ANTI-NUTRITIVE PROPERTIES ASSOCIATED WITH CANOLA SEED COAT AND COTYLEDON CELL WALL

R.D. Reichert and A.T. Ward
Plant Biotechnology Institute
National Research Council of Canada
Saskatoon, Saskatchewan, S7N 0W9

Canola and soybean seeds contain two distinguishable sources of fibre, the seed coat and the cotyledon cell wall. The effect of the canola seed coat in animal diets has been extensively studied (Mitaru 1982; Shires et al 1983) and it is recognized that decreasing the fibre content of canola meal is desirable. The effect of isolated canola cell wall in animal diets has not been investigated. This paper summarizes experiments (Ward and Reichert 1986; Ward et al - to be published) which compared the effect of isolated cell wall and seed coat fibre from canola and soybean on the bioavailability of protein and minerals, and on the metabolizable energy of the meal.

Isolation of Seed Coat and Cell Wall

The fractionation procedure for preparing seed coat and cell wall from canola is illustrated in Fig. 1 and explained in detail by Ward and Reichert (1986). Seed coat was prepared by cracking the seed and separating the seed coat by air aspiration. Cell wall was prepared by a wet grinding and sieving procedure. Preparation of soybean seed coat and cell wall was similar to the process used for canola except that no salt treatment was necessary for isolating soybean cell wall.

Effect of Fibre Source on Bioavailability of Protein and Minerals

Each fibre source was tested at a level of 12% in a semi-purified diet which contained 13-15% protein supplied by casein, 49.3% cornstarch, 0.35% amino acid mixture, 5% mineral mix, 1% vitamins, 0.1% choline, 5% corn oil and 14.3% sucrose. The fibre-free control diet contained 12% extra sucrose to replace the fibre. Each diet was fed to young male rats for 16 days and the results are shown in Table 1. Although final weight gains were similar ($P>0.05$) feed intake of rats fed the cell wall diets were an average of 11% lower than those fed the seed coat diets ($P<0.05$). The protein efficiency ratio (PER) value of the control, canola seed coat and soybean seed coat diets were similar ($P>0.05$). The PER values of canola and soybean cell wall diets were higher than the canola seed coat diet. All fibre diets markedly decreased the protein digestibility compared to the fibre-free control diet. The protein digestibility of the canola seed coat diet was the lowest ($P<0.05$) of all the diets. The protein digestibilities of the canola and soybean cell wall diets were identical.

Table 1: Effect of various fibre diets on rat growth parameters and protein digestibility *,**

Dietary fibre	Feed intake (g)	Weight gain (g)	PER	Protein digestibility (%)
None	207[ab]	92[a]	3.00[ab]	98[a]
Canola cell wall	194[a]	94[a]	3.16[a]	90[c]
Soybean cell wall	197[a]	90[a]	3.18[a]	90[c]
Canola seed coat	220[b]	97[a]	2.78[b]	87[d]
Soybean seed coat	219[b]	102[a]	2.96[ab]	92[b]
SEM	5	3	0.08	<1

* Values are means of five replicates per dietary treatment. PER, protein efficiency ratio.
** Values in columns without a common superscript letter are significantly different. ($P<0.05$).

To study the bioavailability of minerals, young rats were fed the fibre diets for 11 days. Relative availability of minerals was determined by analyzing fecal and diet samples. Table 2 illustrates the apparent mineral availability of Cu, Zn and Mg.

Table 2: Effect of various fibre diets on mineral availability by the growing rat *,**

Dietary fibre	Apparent mineral availability Cu (%)	Zn (%)	Mg (%)
None	74[a]	78[a]	71[a]
Canola cell wall	50[c]	46[b]	68[a]
Soybean cell wall	63[b]	78[a]	69[a]
Canola seed coat	53[c]	87[a]	45[c]
Soybean seed coat	58[b]	91[a]	60[b]
SEM	2	4	2

* Values are means of five replicates per dietary treatment.
** Values in columns without a common superscript letter are significantly different ($P<0.05$).

The canola cell wall and canola seed coat diet showed similar ($P>0.05$) Cu availabilities, which was lower than all other diets. The Zn availability of the canola cell wall diet was only 46% whereas the other diets ranged from 78 to 91%. The Mg availability of the canola seed coat diet was the lowest of all diets. To attempt to explain the mineral bioavailability results, in vitro metal binding studies were conducted with the fibre sources. However, these results could not explain the low Cu and Zn bioavailability of the canola cell wall diet

(Ward and Reichert 1986). Therefore, studies were conducted to determine whether the fibre sources were affecting net transport of minerals across the membrane of intestine isolated from rats fed the fibre sources for 20 days. Jejunal and ileal segments were emptied, rinsed and then filled with a mineral solution. The intestinal sacs were suspended in Tris-HCl buffer and the diffusion rate of minerals into the buffer was measured (Table 3).

Table 3: Net mineral transport through isolated rat jejunal and ileal segments*,**

	Mineral transport			
	Cu		Zn	
Dietary fibre	Jejunal (mg/4.5h)	Ileal (mg/4.5h)	Jejunal (mg/4.5h)	Ileal (mg/4.5h)
None	0.246[ab]	0.487[a]	0.371[ab]	0.596[a]
Canola cell wall	0.198[b]	0.282[c]	0.314[b]	0.397[b]
Soybean cell wall	0.291[a]	0.366[a]	0.435[a]	0.366[b]
Canola seed coat	0.321[ab]	0.403[ab]	0.424[a]	0.545[a]
Soybean seed coat	0.242[ab]	0.476[a]	0.365[ab]	0.584[a]
SEM	0.028	0.029	0.034	0.032

* Values are means of the results from five replicates with a jejunal or ileal segment removed from each replicate rat.

** Values in columns without a common superscript letter are significantly different ($P<0.05$).

The results showed that the transport of Cu was lowest for ileal segments from rats fed the canola cell wall diet. Zinc transport was lowest for jejunal segments from rats fed the canola cell wall and soybean seed coat diets. Zinc transport was lowest for ileal segments from rats fed the canola and soybean cell wall diets. It appears likely that the observed lower bioavailability of Zn and Cu in diets containing canola cell wall are due to changes in mineral transport through the intestinal membrane.

Effect of Fibre Sources on Metabolizable Energy

To determine the effect of the seed coat and cell wall on metabolizable energy, poultry diets were prepared in which the seed coat and the cell wall were progressively eliminated (Ward et al - to be published). Seed coat was eliminated by dehulling whole seed followed by hexane extraction of the cotyledons by a wet-sieving procedure. The canola meal diet contained 35% canola cotyledon, 15% canola hulls and 50% basal mix. The soybean meal diet contained 35% soybean cotyledon, 4% soybean hulls, 11% corn starch and 50% basal mix. Canola and soybean diets without seed coat contained 35% cotyledon, 15% corn starch and 50% basal mix. The canola and soybean diets without seed coat and cell wall contained 30% cotyledon isolate, 20% corn starch and 50% basal mix. The feeding trial was initiated when broiler cockerels were one week of age and the duration of the trial was 7 days. Feed and fecal samples were analyzed using an adiabatic oxygen bomb calorimeter and the results are shown in Fig. 2.

The AME of the canola meal diet was 15% ($P<0.05$) lower than the value determined for the soybean meal diet. Removal of the seed coat improved the AME of canola meal by 14% and of soybean meal by 6%. Removal of the cell wall from canola cotyledon increased the AME of the diet by 11%, whereas a similar treatment of soybean cotyledon improved the diet only 5%. Soybean and canola material in which both seed coat and cell wall had been removed were not significantly ($P>0.05$) different in AME.

Conclusions

1. Cell wall fibre in canola or soybean diets decreased feed intake compared to diets containing canola or soybean seed coats.

2. Canola seed coat depressed protein digestibility more than soybean seed coat.

3. Canola cell wall decreased Zn bioavailability more than any other fibre source. Canola cell wall and seed coat decreased Cu availability more than soybean fibre sources. These findings suggest that phytate is not the only factor affecting trace mineral availability in canola-supplemented diets.

4. The decreased Zn and Cu bioavailability caused by canola cell wall is not due to its ability to chelate these ions but is probably due to a change in the intestinal membrane resulting in lower mineral transport.

5. The AME of autoclaved canola meal and cotyledon diets was lower than that of autoclaved soybean meal and cotyledon diets, respectively. However, the AME of autoclaved canola and soybean diets in which both seed coat and cell wall had been removed were not significantly different.

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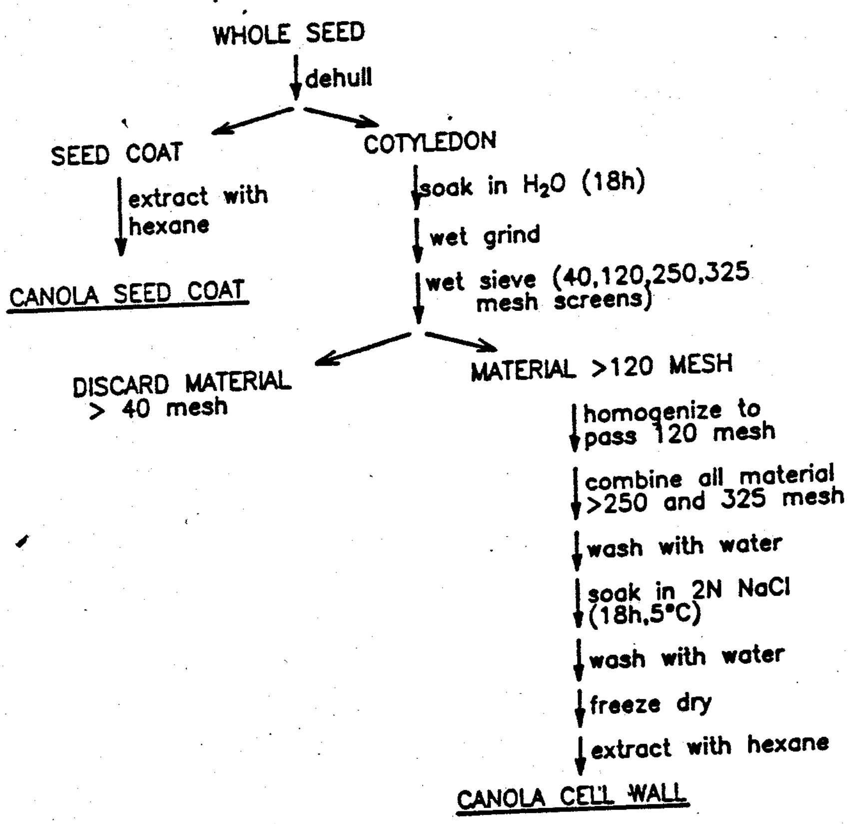

Fig. 1 Schematic diagram illustrating preparation of canola seed coat and cell wall.

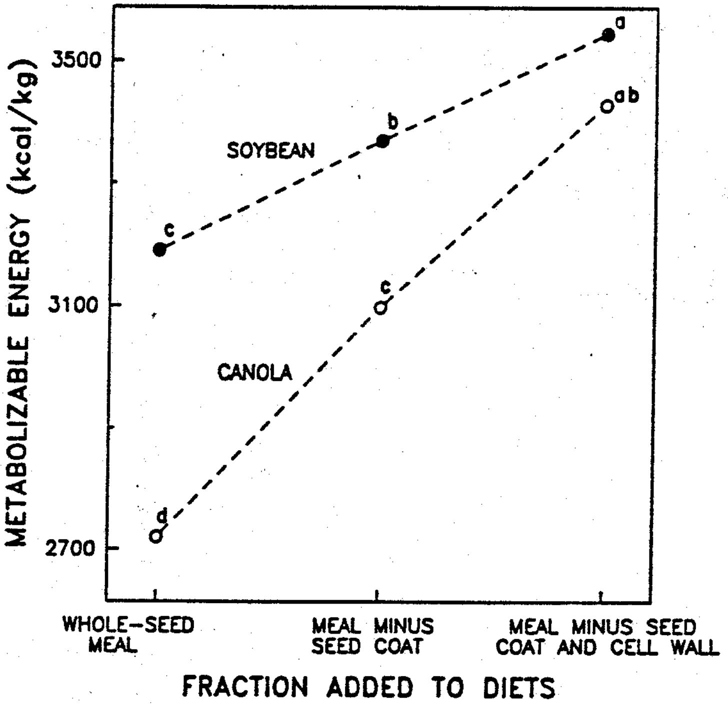

Fig. 2 Effect of removal of seed coat and cell wall from the meal on metabolizable energy of autoclaved soybean and canola poultry diets. Values without a common superscript letter are significantly different ($P < 0.05$)