Voluntary food intake of growing pigs given diets containing rapeseed meal, from different types and varieties of rape, as the only protein supplement

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1. The voluntary food intake, during 30 min periods after morning and afternoon feeds and during 24 h, by growing pigs given diets containing rapeseed meal (Rsm) or soya-bean meal (Sbm) as the only protein supplement was determined. One diet was offered at a time and a daily changeover sequence of feeding was followed.

2. Four rapeseed meals were compared, one from seeds of British-grown winter *Brassica napus* varieties (Brsm) and the others from seeds of the varieties Tower (Trsm), Erglu (Ersm) and Span (Srsm). The effects on feed intake of adding flavouring substances to the Brsm diet were also determined. The flavouring substances were molassine meal, sucrose and four commercially-available substances: P, pig nectar; H, hog nectar; S, sow nectar and A, apple.

3. Intake of the Brsm diet was significantly less than those of the Sbm, Trsm and Ersm diets.

4. Addition to the Brsm diet of molassine meal or sucrose at 50 or 100 g/kg did not improve voluntary feed intake. None of the commercial flavouring substances raised the intake of the Brsm diet to the level of the Sbm diet but they improved intake of the Brsm diet to varying extents. Flavourings H, S and A gave similar improvements which were substantial.

5. The Sbm, Brsm and Trsm diets were each fed *ad. lib.* to groups of growing pigs continuously for 4 weeks. Weekly feed intakes and weight gains were determined. Feed intakes and weight gains followed closely the intake values obtained in the changeover experiments. The highest values were for the Sbm diet; those for the Trsm diet were slightly lower and those for the Brsm diet were substantially and significantly lower.

6. The glucosinolate, sinapine and tannin contents of the rapeseed meals were determined and the results suggested that voluntary feed intake of diets containing these meals was related to their glucosinolate content, but not to their sinapine or tannin contents.

Rapeseed, at present the only economically-viable crop providing oil for human consumption in most temperate climates, affords, after extraction, a potentially-valuable meal of high protein content (360–400 g/kg). The area of rape sown in the UK for seed has increased very rapidly over the past decade; it is likely to continue to do so and therefore the quantity of extracted meal available as animal feed will also increase. However, its use in pig diets is restricted, largely on account of the high levels of glucosinolates present. Substances formed on hydrolysis of the glucosinolates are goitrogenic, and they may also have other undesirable effects. Plant breeders in Canada and Europe are engaged in projects to reduce the level of these compounds in the seed and hence improve the value of the meal as an animal feed.

The use of rapeseed meal is also restricted because of its reputed low palatability. Several workers have reported reduced intake of diets containing rapeseed meal, particularly when given to young growing animals (Manns & Bowland, 1963; Bowland, 1965; Lo & Hill, 1971; Bell, 1975). However, in most of these studies the diets containing rapeseed meal were fed continuously and, where food intake was low, it was not possible to separate the effects of low palatability from those of low nutritive value or goitrogenicity. In the only study carried out specifically to assess the palatability of rapeseed meal, McDonald (1974) found a reduced voluntary intake of diets containing a high proportion of rapeseed meal in rats

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and pigs; it was suggested that the principal substance influencing intake was glucosinolate present in the rapeseed meal.

The objectives of the present study were: (1) to measure the voluntary feed intake of growing pigs given diets containing soya-bean meal or one of four types of rapeseed meal, in a cross-over design, with each diet given for 1 d, or for 3 d (Expt 1); (2) to measure the voluntary feed intake of growing pigs given diets containing either soya-bean meal or British rapeseed meal with or without flavouring compounds (molassine meal, sucrose and four commercially-available compounds) with each diet given for 1 d (Expt 2); (3) to measure the voluntary feed intake and live-weight gain of growing pigs fed continuously on an *ad lib.* basis with diets containing either soya-bean meal or one of two types of rapeseed meal (Expt 3).

MATERIALS AND METHODS

Animals and feeding

Large White and Cotswold hybrid × Large White pigs were housed in groups of two to six animals. The ages and weights of pigs at the start of the experiments varied from 2 months, weighing 15 kg, to 4 months, weighing 60 kg. Within each experiment, treatments were balanced with respect to the number of animals per pen and their sex, age and weight.

In Expts 1 and 2 the pigs were fed twice daily. They were given a quantity at each feed that was eaten almost completely in a fixed time, 30 min (unless otherwise stated), by pigs given the control (soya-bean meal) diet. This was about 6% of body-weight and close to the previously-established *ad lib.* intake of this diet. In Expt 3 the diets were given *ad lib.* in feed hoppers. Feed was added in small amounts twice daily; this reduced feed loss to negligible proportions. The diets were all in cube form except for part of Expt 1, as described below. Water was freely available to all pigs.

Experimental diets

The diets were formulated to contain approximately 180 g crude protein (nitrogen × 6·25) and 14 MJ digestible energy (DE)/kg dry matter (Table 1) and provide adequate levels of all nutrients recommended by the (UK) Agricultural Research Council (1967). Determined crude protein values for all diets, also shown in Table 1, were slightly higher than the calculated values. The control diet contained soya-bean meal as the only protein supplement (Sbm diet) and the experimental diets contained rapeseed meal as the only protein supplement (Rsm diets). To take account of the lower crude protein and DE contents of rapeseed meal compared with soya-bean meal and at the same time maintain similar crude protein and DE in the diets, a higher level of rapeseed than soya-bean meal was needed and, in the Rsm diet, the energy deficit was corrected by including wheat meal in place of part of the barley of the Sbm diet. As body-weight gain was the main response measured in Expt 3, it was necessary to use diets of similar crude protein and DE. The diets were all given in cubed form except in trial 3 of Expt 1. Only a small quantity of rapeseed meal from the variety Span, used in this trial, was available. The amount was too little for the diet to be cubed and, therefore, all four diets used in this part of the experiment were given as meal.

Expt 1

Rapeseed meals from four well-defined types and varieties were compared with Sbm in this experiment: *Brassica napus* varieties currently grown in Britain (Brsm), *B. napus* variety Tower grown in Canada (Trsm), *B. napus* variety Erglu grown in Germany (Ersm), *B. campestris* variety Span grown in Canada (Srsm). These meals were compared in three trials, Brsm and Trsm with Sbm in the first, Ersm as well as Brsm, Trsm and Sbm in the second

Table 1. *The composition (g/kg) of diets based on soya-bean meal or rapeseed meal given to growing pigs*

	Soya-bean meal	Rapeseed meal
Ingredients		
Barley meal	722·5	350·0
Wheat meal	—	320·0
Soya-bean meal	205·0	—
Rapeseed meal	—	257·5
Molassine meal	50·0	50·0
Limestone	10·0	10·0
Dicalcium phosphate	7·5	7·5
Salt	4·0	4·0
Trace element and vitamin supplement*	1·0	1·0
Chemical composition (calculated values expressed on a dry matter basis)		
Digestible energy (MJ)	14·2	14·2
Crude protein (nitrogen × 6·25)	181†	181†
Lysine	9·6	8·4
Methionine + cystine	5·9	6·1
Tryptophan	2·6	2·3
Threonine	6·6	6·9
Calcium	8·2	9·3
Phosphorus	5·9	6·9

* Contributing the following (mg/kg diet): copper 125, zinc 100, manganese 40, iron 54, iodine 2, thiamine 1·5, riboflavin 2·5, nicotinic acid 12, pantothenic acid 10, pyridoxin 2·5, cyanocobalamin 0·01, choline 61·5, vitamin A 0·53, vitamin D 0·01.

† Determined crude protein values were (g/kg dry matter): soya-bean meal (Sbm) 194, British rapeseed meal (Brsm) 198, Tower rapeseed meal (Trsm) 191, Erglu rapeseed meal (Ersm) 211, Span rapeseed meal (Srsm) 190.

and Srsm as well as Brsm, Trsm and Sbm in the third. Smaller quantities of Ersm and Srsm than of Brsm and Trsm were available, sufficient of each for one trial. In each trial there were four replicates, fed as a group. In a fourth trial in which Brsm and Trsm were compared with Sbm, each diet was given for three consecutive days, rather than 1 d, as in all other parts of Expts 1 and 2. This provided information on the possible adaptation of pigs to the Rsm diets.

Expt 2

Flavouring substances were added singly to the Brsm diet; molassine meal at 50 and 100 g/kg (Brsm + 50 m, Brsm + 100 m), sucrose at 50 and 100 g/kg (Brsm + 50 s, Brsm + 100 s) and four commercial products of unspecified composition, P (pig nectar), H (hog nectar), S (sow nectar) and A (apple). Flavours P, H and S, from Salisbury Laboratories, Salisbury Chemicals Ltd, Reading were added at the rate of 1 kg/tonne, and flavour A, from Food Industries Ltd, Bromborough Port, Wirral, Merseyside, at 1·5 kg/tonne; these were recommended levels.

For trials 1 and 2 of this experiment the basal Sbm and Brsm diets contained no molassine meal.

Expt 3

Two of the rapeseed meals used in Expt 1, British and Tower, were included in the continuous-feeding experiment.

Table 2. *Expts 1 and 2. The daily feeding pattern for the comparison of three diets A, B and C*

(For each pen, diet A was offered twice, once following diet B and once following diet C. Similarly, for each pen, diet B was offered following A and C and diet C was offered following A and B)

	Pen no.		
Day of trial	1	2	3
0*	A	B	C
1	C	A	B
2	B	C	A
3	C	A	B
4	A	B	C
5	B	C	A
6	A	B	C

* Day 0 was a non-recording day.

Experimental design

Expts 1 and 2. The experiments were designed to assess the preferences of the pigs for the taste and smell of the diets. The main features of the design, an example of which is given in Table 2, were as follows: the number of pens matched the number of diets in each trial; each pen of four pigs was given only one diet at a time; each pen of pigs received a particular diet for a period of 1 d only; on any particular day each pen received a different diet which meant that all diets were given on each day of the experiment; each diet was preceded once by each of the other diets, e.g. in Table 2 pen 1, diet A was given on two recorded days, once preceded by C and once by B. The design was a balanced Latin square change-over with three pens in six 1 d periods.

In this pattern of feeding there was no opportunity for the pigs to adapt to a diet and therefore the results of these experiments indicate only sensory preferences for the diets. Offering all diets on each day of the trial eliminated any bias in the results that may have occurred from the external environment and giving one diet at a time rather than a choice of diets followed normal feeding practice.

The acceptability of the diets was measured in Expts 1 and 2 by recording the amount of food eaten by the pigs of each pen during 30 min periods after morning and afternoon feeds. In trial 3 of Expt 1 the time allowed was 60 min to allow for the slower rate of ingestion of diet in meal than in cube form. The quantity eaten in this set period was calculated as a proportion of the amount offered. Uneaten food was replaced in the trough and any remaining at the next feed was weighed and discarded. The quantity eaten as a proportion of the amount offered in 24 h was also calculated.

Expt 3. The live weights of seventy-two growing pigs, with equal numbers of males and females, aged 2–3 months and weighing from 16 to 35 kg, were set out in ascending order and in groups of three of similar sex and of consecutive weight; members of each trio were allocated randomly to one of three diets, giving twenty-four pigs per diet. The pigs were penned in fours, also in weight order, giving six pens per dietary treatment; weights per pen at the start of the experiment for each diet were approximately 18, 22, 23, 28, 33 and 34 kg. The pigs of each pen were fed as a group. The three diets, Sbm, Brsm and Trsm, were fed *ad lib.* for 4 weeks: the pigs were weighed and food intake was recorded weekly.

Table 3. *Expt 1. Voluntary food intake, during 30 min* periods after morning and afternoon feeds, by growing pigs given diets containing soya-bean meal (Sbm) or different types and varieties of rapeseed meal (Brsm, Trsm, Ersm, Srsm) measured as a proportion of the amount of food offered*

Trial no.	No. of pens	No. of treatment values	Diet†					SED	Significance of difference between means: *P*
			Sbm	Brsm	Trsm	Ersm	Srsm		
1	3	24	0·98	0·59	0·90	—	—	0·043	< 0·001
2	4	48	0·94	0·54	0·85	0·88	—	0·038	< 0·001
3	4	36	0·67	0·42	0·55	—	0·53	0·035	< 0·001

* 60 min when the diet was given as a meal in trial 3 (see p. 664).
† For details, see Table 1.

Table 4. *Expt 1. Voluntary food intake during 24 h by growing pigs given diets containing soya-bean meal (Sbm) or different types and varieties of rapeseed meal (Brsm, Trsm, Ersm, Srsm), measured as a proportion of the amount of food offered*

Trial no.	No. of pens	No. of treatment values	Diet*					SED	Significance of difference between means: *P*
			Sbm	Brsm	Trsm	Ersm	Srsm		
1	3	24	1·00	0·92	0·99	—	—	0·016	< 0·001
2	4	48	1·00	0·90	0·99	1·00	—	0·014	< 0·001
3	4	36	0·95	0·88	0·95	—	0·91	0·021	< 0·01

* For details, see Table 1.

Statistical analyses

Food intake expressed as a proportion of the amount offered from each trial of Expts 1 and 2 was assessed statistically by analysis of variance. Mean daily feed intake and daily weight gain per pig for each week of Expt 3 were analysed in the same manner.

Determination of toxic compounds

Each rapeseed meal used in the study was analysed for the hydrolysis products of the glucosinolates: oxazolidinethione, isothiocyanate (Appelqvist & Josefsson, 1967) and thiocyanate (Srivastava & Hill, 1975); and for tannins (Burns, 1963) and sinapine (Tzagoloff, 1963; Austin & Wolff, 1968).

RESULTS

Expt 1. Different types and varieties of rapeseed meal

The results for voluntary food intake in 30 min periods after morning and afternoon feeds, measured as a proportion of the amount offered, are given in Table 3. In each trial the proportion of Brsm eaten was lower than that of the Sbm diet and the differences were highly significant. The Trsm diet, though eaten less readily than the Sbm diet, was eaten significantly more readily than the Brsm diet. The intakes of the Ersm diet (trial 2) and the Srsm diet (trial 3) were similar to those of the Trsm diet.

Table 5. *Expt 1, trial 4. Voluntary food intake, during 30 min periods after morning and afternoon feeds, by growing pigs of diets containing soya-bean meal (Sbm) or different varieties of rapeseed meal (Brsm, Trsm) offered for three consecutive days, measured as a proportion of the amount of food offered*

Day of trial	No. of values	Diet*			
		Sbm	Brsm	Trsm	Mean
1	6	0·91	0·64	0·83	0·80
2	6	0·90	0·51	0·78	0·74
3	6	0·93	0·63	0·81	0·79
Mean		0·92	0·60	0·81	
SE of difference between means	Treatment means for each day, 0·081; over-all treatment and day means, 0·046				
Significance of effects: *P*	Diet < 0·001; day, NS; diet × day interaction, NS				

* For details, see Table 1.
NS, not significant.

Table 6. *Expt 2. Voluntary food intake, during 30 min periods after morning and afternoon feeds, by growing pigs given diets containing soya-bean meal (Sbm), British rapeseed meal (Brsm) or Brsm plus 50 or 100 g of molassine meal (m) or sucrose (s) per kg, or Brsm plus flavouring substances (P, pig nectar; H, hog nectar; S, sow nectar; A, apple), measured as a proportion of the amount of food offered*

Trial no.	No. of pens	No. of treatment values	Diet*						SED	Significance of difference between means: *P*
					Brsm					
			Sbm	Brsm	+50 m	+100 m	+50 s	+100 s		
1	4	24	0·64	0·39	0·36	0·31	—	—	0·048	< 0·001
2	4	12	0·88	0·52	—	—	0·56	0·56	0·079	< 0·001
			Diet							
					Brsm					
			Sbm	Brsm	+P	+H	+S	+A		
3	4	24	1·00	0·65	0·69	0·93	—	—	0·040	< 0·001
4	4	24	0·75	0·48	—	—	0·59	0·69	0·046	< 0·001

* For details, see Table 1.

Values for the proportion of food offered in 24 h which was eaten in 24 h are given in Table 4. Almost all the food offered of all diets was eaten in 24 h but intake of the diet Brsm was still significantly lower than that of the control Sbm diet. None of the intake differences between other Rsm diets and Sbm diet was significant.

In one of the replicates of trial 1, the effect on intake of offering each diet on three consecutive days, not 1 d, as in the remainder of these experiments, was determined. Intakes for each of the 3 d are set out in Table 5. Although mean intake on day 2 was lower than on days 1 and 3 for all three diets, none of the between-day differences for a particular diet

Table 7. *Expt 2. Voluntary food intake during 24 h, by growing pigs given diets containing soya-bean meal (Sbm), British rapeseed meal (Brsm) or Brsm plus 50 or 100 g of molassine meal (m) or sucrose (s) per kg, or Brsm plus flavouring substances (P, pig nectar; H, hog nectar; S, sow nectar; A, apple), measured as a proportion of the amount of food offered*

Trial no.	No. of pens	No. of treatment values	Diet*						SED	Significance of difference between means: *P*
					Brsm					
			Sbm	Brsm	+50 m	+100 m	+50 s	+100 s		
1	4	24	0·99	0·84	0·90	0·83	—	—	0·034	< 0·001
2	4	12	1·00	0·91	—	—	0·95	0·97	0·026	< 0·01
			Diet							
					Brsm					
			Sbm	Brsm	+P	+H	+S	+A		
3	4	24	1·00	1·00	1·00	1·00	—	—	0·000	NS
4	4	24	0·99	0·88	—	—	0·94	0·99	0·025	< 0·001

* For details, see Table 1.
NS, not significant.

was significant and, in consequence, a similar picture of intake differences between diets was indicated by the results from days 1, 2 and 3.

Expt 2. Brsm diets containing flavouring substances

The voluntary food intakes in 30 min periods after morning and afternoon feeds, measured as a proportion of the amount offered, are given in Table 6. Values for the Brsm diet were all significantly lower than the corresponding values for the Sbm diet, as in Expt 1. Intakes did not increase significantly as a result of adding molassine meal or sucrose to the diet.

Addition of flavouring substance P did not lead to higher intakes of the Brsm diet whereas flavour H gave a substantial and significant increase in intake. Preparation S gave a modest but significant increase, while flavour A increased intake by a large and significant amount. In general, the addition of these supplements to the Brsm diet led to sometimes markedly higher intakes but none as high as those of the Sbm diet.

Food intakes in 24 h expressed as a proportion of the amount offered in Expt 2 are shown in Table 7. Addition of molassine meal and sucrose resulted in small increases in intake of the Brsm, except for 100 g molassine meal/kg diet, while intakes of diets with the four flavouring substances were almost the same as those for the Sbm diet. None of the differences in intake between the Brsm diet plus flavour and the Sbm diet was significant.

Expt 3. Different rapeseed meals fed continuously

Mean daily food intake and daily weight gain per pig are given in Table 8. There were marked differences in food intake between the diets; the value for the Brsm diet was significantly less than those of the other two diets. Mean intake of the Trsm was lower than that of the Sbm diet but the difference was not significant. The relative intakes of the three diets were similar for each week, there being no interaction of diet with week.

The picture for weight gain was very similar. The weight gain on the Brsm diet was significantly lower than on either the Sbm or Trsm diet and, although gain on the Trsm

Table 8. *Expt 3. Voluntary food intake and weight gain (kg/pig per d) of growing pigs given diets containing soya-bean meal (Sbm) or different rapeseed meals (Brsm, Trsm)*† ad lib. *for 4 weeks*

(Values in parentheses are the proportion of the corresponding value of the Sbm diet)

Week of experiment	Diet...	Feed intake				Weight gain			
		Sbm	Brsm	Trsm	Mean	Sbm	Brsm	Trsm	Mean
1		1·76 (1·00)	1·18 (0·67)	1·59 (0·90)	1·51	0·803 (1·00)	0·447 (0·56)	0·632 (0·79)	0·627
2		1·97 (1·00)	1·40 (0·71)	1·88 (0·95)	1·75	0·695 (1·00)	0·542 (0·78)	0·676 (0·97)	0·638
3		2·09 (1·00)	1·42 (0·68)	1·90 (0·91)	1·80	0·702 (1·00)	0·622 (0·89)	0·628 (0·89)	0·651
4		2·50 (1·00)	1·67 (0·67)	2·13 (0·85)	2·10	0·817 (1·00)	0·612 (0·75)	0·736 (0·90)	0·722
Mean		2·08 (1·00)	1·42 (0·68)	1·87 (0·90)		0·754 (1·00)	0·555 (0·74)	0·695 (0·92)	
SE of differences between means†				Over-all diet	0·084				0·066
				Weekly means	0·167				0·133
Significance of effects: *P*				Over-all diet	< 0·001				< 0·05
				Over-all week	< 0·001				NS

† For details, see Table 1.
NS, not significant.

Table 9. *Concentrations (g/kg) of hydrolysis products of glucosinolates, tannins (as tannic acid equivalent) and sinapine (as bisulphate) in different types and varieties of rapeseed meal (Rsm)*

Rsm	Hydrolysis products of glucosinolates			Tannic acid equivalent	Sinapine bisulphate
	Oxazolidinethione	Isothiocyanate	Thiocyanate		
British*	9·69	0·89	0·49	17·0	10·0
Tower	1·44	0·60	0·32	23·9	7·5
Erglu	0·70	0·30	0·47	28·7	10·1
Span	2·25	0·73	0·42	21·7	8·3

* Values for British Rsm are the means from seven different batches used throughout the study.

diet was less each week than on the Sbm diet, the over-all difference did not reach significance.

Toxic compounds

Results of analysis of the rapeseed meals for glucosinolates, tannin and sinapine are given in Table 9. Glucosinolates are shown as their hydrolysis products (oxazolidinethione, isothiocyanate and thiocyanate), tannin as an equivalent of tannic acid and sinapine as bisulphate. The major characteristic shown by these results was the very high level of glucosinolate in Brsm, particularly of progoitrin that gives oxazolidinethione on hydrolysis.

DISCUSSION

The results of the present study showed clearly that when a diet containing approximately 250 g Brsm/kg was offered to growing pigs there was a large and highly significant reduction in voluntary feed intake when compared with intakes on a diet containing soya-bean meal. They also showed that diets containing rapeseed meals from the new *B. napus* varieties, Tower and Erglu, were eaten more readily than those containing meal from the British varieties or the *B. campestris* variety, Span. The influence of age and weight of the pig on the acceptance of Rsm diets was not studied specifically in the present experiments. There was an age range of 2–4 months and a weight range of 15–60 kg at the start of the experiments and the intake values suggested that at least over these age- and weight-ranges there was no interaction of age or weight with palatability of rapeseed meal. Thus, the results appear not to support the suggestion of Bowland (1965) that Rsm diets were eaten less readily than other diets only until the pigs reached approximately 25 kg. However, it would be useful to obtain more detailed information on the effect of age and weight on the palatability of rapeseed meals from experiments designed to study this aspect of the problem.

It seems probable, from the results of the 1 d change-over experiments, that the reduction in voluntary feed intake of the rapeseed meal was caused by an aversion to the smell or taste of the meal and not by any metabolic changes occurring in the animal as these changes would probably have taken longer to develop. Although sinapine has been described as having a bitter taste (Schultz & Gmelin, 1952) and tannins are known to have an astringent effect in the mouth (McLeod, 1974) the differences in the toxic contents of the meals suggest that the high glucosinolate content of Brsm, particularly of progoitrin which is converted to oxazolidinethione on hydrolysis, may have been the major factor depressing its intake. The present experiments, therefore, support the results obtained by McDonald (1974) who suggested that feed intake was inversely related to the glucosinolate content of the diet. More direct evidence of the importance of glucosinolates in reduced feed intake will be published later.

The results obtained for the flavoured Brsm diets showed that the palatability of a diet containing approximately 250 g Brsm/kg was not improved by the addition of sucrose or molassine meal at 50 or 100 g/kg diet.

There is conflicting evidence in published work on the value of adding sucrose or molassine at these levels to improve feed intake in young pigs (Terrill *et al.* 1952; Notzold *et al.* 1955; Diaz *et al.* 1956; Wahlstrom *et al.* 1974) and, therefore, it is difficult to interpret the results reported. However, it has been shown that sucrose increased the palatability of a whey diet only when a choice of diets was given but had little effect when only one diet was offered (Wahlstrom *et al.* 1974).

Flavouring substances H, S and A improved the intake of the Brsm diet and this effect, particularly from flavours H and A, may be sufficiently great to overcome any depression of productivity that could occur from low intake of the Brsm diet.

The substitution of part of the barley of the Sbm diet by wheat in the Rsm diets was made to raise the DE of the Rsm diets to that of the Sbm diet. This adjustment was necessary to provide diets suitable for the growth experiment. It is possible that this inclusion of wheat in the Rsm diets may have contributed to the reduced intake of these diets, wheat being regarded as somewhat unpalatable for pigs. However, the inclusion of wheat was at 320 g/kg diet, a level which is unlikely to cause palatability problems. Bloch *et al.* (1972) compared diets containing combinations of 0–1000 g barley and wheat/kg diet and found the greatest feed intake on a diet containing 900 g barley and 100 g wheat/kg; feed intake was significantly reduced only at inclusions of wheat greater than 500 g/kg. This is consistent with the results of Meiser *et al.* (1973), who showed that wheat inclusions of greater than 700 g/kg diet were necessary to cause a reduction in feed intake. It has also been shown that diets containing over 800 g wheat/kg had no effect on feed intake when compared with those containing similar amounts of barley (Bowland, 1974; Mitchall *et al.* 1976). From this evidence it may be concluded that the inclusion of 320 g wheat/kg in the Rsm diets should not have influenced the differences of intake between the Sbm and Rsm diets; also there was no such problem on comparing the results of one Rsm diet with another because the same proportion of wheat was included in all Rsm diets.

In Expt 3, where the Sbm, Brsm and Trsm diets were fed *ad lib.* for 4 weeks, feed intake values reflected very closely those obtained in the 1 d change-over trials of Expt. 1. They were, surprisingly, more similar to intake during the 30 min after morning and afternoon feeds (Table 3) than over 24 h (Table 4). Although the Trsm diet intake during 24 h was virtually the same as for the Sbm diet, there was still a strong tendency for intake and growth rate to be lower for Trsm than Sbm with *ad lib.* continuous feeding during 4 weeks (Expt 3). The results of the short-term trials thus appear to be consistent with those obtained in the performance trial under more practical conditions.

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