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THE INFLUENCE OF VARIATION IN DRY MATTER CONTENT ON VOLUNTARY INTAKE OF WILTED SILAGE

By

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Calves were offered silage of 56.2 (High) or 36.6% (Medium) dry matter in quantities that exceeded their actual intake by 15 — 30%. The calves offered the medium D.M. silage consumed significantly ($P > 0.001$) more fresh material than those offered the high D.M. silage but had a slightly, though not significantly, lower intake of dry matter.

Fresh intake increased as dry matter percentage declined but not sufficiently to prevent a significant decline in dry matter intake.

Variation in silage dry matter intake between individual calves was closely associated with variation in liveweight ($r = 87 — 97\%$ liveweight range 94 — 237 kg).

The calves consumed dry matter as high D.M. silage in quantites equivalent to 2.56% of liveweight and as medium D.M. silage to 2.35% of liveweight. This difference of 9% was not significant.

There is considerable interest in utilisation of silage for the production of milk and meat. High production from silage can only be obtained when the silage has a high nutritive value and is consumed in large quantities by livestock. In many circumstances intake of silage *per se* imposes a most important limitation on production.

There is ample evidence that the dry matter intake from silage by ruminants depends on factors related to its digestibility dry matter content, physical state and "palatability" (Moore *et al.*, 1960 ; Thomas *et al.*, 1961; Murdoch, 1966 ; Pratt and Conrad, 1967). **The relationship between digestibility of silage and the time feed residues are retained in the rumen** (Freer *et al.*, 1961)**has been used to explain the greater the voluntary intake of high** versus low digestibility silage (Murdoch, 1964). **Increasing dry matter content of the silage (over the range 30—60%) has generally been associated with an increase in voluntary intake of this feed** (Gordon *et al.*, 1965; Pratt and Conrad, 1967 ; McCullough, 1961).

It has been demonstrated that under unfavourable condition of fermentation as with material of a high moisture content, butyric acid and the end-products of protein break-down are produced in the silage and have inhibitary effects on silage intake by livestock (Thomas *et al.*, 1961; Morgan, 1963).

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Cutting herbage at an early stage of maturity, when it has a high digestibility and wilting this herbage to 30—50% dry matter before ensiling in seared containers produces high quality silage (Pratt and Conrad, 1967). Wilting silage increases the sugar concentration in the herbage and also increases the osmotic pressure potential of this material (Wieringa, 1960). The increase in osmotic pressure of silage produces a decrease in butyric acid production even when the material has a relatively high pH (Wieringa, 1960).The lactic acid concentration in the silage increases as moisture content decreases.

The experiment descibed hereafter was conduicted to investigate the acceptability of Jersey calves to two silages similar in all respects other than dry matter content. These silages were wilted in the field to a variable extent and stored in sealed silos. The medium D.M. silage contained an average slightly more than 35% dry matter and high D.M. silage rather more than 55%.

Material and Methods

1.—*Experimental design and treatments*

The experiment conformed to a two treatment comparison of change-over design. Fourteen Jersey calves were grouped into seven pairs of similar age liveweight, and one member of each pair was allocated at random to one or other of the experimental treatments. The experiment was organised in two, fifteen-day, feeding periods. During the first period one member of each pair of calves was offered high dry matter silage and the other medium dry matter silage and during the second period each calf was offered the alternative type of silage. A description of the two groups of calves and the layout of the experiment is presented in Table 1.

TABLE 1.—DESCRIPTION OF EXPERIMENTAL ANIMAL AND LAYOUT OF EXPERIMENT

Calf group	No. of calves	Mean age (days)	Mean weight (kg)	Experimental silage offered	
				Period I	Period II
I	7	327 ± 34.6	170.3 ± 17.03	High	Medium
II	7	329 ± 35.5	163.0 ± 16.20	Medium	High

2.—*Feeds*

The experimental silages were 'second-cut' herbage from a two year old timothy-perennial ryegrass-white clover sward. The grass was wilted and different period of drying and different methods of herbage conditioning were employed in order to obtain two experimental silages uniform in all respects other than dry matter content (Tabe 2). Each type of silage was stored in lined and sealed silos holding from 980 to 1060 kg silage dry matter.

TABLE 2.— CRUDE PROTEIN, DIGESTIBLE CRUDE PROTEIN AND *in vitro* DIGESTIBILITY *of the silages and concentrates*

	Crude protein (%)			D.C.P.+ (%)	*In vitro* Digestibilty
	Period I	Period II	Mean		
High D.M. silage . . .	12.4±0.10	12.5±0.14	12.41	8.7	71.2
Medium D.M. silage . .	12.5±0.14	1.36±0.07	12.41	8.7	69.7
Concentrates	17.68±0.03	17.52±0.06	17.60	13.6	

3.—*The dry matter content of the experimental silages*

The dry matter content of the silages used in this experiment were 56.2 and 36.6%. The high D.M. material was however more cosistent in moisture content than the medium D.M. material (Coefficients of variation being 12 and 30% for he two types of silages respectively). The former was of similar dry matter content in both periods I and II whereas the medium D.M. silage was significantly lower in dry matter content in the second of the two periods (Table 3).

TABLE 3.—DRY MATTER PERCENTAGE OF THE EXPERIMENTAL SILAGES

Silage type	Period I	Period II	Mean
High D.M.	56.32 ± 1.14	56.05 ± 0.67	56.18 ± 1.23
Medium D.M.	42.14 ± 1.50	30.99 ± 1.58	36.56 ± 1.95

The variation in dry matter content of the medium D.M. silage was due to the greater moisture content of the lower layers of material in the silos ; material that was fed in the later stages of period II. Thin variation in moisture content at different levels in the medium D.M. silo was not associated with any progressive changes in the dry matter content of the herbage during the filling of the silos, nor was it due to ingress of rain water as this was effictively excluded at all stages. It is suggested that this difference within silos might be associated with the downward seepage of moisture being retained within the polythene lining of the sealed silo. Part of this moisture presumably derived from respiration of the plant material during the initial stages of ensilage.

4.—*Management of experimental calves and feeding procedure*

The calves were housed in a byre and tied by neck in single stalls. The calves were housed seven days prior to the start of the experiment. The calves received a daily allowance of 2 lb. concentrates (80% rolled barley + 20% decorticated groundnut cake) fed twice daily, and the silage allowances were fed three times daily in quantities which exceeded the actual intake of the calves by 15—30%.

Daily samples from silage offered and refused were taken for D.M. and crude protein determinations.

The calves were weighed at 10 a.m. on Tuesdays and Fridays of each week. Before the start of the experiment, between the two fifteen day feeding periods and at the end of the experiment weighing was preceded by a standard period of feed (24 hours) and water (12hours) withdrawal. This was intended to improve the precision of liveweight determinations by reducing variation in the weight of feed residues in the alimentary tract (Whiteman, *et al*., 1954 ; Algeo, 1963).

Results

1.—*The intake of experimental silages*

In both periods I and II the calves receiving the high D.M. silages consumed less fresh silage than those receiving the medium D.M. silage. This differences was more evident in period II than in period I and overall was highly significant (Table 4).

The dry matter intake of the calves receiving the high D.M. silage was significantly greater than that of calves receiving the medium D.M. silage in period I (P 0.05) but this difference was not confirmed in period II. Overall, calves receiving the high D.M. silage had a marginally greater dry matter intake than the other but the difference was not significant (Table 4).

TABLE 4.—FRESH AND DRY MATTER INTAKE OF THE SILAGES (PER CALF)

Silage type	Fresh intake (kg / calf / day)			Dry matter intake (kg / calf / day)		
	Period I	Period II	Mean	Period I	Period II	Mean
High D.M. . .	7.37	6.86	7.11	4.54	4.07	4.31
Medium D.M. .	8.35	13.30	10.82	3.81	4.24	4.02
S.E. of Diff. .	0.58	0.47+++	0.29+++	0.23+	0.11	0.15^{NS}

2.—*Silage intake in relation to liveweight* :

The calves ranged in liveweight from 94 to 237 kg. and in metabolic liveweight (L.W. 0.73) from 27 to 53 kg. The high correlations between intake of dry matter from the two types of silage and liveweight of the calves are shown in Table 5. These indicate that 87 to 97% of individual

TABLE 5.—THE RELATIONSHIP BETWEEN DRY MATTER INTAKE (Y) AND LIVEWEIGHT (X-) AND MATABOLIC BODYWEIGHT 0.73

Silage type	Linear regression equations	Significance of regression
High D.M. . .	$Y = -1.45\ (\pm 1.38) + 0.034\ (\pm 0.01)\ X_1$*	+++
Medium D.M. .	$Y = -0.39\ (\pm 1.25) + 0.026\ (\pm 0.008)\ X_1$*	+++
High D.M. . .	$Y = -2.33\ (\mp 1.38) + 0.16\ (\pm 0.049)\ X_2$**	+++
Medium D.M. .	$Y = -1.88\ (\pm 1.25) + 0.14\ (\pm 0.044)\ X_2$**	+++

* The difference between the two regression coefficient is significant ($P < 0.05$).

** The difference between the two regression coefficient is not significant ($P > 0.05$).

variation in dry matter intake was associationed with variation in liveweight. Table 6 presents the regression equations with standard diviations of the relationship between dry matter intake and liveweight, Figures 1, 2 also illustrate this relationship. These indicates that variation in dry matter intake was closely associated with variation in liveweight *per se* and that adjustment of liveweight to estimated metabolic body size did not improve the closeness of this relationship ; in the case of high D.M. rather the reverse.

TABLE 6.—CORRELATION BETWEEN THE INTAKE OF SILAGE DRY MATTER AND THE LIVEWEIGHT OF CALVES

Silage type	Silage D.M. intake	
	L. Wt.	L. Wt. 0.73
High D.M.	0.985+++	0.986+++
Medium D.M.	0.932+++	0.934+++

Regression analysis of dry matter intake on liveweight was also carried out after logarithmic transformation of the intakes and weights. The regression coefficient from this analysis gave estimate of the appropriate exponent of liveweight in the equation D.M.I. = a (L.Wt.) ^{k} ; the value of k was similar with both types of silage, 1.17 $\pm$ 0.055 and 1.17 $\pm$ 0.054 for high and medium D.M. silage respectively.

The effect of silage treatment on dry matter intake of the calves has also been analysed after adjustment for variation in their liveweight. The results are presented in Table 7. The calves receiving the high D.M. silage consumed more silage dry matter per unit of liveweight than those receiving the medium D.M. silage in both periods I and II and the calves changing from high to medium D.M. silage slightly reduced their intake, whereas those changing from medium to high D.M. silage slightly increased their intake (Table 7). These differences however did not attain significance on either within or between period basis ($P > 0.05$).

TABLE 7.—SILAGE DRY MATTER INTAKE (KG) PER 100 KG. OF LIVEWEIGHT

Silage type	Period I	Period II	Mean Period I and II
High D.M.	2.60 (3.10)	2.41 (2.91)	2.56 (3.00)
Medium D.M.	2.33 (2.83)	2.37 (2.87)	2.35 (2.85)
S.E. of Diff.	0 10_{NS}	0.0 8	0.07^{NS}

Note.—Total dry matter intakes shown thus ( ).

3.—*Liveweight changes*

Because of the short experimental periods, the records of liveweight were not sufficient to permit any precise determination of the effects of treatment on this parameter.

Discussion

Intake in relation to dry matter content

In both periods I and II the calves receiving the medium D.M. silage consumed more fresh silage than those receiving the high D.M. silage and this difference was more marked and very highly significant in the second period. This was associated with the lower dry matter content of the medium silage ; a feature recognised in other experiments (Murdoch, 1960; Byers, 1965).

Examination of dry matter intake in relation to dry matter content of the silage which was 36.6 and 56.6% on average indicates that dry matter consumption was 9% higher with the high D.M. silage than with the medium D.M. silage (2.56 kg./100 kg. liveweight V 2.35 kg/100 Kg liveweight respectively), but this difference was not quite significant. However it was also evident that when calves fed medium D.M. silage in period 1 were changed to high D.M. silage in period II their dry matter intake per 100 kg liveweight increased by 3 per cent, whereas when those fed high D.M. silage in period I were changed to medium D.M. silage their dry matter intake per 100 kg liveweight decreased by 10 per cent. Gordon *et al.* (1965), observed that on silage with 43% dry matter, the lactating cows consuming 2.251 kg/100 kg L.Wt. increased their consumption by 10 per cent when fed silage with 65% dry matter.

Table 8 presents a summary of other experiments reported in the literature about the relationship between dry matter intake and dry matter content of the silage. These experiments describe average 'long-term' (*i.e.* over feeding period of 10 days or more) effects of silage moisture content on dry matter intake by livestock, and it is generally accepted that in this content the effects of variation in moisture content are mediate by their influence on the type of fermentation the material undergoes during ensilage (Murdoch, 1967) and not attributable to moisture content per se (Moore, *et al.*, 1960).

TABLE 8.—DRY MATTER INTAKE IN RELATION TO DRY MATTER CONTENT OF THE SILAGE

Source	Range D.M. percentage	Effect of increasing D.M. % on D.M. intake
Dodsworth and Campbell (1952)	16.9—22.7	+
Dodsworth (1954)	15.8—19.5	+
Harris and Raymond (1963)	25.9—30.6	+
Gordon *et al.* (1965)	30.8—65.0	+

In the present experiment there was an opportunity to examine 'short-term' variations in silage intake associated with variation in the moisture content of the silage which had arisen after or during ensilage. Variation considered to be associated with the movement of free water within the silage mass.

There was a close relationship between daily variation in the moisture content of the medium dry matter silage (over the range 18—48) and the intake of fresh material; when moisture content of the silage was high the intake of fresh material increased but not sufficiently to maintain the same dry matter intake as was attained on silage with a lower moisture content. This must presumably be largely associated with immediate filling effects of the fresh silage in the rumen having an influence on the amount eaten over a particular 24 hour period and to a lesser extent mediated through variation in rate of passage of material through the rumen, since the variation in the latter respect would presumably be evident only over a longer period of 2 to 3 days (Balch and Campling, 1962).

Dry matter intake in relation to body weight

Strong positive correlations were obtained when the silage dry matter intake was regressed on the liveweight and metabolic liveweight (L.Wt. 0.73). These correlations indicate that for high and medium D.M. silage respectively 97 and 87% of individual variation in D.M. intake of the calves was associated with variation in liveweight. McCullough (1961), found that the liveweight explained 43% of the variation in silage dry matter intake of lactating cows. The difference between calves and lactating cows could be explained by the fact that with lacting cows factors other than liveweight such as stage of lactation and milk yield affect silage intake (McCullough, 1961 ; Holmes, 1961).

The regression of dry matter intakes on calf liveweight revealed that dry matter intake of the medium D.M. silage increased by 2.6 kg for every 100 kg increase in liveweight, whereas for the high D.M. silage the increase was 3.4 kg D.M./100 kg liveweight and the difference was sigificant. The value for high D.M. silage with (3.4 kg/100 kg L.Wt.) obtained by Martine *et al.* (1955).

Logarithmic transformation of dry matter intakes and liveweights data indicated that for every 100% increase in calf liveweight their dry matter intake of silage (of both types) increased 117 + 5.4%. A similar value of 116 ±37% was obtained by Hadijpieris *et al.* (1965), with growing wethers; with older sheep the same workers found values of 97 + 17%and 85 + 24% which were close to 100 but not significantly different to 73%. In most studies dry matter intake has usually been found to increase only 66—75% as much as liveweight (Blaxter *et al.*, 1961). The reference base of L.Wt. 0.73 was one calculated by Brody (1945) and relates to changes in basal metabolism with differences in size between *mature* animals of different species and was shown by Brody to be inappropriate to growing animals

within a species. Holmes *et al.* (1961) and Hodgson and Wilkinson (1967), recognised a difference in the relationship between organic matter (O.M.) intake from grazing and liveweight in cows compared with heifers and calves. The liveweight exponent relating these two features increased in size when cows were excluded from the data; viz :

Holmes *et al.* (1961) :

Cows, Heifers and calves D.O.M.I. = a L.Wt. 0.43
Cows, Heifers and calves D.O.M.I. = a L.Wt. 0.62

Hodgson and Wilkinson (1967) :

Cows, Heifers and calves O.M.I. = a L.Wt. 0.61
Cows, Heifers and calves O.M.I. = a L.Wt. 0.71

In both these experiments small numbers of animals were involved and separate equations were not derived for calves, (which were comparable in size with those used in this study). However, Holmes *et al.* (1961), concluded that their equations implied some change in the relationship of intake to size at weights lower than 400 lb. This seems likely in that the rumen develops relatively faster than liveweight in the young animal (Large, 1964) whereas at a later stage of development extention of runmen size proceeds relativly mor slowly. Such dvelopment is appropriate to the young ruminant if it is to obtain a sufficient nutrient supply from bulky feeds of low energy density. In the present study it is notable that variation in chronological age, the lightest calves were 8 months younger than the heaviest calves these differences may have influenced the relationship between the variation in feed intake and liveweight.

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تأثير التباين فى المادة الجافة بالسيلاج المعطن على قابلية الحيوان لتناوله

الدكتور ابراهيم رفعت

الملخص

زودت العجـول بسيلاج ٢ر٥٦٪ (مرتفـع) أو ٦ر٣٦٪ (متوسط) المـــادة الجافة بـكميات تزيد على احتياجاتها الفعلية بنسـبة تتراوح بين ١٥ ــ ٣٠٪ • واستهلكت العجول التى زودت بالسيلاج المتوسط مادة طازجة بنسـبة تفوق تلك التى زودت بسيلاج مرتفع وان كان مأخوذها من المـــادة الجافة ضئيلا نسبيا •

وقد زادت نسبة المأخوذ من المادة الطازجة كلمانقصت النسبة المئوية للمادة الجافة الا أنها لم تكن كافية بدرجة تمنع تضاؤلا ملموسا فى المأخوذ من المادة الجافة •

وكان التباين فى المأخوذ من المادة الجافة فى العلف بين أفراد العجول يرتبط ارتباطا وثيقا بوزنها الحى •

(المدى = ٨٧ ــ ٩٧٪ مدى الوزن الحى ٩٤ ــ ٢٣٧ كجم)

واستهلكت العجول مادة جافة كما فى السيلاج المرتفع بكميات تساوى ٥٦ر٢٪ من الوزن الحى • وهذا الاختلاف الذى يبلغ ٩٪ لم يكن ذا قيمة •