THE DIGESTIBILITY OF CANOLA MEAL BY PIGS AS AFFECTED BY AGE OF PIG AND CHARACTERISTICS OF THE DIET

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Abstract

Canola meal (B. napus, cult. Westar) at levels of 0, 15 and 30% in diets based on wheat, hulless barley, hulless barley plus 25% barley hulls, lightweight barley and sorghum was tested in digestibility trials with castrate male pigs, initially 20 kg. The diets were supplemented with vitamins, minerals and lysine. The pigs were randomly rotated through four successive replications. The digestibility of crude protein (CP) increased 0.31 percentage units per kg increase in pig weight. Energy digestibility increased at 0.21 units per kg. Metabolic fecal protein (MFP) values ranged from 0.36 to 2.24 g per 100 g dietary dry matter. True digestibility of CP was determined. True digestibility of CP increased and MFP values decreased as pig weight increased. The level of MFP was significantly correlated with percentage neutral detergent fibre (NDF) in the diet. There was a strong negative correlation between NDF and apparent digestibility of CP (r=0.89), when sorghum was excluded. Sorghum exhibited protease inhibitor effects. The apparent digestibility of CP in canola meal was found to range from 70 to 89 percent depending on pig weight (25 to 45 kg) and percent NDF in the diet (10 to 25%), when fed in diets containing 16% CP. Digestibility of CP improved with increasing dietary CP level. The effects of dietary NDF, pig weight (or age) and dietary CP on digestibility of CP appear to be independent effects. Effects of pig weight and dietary CP on energy digestibility were less than on CP digestibility.

Introduction

The relatively high content of hull or fibre in rapeseed and canola meal (CM) reduces the digestibility of the energy and protein fractions when meal is fed to pigs. The cereal grains used in the diet may also vary in fibre content and influence the digestibility of the CM in the diet. The digestibility of protein is positively related to the level of crude protein (CP) in the diet (Lloyd and Crampton 1955; Shah et al. 1982). Digestibility is also positively correlated with age of pig (Roth and Kirchgessner 1984). The digestibility of rapeseed and canola meals has been reported by several investigators (Saben et al 1971; Rundgren 1983; Bell and Keith 1987) but in view of the above-mentioned effects of fibre level, protein level and pig age it is necessary to develop evaluations

of CM that reflect more accurately the effects of other characteristics of the diet and the effect of age of pig.

Materials and Methods

A factorial experiment was designed involving five basal grains of various hull or fibre contents and three levels of CM (0, 15, 30% of the diet) (Table 1). The 15 diets contained similar amounts of mineral and vitamin supplements to meet or exceed the minimum nutrient requirements and were fed in digestibility trials to barrow pigs weighing 25±2 kg initially. A chromic oxide (Cr_2O_3) marker was used for estimating dry matter digestibility and subsequently the digestibility of CP and gross energy was determined.

The composition of the basal grains varied from about 11 to 16% CP, 11 to 21% neutral detergent fibre (NDF), 3 to 9% acid detergent fibre (ADF) and 2 to 7% crude fibre (CF) (Table 2). Barley hulls derived from hulless barley, were added, at a level of 25% to simulate hulled barley. The lightweight barley had shrunken kernels on account of drought stress.

The digestibility (apparent) of CP in the diet varied significantly among basal grains (Table 3), averaging the three CM levels used with each grain. The CP of hulless barley was lower than for CP in wheat or the other barley samples. Sorghum CP was also poorly digested. The dietary CP levels varied and the two lowest CP digestibility coefficients were obtained with the two diets having the lowest CP levels.

As the dietary level of CM increased, the digestibility of dietary CP also increased, however the level of dietary CP also increased (Table 4). Because of the effect of dietary CP level on digestibility of CP, it cannot be determined from this table whether the higher digestibility at 30% CM was because CM CP was more digestible than grain CP or because there was a higher dietary level of CP.

The digestibility of energy in the basal grains (Table 5) showed hulless barley and wheat to be similar and superior to the other grains. Hulless barley + hulls and sorghum had similar digestibility coefficients, although their fibre contents were different (Table 2). Contrary to the observed effects of CM level on CP digestibility, increasing levels of CM resulted in decreasing energy digestibility (Table 6), possibly reflecting increasing fibre contents of the diets.

Metabolic fecal protein (MFN x 6.25, in g/100 g diet dry matter) was determined by regression methods and was subsequently found to be highly correlated with dietary percentage of NDF, except for sorghum for which there was evidence that a protease inhibitor depressed CP digestibility. From this relationship it was possible to estimate the true

digestibility of CP for the basal grains (Table 7). The digestion coefficients for wheat, hulless barley and hulless barley + hulls, were similar but lower values occurred for lightweight barley and for sorghum.

The digestibility of CP was found to be positively correlated with pig weight ($r=0.59$, $P<0.001$), with digestibility increasing 0.31 percentage units for each kg increase in pig weight. The corresponding change in energy digestibility was 0.21 units (Fig. 1). Application of this regression relationship to CP digestibility in the basal grains (Table 8) for pigs over the weight range of 25 to 45 kg reveals that pig weight effects tend to be relatively more severe with grains of low digestibility such as sorghum and lightweight barley. The same trends are evident with energy digestibility (Table 9) but because the digestion coefficients are higher than for CP and because the change with pig weight or age is smaller than for CP, the risk of error in adjusting for weight effects is relatively small compared with the risk associated with ignoring weight effects with CP.

When the effects of percentage of dietary NDF and of pig weight are applied to the digestibility of CP in CM (Table 10), the apparent digestibility of CP for CM, when used in diets containing about 10% NDF, may change from 84 to 89% for pigs ranging in weight from 25 to 45 kg. Such might be the case with diets based on wheat or hulless barley containing relatively high CP levels thereby minimizing the amount of fibre (NDF) or CM added. In contrast, if CM were used to supplement a low protein barley resulting in a diet containing 20% NDF the appropriate CP digestion coefficients would range from 74 to 80%. Corresponding levels of availability of essential amino acids could be assumed to prevail since availability of amino acids is largely a function of CP digestibility.

The CM used in this experiment contained gross energy at 19.96 MJ kg^{-1} dry matter. When energy digestibility is allowed for, the digestible energy values of CM, on a 10% moisture basis, would range from 13.29 to 15.98 MJ or 3175 to 3819 kcal kg^{-1} depending on the weight of the pig within the 25 to 45 kg range and on the NDF in the diet between 10 and 20% NDF. These findings emphasize the need to use appropriate feed value data when formulating rations for pigs.

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Table 1. Experimental plan for digestibility trial

Basal grain	Canola meal in diet, %		
	0	15	30
Wheat, HY320 Hulless barley, Scout Hulless barley + hulls Lightweight barley Sorghum	15 diets 4 replications pigs 25 to 45 kg		

Table 2. Crude protein and fibre† content of diet ingredients (dry matter basis)

Basal grain	Crude protein %	NDF %	ADF %	CF %
Wheat	13.75	10.78	3.78	2.42
Hulless barley	16.39	10.11	3.36	2.42
Hulless barley + hulls	15.54	17.47	8.62	6.51
Light weight barley	13.25	21.72	8.80	6.80
Sorghum	11.29	8.33	4.31	1.89
Canola meal	44.01	22.05	17.26	13.08
Barley hulls	12.99	49.65	24.40	18.63

† Neutral detergent fibre, acid detergent fibre and crude fibre.

Table 3. Apparent digestibility (%) of dietary protein, averaged over all canola meal levels, for the basal grains

Basal grain	Crude protein	
	In diet %	Digestibility %
Wheat	17.99	78.9*a*
Hulless barley	16.57	68.6*b*
Hulless barley + hulls	20.16	76.3*a*
Lightweight barley	20.68	76.5*a*
Sorghum	16.58	65.5*b*

Table 4. Apparent digestibility (%) of dietary protein, averaged over all basal grains, for diets containing different levels of canola meal

Canola meal level in diet, %	Crude protein	
	In diet %	Digestibility %
0	13.62	70.6*c*
15	18.50	73.1*b*
30	23.07	75.8*a*

Table 5. Energy digestibility (%) in diets based on different grains, averaged over all canola meal levels

Basal grain	Gross energy	
	In diet MJ kg^{-1}	Digestibility %
Wheat	17.92	81.7*a*
Hulless barley	18.15	81.2*a*
Hulless barley + hulls	18.28	78.0*b*
Lightweight barley	18.18	71.5*c*
Sorghum	18.47	77.9*b*

Table 6. Energy digestibility (%) in diets containing 0, 15 or 30% canola meal, averaged over all basal grains

Canola meal level in diet, %	Gross energy	
	In diet %	Digestibility %
0	18.02	79.9*a*
15	18.19	77.9*b*
30	18.39	76.5*c*

Table 7. True digestibility of crude protein in basal grains for 35 kg pigs

Basal grain	True digestibility of crude protein %
Wheat	84
Hulless barley	84
Hulless barley + hulls	84
Lightweight barley	78
Sorghum	77

Table 8. Effect of pig weight on digestibility (%) of crude protein in the grains

Basal grain	Weight of pig, kg		
	25	35	45
Wheat	76	79	82
Hulless barley	73	76	79
Hulless barley + hulls	71	75	77
Lightweight barley	62	65	68
Sorghum	58	61	64

Table 9. Effect of pig weight on digestibility (%) of energy in basal grains

Basal grain	Weight of pig, kg		
	25	35	45
Wheat	80	82	84
Hulless barley	79	81	83
Hulless barley + hulls	76	78	80
Lightweight barley	70	72	74
Sorghum	76	78	80

Table 10. Estimated apparent digestibility (%) of crude protein in canola meal when fed in 16% protein diets with various NDF levels and for pigs 25, 35 or 45 kg weight

NDF in diet, %	Weight of pig, kg		
	25	35	45
10	84	87	89
15	79	82	85
20	74	77	80
25	70	73	76

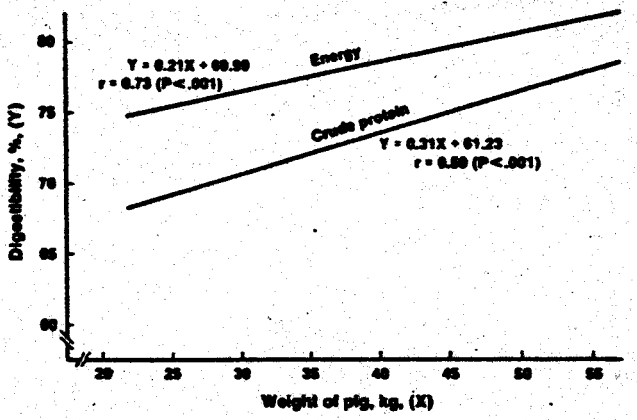

FIG. 1 RELATIONSHIP BETWEEN WEIGHT OF PIG AND DIGESTIBILITY OF DIETARY ENERGY AND CRUDE PROTEIN