120 lb/ton gave lower pH and lower volatile bases than the control and molasses at 80 lb/ton gave little or no improvement. Salt at 3% produced better silage than lower salt concentrations and gave a similar product to wilting and molasses added at 160 lb/ton.

Stock-food analyses and dry-matter losses (Table 3) show an increase in nitrogen-free-extract with the addition of molasses and smaller fermentation losses with the addition of salt. Silage protein percentage was higher than in previous years, apparently due to earlier harvest. The control silage was completely rejected and silage with molasses at 160 lb/ton was slightly more palatable than the remainder.

(e) 1965 Experiment

Only new season's growth was harvested (on November 13, 1964) for the 1965 experiment. Its preharvest treatment was a period of dormancy during the dry spring after being grazed low in late winter. Both grass and legume were young and leafy. The succulence of the pasture is reflected in its moisture content (Table 1), which is highest of all harvests.

Quality tests (Table 2) show that the control silage was particularly poor and that there was no improvement with molasses at 80 lb/ton either alone or combined with 1% or 2% salt. Greatest lactic acid dominance occurred with molasses at 200 lb/ton, where it was four times as high as volatile acid. It was accompanied by lowest volatile base content. Molasses at 120 lb/ton combined with salt at 2% gave strongly lactic acid dominant silage with low volatile base but not to the same extent as molasses at 200 lb/ton. Where molasses at 120 lb/ton alone and with 1% salt had been used there were relatively minor improvements over control.

Silage protein (Table 3) was high, as could be expected from this type of pasture. Nitrogen-free-extract was higher than control with the use of molasses and highest with the largest molasses addition. Molasses and salt combined in higher levels of either one above 80 lb/ton and 1% respectively gave lower dry-matter losses and lowest loss with the highest level of each in combination. Silage with molasses at 200 lb/ton was clearly the most palatable and was quickly eaten. Next preference was given to silages with molasses at 120 lb/ton alone and with 2% salt. The remainder were slowly eaten, except control and that with molasses alone at 80 lb/ton, which were completely rejected.

IV. DISCUSSION

Silage quality was influenced to the greatest extent by type of pasture and the addition of sufficient molasses.

(a) Effect of Pasture

The type of pasture harvested each year depended mainly on the advancement of the season but also on the length of the deferment before harvest. Accumulation of dead material was greater later in the season and the amount of senescent material increased with longer deferment periods. The former observation is in agreement with measurements made by P. G. Tow (unpublished data), whose harvests from a similar pasture in 1966 contained 0%, 22% and 44% dead pasture on a dry-matter basis in January, March and April respectively. Most of the dead material was grass that had lodged and been trampled during previous grazings.

Without additive, the best silage resulted when harvest included the highest proportion of dead and senescent material but it was not lactic acid dominant. When there was no dead pasture, silage quality was particularly poor. Lanigan and Catchpoole (1962) have pointed out that immature herbage is often ensiled with disappointing results.

Poor silage quality is often related to high protein content of the pasture. Relative pasture protein values for the various years are reflected in the silage protein values. That quality of silages without additive in 1961 was better than quality of those without additive in 1962 and 1963, where protein was similar or slightly lower, suggests that at least more than protein is involved. Playne (1963) reported that the buffering capacity of sweet sorghum decreased with maturity and that this could not be related to nitrogen content of the plant. In another paper Playne (1966) estimated that plant proteins accounted for only 10% to 20% of the total buffering capacity in silage made from several herbage species and that the organic acids in both plants and silage were more important in this respect.

(b) Effect of Molasses Addition

If sufficient molasses was added, lactic acid dominant silage resulted. The amount required depended on the type of pasture harvested. Addition of 120 lb/ton was sufficient for late-harvested mature pasture, but 200 lb/ton was required for the most immature pasture ensiled. These levels exceed the usual recommendations. Watson and Nash (1960, p. 301) reported levels from 10 to 60 lb/ton being used by various workers. Bender (1952, p. 569) recommended up to 80 lb/ton with mixed grasses. Catchpoole (1966) found that 90 lb/ton produced lactic acid dominant silage from *Setaria sphacelata,* but only when it was harvested at the heading stage.

The reason for such high levels being necessary in the present experiments may lie in the sugar content of the species ensiled. Levitt (unpublished data) found only 1 to 1·5% soluble sugars on a dry-matter basis in samples of the green components of the pasture ensiled in 1962. This is well below the 6% stated as the minimum content for successful silage-making by Wieringa (1960).

When insufficient molasses (the amount again depending on maturity of the pasture) was added, the resultant silage was better than that from the controls but was not lactic acid dominant. With immature pasture, 80 lb/ton was clearly inadequate, as no improvement over the controls resulted. These results accord with the findings of Levitt, Taylor, and Hegarty (1962), who used molasses at 40 and 80 lb/ton on *Paspalum dilatatum,* and of Catchpoole (1966) when the grass was harvested at the vegetative stage.

(c) Effect of Wilting and Salt Addition

Wilting and the addition of salt with and without molasses were imposed only on immature pasture. Salt alone at 3% and wilting had limited effects and produced a silage similar to that where sub-optimum molasses had been applied. The improvement with increasing salt concentration up to 3% suggests that the optimum level had not been reached. When salt and molasses were added together it was only at the highest levels of each that lactic dominant silage resulted. With this treatment there was a large reduction in volatile acid content compared with the same molasses level alone and only a small increase in lactic, so the lactic dominance appears to have been a result of volatile acid suppression rather than a direct lactic stimulation. Volatile acid suppression was evident to a lesser extent with all other salt additions and with wilting but there was apparently insufficient sugar to enable lactic to become dominant.

How volatile acid formation is inhibited is not evident here. Wieringa (1958) demonstrated that wilting and adding salt inhibited butyric acid bacteria by increasing the osmotic pressure and that their osmotic pressure tolerance decreased with decreasing pH. As volatile acids were not separated, this could not be examined.

(d) Effect of Length of Cut and Time of Harvest

The differences in silage quality between the length-of-cut treatments and between the time-of-harvest treatments were small and irregular. The period separating the times of harvest led to only minor changes in maturity of the pasture. A low sugar content of the pasture would explain why neither treatment had little effect.

(e) Nutritive Value

Silage protein varied from year to year according to maturity of the pasture and proportion of legume, whereas variation within a year was probably due to relative changes following high dry-matter loss, particularly from the nitrogen-free-extract (Watson and Nash 1960, p. 401). The proportion of this protein that underwent "harmful" breakdown to volatile base (Watson and Nash 1960, p. 482) was high with an unsuccessful fermentation, especially from high-protein pasture, but much lower with lactic acid dominance even from pasture with the highest protein.

Higher nitrogen-free-extract associated with the addition of molasses was apparently due to the direct addition of extra soluble sugar.

The most prominent feature of the palatability grading was the readiness with which cattle ate silages of optimum quality. Watson and Nash (1960, p. 448) pointed out that stock show a preference for silages that have been well preserved.

(f) Dry-matter Loss

Losses of dry matter were relatively high. They would have been accentuated by the excessive loss from the layers at the top compared with sealed experimental silos or compared with unsealed, farm-scale tower silos, where, because of their greater depth, a similar depth of mouldy layer would have been a smaller part of the whole.

Lowest dry-matter losses were brought about by salt, especially in combination with molasses at 120 lb/ton. The reason for this is not evident in these experiments. The value of salt as an additive would depend on the economic value of the dry matter preserved. When this is considered, comparing the two lactic acid dominant silages in 1965, the value does not appear to be very great. The very high lactic acid content of the one made with molasses at 200 lb/ton implies that there was a large amount of sugar (molasses in this case) fermented. It is also noticed that the weight of the dry matter lost did not exceed the weight of the molasses dry matter added and that its pasture components show no greater or even lower a decomposition, as judged by volatile bases, than in the silage with the molasses/salt combination. The difference in dry-matter loss between these two would therefore appear to be due to the high loss from the molasses and not from the pasture components.

(g) Comparison between Molasses and Salt as Additives

From the results of the present experiments, molasses is preferred for three reasons. One is that when either was used alone only adequate molasses produced lactic acid dominant silage. Another is that for a similar quality without lactic dominance, greater palatability was associated with higher nitrogen-free-extract, which was dependent on the amount of molasses added. The third is the relative costs. The unit price of salt is more than four times that of molasses. This makes molasses at 200 lb/ton a cheaper additive than salt at 3%. If, as suggested, it were possible to produce better silage with higher salt concentrations the price difference would be even greater. The same would apply to the saving of dry matter by salt. It is indicated that it was a saving of molasses dry matter.

(h) Conclusions

It can be concluded that, to produce lactic acid dominant silage from these species, much higher levels of molasses need to be added than are generally recommended and that the amount necessary increases with immaturity of the pasture. Although salt was helpful towards lactic dominance, sufficient molasses alone gave it at less cost.

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S. J. Barker is an officer of Agriculture Branch, Queensland Department of Primary Industries, and is stationed at Kairi Research Station. M. S. Levitt is an officer of Biochemical Branch and is stationed at Animal Research Institute, Yeerongpilly.