USE OF LUCERNE MEAL AND LUCERNE PROTEIN CONCENTRATE BY GROWING PIGS

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SUMMARY

Lucerne meal and lucerne protein concentrate (LPC) have been evaluated as feeds for growing pigs. When fed at dietary levels of 20, 40 and 60%, lucerne meal resulted in reduced gains, a poorer feed conversion ratio, and a reduced digestible energy intake as compared to pigs fed the lucerne-free control diet. The feed intake data suggested that low palatability of lucerne caused the pigs to not consume sufficient feed to meet their energy requirements. Lucerne selected for a low saponin content gave superior gains compared to unselected or high saponin lucerne. Low saponin lucerne fed at 40% of the diet gave the same pig performance as unselected lucerne fed at 20% of the diet. In feed preference studies, pigs were found to discriminate against lucerne-containing diets at levels as low as 1% dietary lucerne. The fibre fraction per se seemed to be mainly responsible for the low palatability. An antibiotic feed additive (ASP-250) improved pig performance when high lucerne diets were fed. Substitution of lucerne meal for soybean meal on a protein equivalent basis again demonstrated that dietary lucerne meal causes pigs to not eat sufficient feed to satisfy their energy requirements. Studies with LPC demonstrated that this product can be used as a complete replacement for soybean meal in a swine grower diet with no negative effects on performance.

INTRODUCTION

In many parts of the world, including the western United States., lucerne is a highly productive crop, producing several times as much protein per hectare as soybeans and other high protein crops. As competitio for grains between livestock and humans -increases, crops like lucerne that can't be consumed directly by humans may be increasingly used in animal feeding. At Oregon State University, a program has been conducted to: 1). evaluate the potential of lucerne as a feedstuff for swine and other non-ruminants, 2). identify the problems associated with its use, and 3). attempt to develop methods of overcoming some of the problems to increase the amount of lucerne that can be used. Since the majority of the feed used in a farrow-to-finish swine production unit is fed to the post-weaning growing-finishing pigs, these studies have used pigs in this growth stage.

There are two basic ways by which lucerne could be used as a feedstuff for pigs. It could be dried, and ground to produce lucerne meal, or the lucerne could be wet-fractionated, to separate the protein from the fibre and water soluble components. The resulting product, lucerne protein concentrate (LPC), has a protein content of 50-60%, and has considerable potential as an animal feed. Both methods ie. lucerne meal and LPC-have been investigated in the studies to be summarized here. This paper will be a general review of the Oregon State work; specific experimental details may be obtained by consulting the original papers.

LUCERNE MEAL

The effect of several levels of dietary lucerne on the performance

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of growing pigs was determined. The growth rate decreased with each increase of lucerne in the diet (Table 1).

TABLE.1 Growth, feed intake and carcass characteristics of pigs fed different levels of lucerne meal (from Powley et al, 1981).

Item	% Dietary lucerne meal 0	20	40	60
Av. daily gain, g	860^{a}	730^{b}	630^{c}	410^{d}
Av. daily feed intake, kg	3.0	3.0	3.2	2.7
Feed conversion ratio	3.6^{a}	4.1^{b}	5.0^{c}	6.7^{d}
Daily digestible energy intake, MJ	37.30	32.64	30.96	23.00
Digestible energy conversion ratio (MJ/kg gain)	43.4	44.7	49.1	56.1
Dressing percent	77.9^{a}	76.2^{bc}	75.4^{cd}	75.2^{d}
Av. backfat thickness, cm	3.9^{a}	3.5^{bc}	3.2^{cd}	2.9^{d}
Percent four lean cuts	52.4^{a}	54.1^{ab}	55.2^{bc}	57.5^{d}

For each parameter, means with common superscripts are not different ($P<0.05$)

The depression in growth rate is probably due to factor(s) in lucerne limiting feed intake. It is widely acknowledge that non-ruminants adjust their feed intake to meet their energy requirements. As the energy level of the diet. decreases, feed intake usually increases, maintaining calorie intake, In the case of pigs fed lucerne meal, feed intake is not increased with the lower dietary energy levels of the high-lucerne diets (Table 1), with the result that energy intake decreases and growth rate consequently is decreased. Thus the principal effect of feeding high dietary lucerne levels seems to be a restriction of voluntary energy intake. Lucerne appears to possess factor(s) which are unpalatable to swine or otherwise cause feed intake to be limited.

One of the components of lucerne which may account for its low palatability is its saponin content. Saponins are bitter-tasting glycosides (Cheeke, 1976) found in legume forages. Cultivars of lucerne containing either high or low saponin contents have been developed. In a feeding trial with weanling pigs fed diets containing 15% lucerne meal or a control diet with no lucerne, gains were lower ($P<0.05$) with high saponin lucerne than with the low saponin type (Cheeke et al, 1976). Gains with 15% low saponin lucerne were not different than with the control diet. In a subsequent study (Cheeke et al, 1978), superior results were also obtained with low saponin lucerne. These results are summarized in Table 2. At both lucerne levels, gains were highest with the low saponin lucerne (Table 2), although gains were lower in all cases than with the lucerne-free control diet. Gains and feed conversion with 40% low saponin lucerne were similar to those with the 20% level of unselected lucerne. Thus it appears that low saponin lucerne is of improved feeding value for swine, and will allow use of higher levels of lucerne meal in swine diets than are currently being used.

TABLE 2 Performance of growing pigs fed lucerne with different saponin contents (Cheeke, et al. 1978).

Treatment	Av. daily gain (g)	kg feed/kg gain
Control	910[a]	3.62[a]
20% high saponin lucerne	700[b]	4.21[ab]
20% low saponin lucerne	760[b]	4.17[ab]
20% unselected lucerne	680[bd]	4.24[ab]
40% high saponin lucerne	500[c]	5.48[c]
40% low saponin lucerne	670[bd]	4.23[ab]
40% unselected lucerne	580[cd]	4.58[bc]

Means with common superscripts are not different ($P<0.05$)

The superior performance obtained with low saponin lucerne may be a result of effects on feed intake. Since saponins are bitter compounds, a reduction in saponin content of lucerne may increase its palatability. Two choice feed preference trials were conducted to examine this possibility.

The first feed preference trial involved an assessment of the effect of commercial lucerne meal on the acceptability of a diet. The feed preference trials were conducted by giving pigs a choice between two feeds, and measuring intake of each diet. A very interesting response to lucerne meal was found (Table 3). Even when lucerne meal was fed at a level as low as 1% of the diet, pigs preferred not to consume it, and selected significantly more of the control diet (LeaMaster and Cheeke, 1979). At this lucerne level, the diets had a similar appearance, smell and taste to human observers.

TABLE 3 Effect of dietary lucerne level on diet preference by swine (LeaMaster and Cheeke, 1979).

% dietary lucerne	% intake of each diet	
	Control diet	lucerne diet
0.5	49[a]	51[a]
1	63[a]	37[b]
2.5	66[a]	34[b]
5	65[a]	35[b]
10	74[a]	26[b]
20	81[a]	19[b]
30	97[a]	3[b]

a different than b ($P<0.01$)

These results indicate that pigs are very sensitive to some factor(s) in lucerne, and when given a choice, would prefer not to consume lucerne-containing diets.

Feed preference tests were conducted with high and low saponin lucerne meal. When offered a choice between two diets containing the same level of lucerne, pigs preferred the diet with low saponin meal (Table 4). However, when offered a choice between a control and a low saponin lucerne-containing diet, they preferred the control diet even at a low level of 1% lucerne. Thus, low saponin lucerne is more palatable than high saponin meal, but pigs prefer to consume a lucerne-free diet, even when the low saponin type is used.

TABLE 4 Effect of high and low saponin lucerne on feed preferences (% intake of each diet) of swine (LeaMaster and Cheeke, 1979).

Diet comparison	% dietary lucerne			
	1	2.5	5	10
Low saponin	26[a]	34[a]	29[a]	11[a]
Control	74[b]	66[b]	71[b]	89[b]
High saponin	26[a]	27[a]	18[a]	9[a]
Control	74[b]	73[b]	82[b]	91[b]
High saponin	39[a]	--	18[a]	--
Low saponin	61[b]	--	82[b]	--

a different than b ($P<0.01$)

The principal effect of saponin content of lucerne on performance of non-ruminants appears to be on palatability and feed intake. In rat studies, lucerne saponin did not affect nutrient digestibility (Cheeke et al, 1978), and the growth rates of rats pair-fed the same quantities of diet with high and low saponin. lucerne were the same.,

To further assess the effect of lucerne meal on diet palatability, lucerne was'extracted with 95% ethanol to remove various soluble compounds, such as saponins, chlorophyll, and other pigments, leaving a residue of lucerne fibre. A feed preference trial was conducted with the extracted material. Again pigs preferred the control diet over that containing extracted lucerne meal (Table 5). It appears that fibre per se may be the major component of lucerne that renders it unpalatable to pigs.

In a preliminary study (Powley et al, 1981), a significant growth response occured when an antibiotic preparation (ASP-250) was added to a. swine grower diet containing 40% lucerne. The antibiotic response was further evaluated. Two antibiotic preparations (Virginiamycin and ASP-250, which contains chlortetracycline, sulfamethazine and penicillin) were incorporated into diets for growing-finishing pigs. Virginiamycin was fed at 27.5 mg/kg diet and 11 mg/kg diet in the grower and finisher phases respectively. ASP-250 was fed to provide 110 mg chlortetracycline, 110 mg sufamethazine and 55 mg penicillin per kg diet. Performance of pigs fed the two antibiotics in a diet containing 20% lucerne is shown in Table 6.

TABLE 5 Effect of ethanol extraction of lucerne on its palatability to swine (Cheeke and Powley, 1980)

% extracted lucerne in diet	% intake of each diet	
	Extracted lucerne diet	Control diet
2.5	26[a]	74[b]
5	30[a]	70[b]
10	7	93[b]

a different than b ($P<0.01$)

TABLE 6 Performance of pigs fed 0 and 20% lucerne with and without antibiotics (Powley et al, 1981)

Treatment and response	Grower phase		Finisher phase	
	0 lucerne	20% lucerne	0 lucerne	20% lucerne
Av. daily gain (g)				
No additive	720[a]	670[a]	800[a]	860[a]
Virginiamycin	710[ab]	730[ab]	800[a]	790[a]
ASP-250	750[b]	750[b]	850[a]	830[a]
Feed/gain				
No additive	2.6	2.8	3.5	4.0
Virginiamycin	2.5	2.7	3.4	3.8
ASP-250	2.6	2.8	3.4	3.8

a different than b ($P<0.05$)

Gains in the grower phase were significantly increased in both the control and lucerne-containing diets with the addition of ASP-250. Gains with 20% lucerne + ASP-250 were superior to those with the control diet without antibiotic supplementation.

The response to ASP-250 was investigated further with a dietary level of 30% lucerne meal. For both the control and lucerne diets, gains were significantly increased with ASP-250 (Table 7)

Growth rate with 30% lucerne + ASP-250 was greater than with the control diet without antibiotics. Thus the feeding of antibiotics may be a means of increasing the level of lucerne that can be fed to growing pigs without a reduction in performance.

In the previous growth trials, lucerne meal was used as a direct replacement for the grain component of the diet. Another experiment was conducted, in which lucerne meal as a replacement for soybean meal was evaluated.

TABLE 7 Performance of pigs fed 0 and 30% lucerne with or without ASP-250 (Powley et al, 1981)

	0 lucerne		30% lucerne	
	No additive	ASP-250	No additive	ASP-250
Av. daily gain (g)	670[a]	760[b]	640[a]	730[b]
Feed/gain	2.8[a]	2.9[a]	3.9[b]	3.5[b]

a different than b (P<0.01)

Various proportions of the protein provided by soybean meal (10, 20, 30, 40, 50 and 75%) were replaced by protein provided by lucerne meal. To provide the above replacement of soybean meal, dietary levels of 4.2, 8.4, 12.6, 16.8, 21.0 and 31.5% lucerne meal were used. Performance of the pigs is shown in Table 8.

TABLE 8 Performance of growing-finishing pigs fed lucerne meal as a substitute for soybean meal (Powley et al, 1981)

% lucerne in diet	Av. daily gain, g	Feed/gain	Daily feed intake,kg	Daily energy intake,MJ	g gain/g protein consumed
0	749[a]	3.3[a]	2.5	38.79	2.0
4.2	704[a]	3.4[a]	2.5	34.08	1.9
8.4	708[a]	3.6[a]	2.6	33.52	2.0
12.6	704[a]	3.6[a]	2.5	32.11	2.0
16.8	681[a]	3.7[b]	2.5	31.54	2.0
21.0	663[b]	3.8[b]	2.5	30.19	2.0
31.5	667[a]	4.2[b]	2.8	31.70	1.9

a different than b (P<0.05)

Substitution of lucerne for soybean meal resulted in reduced gains at all treatment levels (Table 8) although in only one case (21% lucerne) was the gain reduced significantly. The major effect of increased dietary lucerne was a reduction in digestible energy intake. Daily feed intake was similar at all lucerne levels between 0 and 21%, indicating that the pigs did not compensate for reduced diet caloric density by increasing feed intake. It is likely that intake was not increased because of the low palatability of lucerne. The protein efficiency ratio (g gain/g protein consumed) was similar with each treatment, suggesting that lucerne protein was used about as efficiently as soybean meal protein.

To summarize the use of lucerne meal by growing pigs, the following conclusions may be drawn:

1) Growth rate tends to decline as the dietary lucerne level increases.
2) The reduced growth appears to be a result of low palatability of lucerne to swine with a consequent reduced

energy intake.

3) Feed preference tests have shown that pigs can detect and discriminate against a dietary lucerne level as low as 1%. The fibre per se seems to be the major factor responsible for the low palatability.

4) Lucerne selected for low saponin content can be used at higher dietary levels than unselected or high saponin lucerne before performance is reduced. The major effect of low saponin appears to be increased palatability of lucerne-containing diets.

5) The performance obtained with high lucerne meal diets can be improved by the use of antibiotic feed additives.

LUCERNE PROTEIN CONCENTRATE

Lucerne protein concentrate (LPC) is prepared by squeezing the juice out of green-chopped lucerne, coagulating the protein in the juice with steam, and drying the coagulated protein to produce a protein concentrate. The fibre residue can be used as a feed for ruminants.

Several experiments were conducted to evaluate LPC as a feed for growing swine. In the first experiment; LPC was used as a replacement for soybean meal in a barley-based diet. At the 24% level, LPC provided all of the supplementary protein. Performance is shown in Table 9.

TABLE 9 Performance of growing-finishing pigs fed lucerne protein concentrate (Myer et al, 1975)

Dietary level of LPC	Av. daily gain (g)	Feed/gain
0	1003	3.41
5	903	2.96
10	1067	3.16
15	908	3.42
20	881	3.29

Performance was excellent with all levels of LPC. Several other experiments were conducted with similar results (Myer et al, 1975). In later studies (Cheeke et al, 1977a), drying temperature of the LPC was shown to be important. Avoidance of heat by freeze-drying gave the best results. As drying temperature increased, gains were somewhat depressed.

Well prepared LPC, with heat damage avoided in the drying process, can be used as a complete replacement for soybean meal in grower swine diets with no detrimental effects on growth. The production of LPC, by which the lucerne protein is separated from the fibre and water-soluble components such as saponins, avoids the problems associated with feeding of lucerne meal. The use of this process offers a method of exploiting the high protein production capability of lucerne. Whether or not this process is employed commercially will depend on the economics of lucerne fractionation.

In conclusion, lucerne can be used in both the meal form and as a

protein concentrate for swine. Further identification of the factor (s) responsbiel for its low palatability, and development of ways to overcome these effects, would allow increased use of lucerne meal in the feeding of non-ruminants. The increasing use of grains directly by humans suggests that increased emphasis should be given to the utilization of roughages such as lucerne by non-ruminant livestock.

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