New Zealand Researches on the Effect of Pasture Species on Fat Composition and the Degree of Mutton Flavour in Romney-Southdown Lambs

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A Preliminary Communication

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In the more productive areas of New Zealand, sheep and cattle are fed throughout the year on pasture which consists predominantly of perennial rye grass and white clover. Recent work (Rae et al 1963, 1964) has shown that under conditions where the pasture is in excess of grazing requirements mixed pastures of rye grass and white clover as compared with pastures consisting of rye grass species only, result in an increased rate of growth of lambs. Associated with this increased rate of growth is a greater content of fatty tissue (Barton and Ulyatt, 1963) a higher iodine value and in some instances a lower melting point of the depot fats (Shorland et al 1966) and a higher content of volatile acids especially, propionic and rumen butyric (Johns, Ulyatt and Glenday, 1963). Little work has been carried out on the effect of pasture species on the acceptability of lamb. Although lamb is highly acceptable in New Zealand and Great Britain it is not favoured in some other countries. In the U.S.A., for example, the annual per capita consumption is only about 4.5 lbs. The reason for this low consumption has been attributed by the American Sheep Producers' Council to the undesirable mutton flavour. However, no attempts have been made to evaluate or define mutton flavour. Objections have also been raised on the grounds of the unpalatable nature of the fat. It has been claimed in the U.S.A. that their lamb fat is too highly saturated and as a result it solidifies on the dinner plate at a relatively high temperature and tends to leave a "tallowy" after-taste in the mouth. (Cramer, Marchello and Sutherland, 1961).

In the present work, therefore, an attempt has been made to assess the degree of mutton flavour in lamb and to relate the results to pasture treatment using for the first time pastures consisting entirely of perennial rye grass or of white clover.

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The project has involved the determination by dissection of the weight of the carcase components including fat, muscle, and bone as well as of the non-carcase components. On the chemical side the characteristics and composition of the depot fats have been determined, as has been the content and composition of the rumen volatile fatty acids as well as that of the blood lipids. The purpose of these chemical studies has been to obtain a more complete understanding of the reasons for differences in growth rate, fat composition, and the degree of mutton flavour between rye-grass fed and clover fed lambs.

The final assessment of the data obtained has not yet been completed but an outline of the main conclusions has emerged with sufficient clarity to warrant the presentation of this present paper.

The Romney-Southdown cross lambs used in this work comprised 20 wethers and 10 ewes which were born during the period 13/8/64 to 29/9/64. They were allocated at random to two groups of 15, one of which was grazed throughout on pure perennial rye grass and the other on white clover. The lambs were killed on 5/5/65.

In the present investigation, the dissection and analytical techniques used followed conventional lines and will be reported in the final paper. The evaluation of the degree of mutton flavour and odour proved more difficult as no quantitative procedures for this purpose had hitherto been developed. In addition, the degree of mutton flavour and odour in New Zealand lamb is only slight. In the work now reported the degree of mutton flavour and odour was assessed on the casseroled chop from the 12th rib cooked under standard conditions. The cooked chop was separated into lean and fat and these components after cutting into cubes (1 cm. square) were served separately and evaluated while warm. In addition the residue from the dissection including the bone was placed in a wide necked jar and smelled for mutton odour.

The range on the score sheet consisted of five degrees as follows: none, slight, moderate, strong and intense. The four panel members who had been trained for six weeks with daily tasting sessions using lamb and mutton covering a range of age and condition scored each sample to one third of a degree by marking the score sheet with a minus sign, check or plus mark The scores were converted to numerical values by assigning zero to samples marked "none" and one point for each one third of a degree with increasing intensity, thus giving a twelve point scale. At each session one chop from the experimental group and one from the control group was evaluated, the source of the chop being disguised by means of a code number.

The Effect of Pasture Species on Live Weight and Carcase Components

The results for the weights of live animals, their carcases and the carcase components are collected together in Table I.

Table I. A comparison of the effects of perennial rye grass and of white clover on the live weight, weight of carcase and of carcase components of lambs. (Mean values per lamb together with standard deviations)

	Perennial rye grass		White clover		Significance level
Live weight (lbs)	67.3	(6.7)	93.7	(8.8)	H.S.
Frozen Carcase (lbs)	28.4	(3.4)	46.0	(5.0)	H.S.
Total fat (g.)	276.1	(76.2)	765.9	(217.0)	H.S.
Total lean (g.)	619.1	(93.9)	910.3	(130.4)	H.S.
Total bone (g.)	148.8	(24.4)	185.1	(30.6)	H.S.
Kidney fat (g.)	131.9	(46.2)	282.8	(74.4)	H.S.

*In this and succeeding tables S = significant at the 5% level, H.S. = significant at the 1% level and N.S. = not significant. Figures in brackets refer to the standard deviation of the mean.

As in the experiments of Rae et al (1963, 1964) in which lambs grazed on pure rye grass species (short rotation and perennial) were compared with lambs grazed on these two species mixed with white clover, under conditions of surplus feed the increased rate of growth due to white clover is clearly indicated. The superiority of white clover over rye grass species is perhaps related to differences in cellulose content. As indicated by the results of Lancashire and Keogh (1966) rye grass species contain, on a dry weight basis about twice as much cellulose (c.20%) as white clover which renders the pasture less readily digestible. In addition, the effect of the addition of white clover to pure rye grass pasture in increasing the weight of fat, bone, and muscle and non-carcase components has been demonstrated by Barton and Ulyatt (1963).

The present data derived by comparison of lambs grazed on pure perennial rye grass with those grazed on pure white clover support these findings. (See Tables I and II)

Table II. A comparison of the weights (g.) of some non-carcase components of perennial rye grass and of white clover-fed lambs

	Perennnial rye grass	White clover	Significance level
Empty rumen	568.5 (88.9)	762.7 (102.7)	H.S.
Rumen contents	2721.3 (772.6)	1931.8 (418.1)	H.S.
Liver	491.2 (64.4)	690.6 (55.8)	H.S.
Kidney	96.4 (11.9)	133.3 (13.0)	H.S.

The Effect of Pasture Species on the Composition of Fatty and Muscular Tissues and on the Characteristics of the Fats from these Tissues

The work in this section has not yet been completed. Shorland et al (1966) have already observed the marked effect of the addition of white clover to pure rye grass species on the elevation of the iodine value of the depot fats of wethers as well as certain minor effects on their melting points and on the percentage dry matter and fat of the fatty tissues. In the present work as shown in Table III the composition of the subcutaneous fatty tissues and of the I. dorsi muscle has been altered significantly by pasture treatment. In the first tissue the percentage dry matter was significantly higher in the perennial rye grass fed lambs while in the second tissue the white clover-fed lambs contained a higher percentage fat than the lambs fed on perennial rye grass.

The subcutaneous fat of the white clover fed lambs as compared with those fed on perennial rye grass was shown to have a much higher iodine value but a lower percentage of unsaponifiable matter, the differences between treatments being respectively highly significant and significant. In the l. dorsi fat no differences in iodine value were observed between the treatments, but the fat from the white clover fed lambs contained much less unsaponifiable matter, the difference being highly significant. No significant differences were observed between the melting points of the same depot fats. The results to date therefore suggest that although white clover as compared with perennial rye grass pastures lead to higher iodine values in lamb depot fats, the melting points of the fats are relatively unaffected. These observations also indicate that the use of the iodine value as a guide to the softness of lamb fat may be misleading.

Table III. The percentage fat and percentage dry matter in the subcutaneous fatty tissues and the longissimus dorsi muscle together with the characteristics of the fats of lambs fed rye-grass and white clover respectively.

	Subcutaneous fatty tissue			Longissimus dorsi muscle		
	Perennial rye grass	White clover	Significance	Perennial rye grass	White clover	Significance
% Dry matter	6.0 (3.3)	2.9(1.0	H.S.	19.0 (0.9)	18.9(0.8)	N.S.
% Fat	85.5 (9.5)	89.9(3.5)	N.S.	5.5 (1.6)	8.1(1.5)	H.S.
Iodine value	44.9 (1.9)	50.3(1.7)	H.S.	59.5 (4.7)	58.7(1.8)	N.S.
Melting point (^{o}C)	43.8 (2.2)	44.2(1.7)	N.S.	46.3 (2.5)	44.9(2.4)	N.S.
% Unsaponifiable	0.69(0.34)	0.45(0.1)	S	3.04(1.20)	1.80(0.34)	H.S.

Correlation coefficients between the iodine values of the subcutaneous and l. dorsi fats and the total weight of fat in the carcase were found to be non-significant. It is thus evident that the Callow (1935a,b) growth rate theory of iodine value which he used to explain the higher iodine values of the depot fats of slow growing as compared with fast growing pigs as resulting from their greater incorporation of soft dietary fats, does not apply to sheep. This may follow from the fact that the dietary fat in sheep is hydrogenated by the rumen microorganisms (probably to a varying degree) leading to fats which are harder than those made endogenously from the non-fatty constituents of the diet (cf Shorland, Weenink and Johns, 1955).

The Amount and Composition of the Volatile Fatty Acids (V.F.A.) in the Rumen

Johns et al (1963) have already shown that sheep grazed on rye grass alone as compared with those fed on a mixed pasture consisting of rye grass and white clover are characterised by a greater weight of rumen contents and by a lower concentration of V.F.A. with diminished proportions of propionic and butyric acids. These findings accord with those of the present investigation in which the effects of perennial rye grass and of white clover have been studied separately. (See Table IV)

Table IV. Total volatile fatty acids (V.F.A.) and the composition of the component volatile fatty acids μM/ml.

V.F.A.	Perennial rye grass	White clover	Significance levels
Acetic	56.8 (7.2)	101.9 (9.4)	H.S.
Propionic	17.1 (3.0)	43.7 (5.5)	H.S.
Butyric	10.3 (2.5)	27.5 (4.0)	H.S.
Isovaleric	3.4 (0.6)	7.2 (0.9)	H.S.
Valeric	1.8 (0.4)	5.5 (1.1)	H.S.
Total	89.4 (13.1)	185.7 (17.4)	H.S.

In the present investigation the effect of feeding white clover alone as compared with perennial rye grass has been to double the concentration of V.F.A. in the rumen. This effect is much more marked than was found by Johns et al. (1963) where an increase of 114% was observed for the sheep grazed on perennial rye grass-white clover pastures as compared with pasture consisting of rye grass only.

The higher level of volatile fatty acids in the rumen is thus consistent with the greater rate of growth of white clover fed lambs as compared with those fed on perennial rye grass alone. Moreover, as pointed out by Annison and Lewis (1959), the lower the pH, the greater, is the rate of absorption of the V.F.A. across the rumen wall.

The Effect of Pasture Species on Levels of Serum Lipids

The concentration of total lipids, phospholipids, free fatty acids and of cholesterol in the serum is indicated in Table V.

Table V. A comparison of the serum lipids of perennial rye grass-fed and clover fed lambs (Mg/100 ml.)

	Perennial rye grass	White clover	Significance
Total lipids	203.3 (16.4)	181.8 (18.1)	N.S.
Phospholipids	28.6 (2.25)	23.9 (3.14)	H.S.
Free fatty acids	15.1 (1.70)	20.5 (2.92)	H.S.
Cholesterol	97.00 (9.5)	73.8 (14.6)	N.S.

It will be seen from Table V that the free fatty acid levels are increased and the phospholipid levels diminished in the white clover-fed sheep as compared with those fed on perennial rye grass. These results are difficult to interpret, at present, because an increased free fatty acid content in the serum is usually associated with fasting.

The Intensity of Mutton Flavour and Odour in the Cooked Meat from Perennial Rye Grass-Fed and White Clover-Fed Lambs

The use of casseroled meat for the evaluation of mutton flavour was to avoid the production of burnt flavours and other complications associated with roasting. Furthermore, the use of salt or condiments that might interfere with the flavour evaluation was avoided. The results of the taste panel indicated that it was readily feasible to distinguish between the 12th rib chop both in regard to the flavour of the lean and the fat as well as to detect differences in odour between the perennial rye grass and the white clover-fed groups. (See Table VII)

Table VII. Comparison of the effect of pasture treatment on the intensity of mutton flavour and odour of the lean and fatty tissues of the 12th rib chop

	Mutton flavour			Mutton odour		
	Perennial rye grass	White clover	Significance	Perennial rye grass	White clover	Significance
Lean	3.20(0.85)	5.38 (0.97)	H.S.	-	-	-
Fatty tissue	4.20(1.16)	5.88 (1.05)	H.S.	-	-	-
Total Chop	-	-	-	3.77(0.88)	4.77 (0.89)	H.S.

The results show that the white clover-fed animals as judged from the 12th rib chop possess a highly significantly greater degree of mutton flavour and of odour than the perennial rye grass-fed animals. It is not yet known whether the degree of fatness *per se* is responsible for these differences or whether the components of the white clover apart from their enhancing effect on growth rate influence the development of mutton odour. It is hoped by further analysis of the present data as well as by conducting further investigations to shed light on this problem and to pave the way for increasing the growth rate of sheep without incurring an increase in the intensity of mutton flavour.

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