Canola Meal for Poultry:
Recent Studies and Perspectives

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15th International Rapeseed Congress, Berlin, June 2019

Outline

- Canola/rapeseed processing effects on:
  - Chemical composition, and
  - Variability in the nutritive value of CM/RSM.

- High inclusion levels of CM/RSM in poultry nutrition:
  - Broiler chickens,
  - Turkeys,
  - Laying hens.

- Expeller/cold pressed canola/rapeseed.
  - Advantages and limitations

- An update on yellow-seeded canola research.

- Conclusions.

Chemical composition of CM/RSM (% DM)

Component	Conventional CM/RSM			SBM
	Canada	Europe	Australia	
Crude protein	41.6	40.5	40.4	50.2
Ether extract	3.3	2.4	2.1	2.5
Sugars[1]	6.6	7.3	7.2	7.5
Oligosaccharides[2]	3.0	2.9	3.2	6.2
NDF	29.6	29.6	32.5	14.4
Total dietary fiber	38.4	39.6	42.9	24.0
Total P	1.12	1.21	1.10	0.73
Non-phytate P	0.41	0.34	0.36	0.31
Glucosinolates[3]	3.6	6.3	1.8	-
AMEn, poultry	1987	1971	-	2453

[1] Includes glucose, fructose, and sucrose; [2] Includes raffinose and stachyose; [3] µmol/g

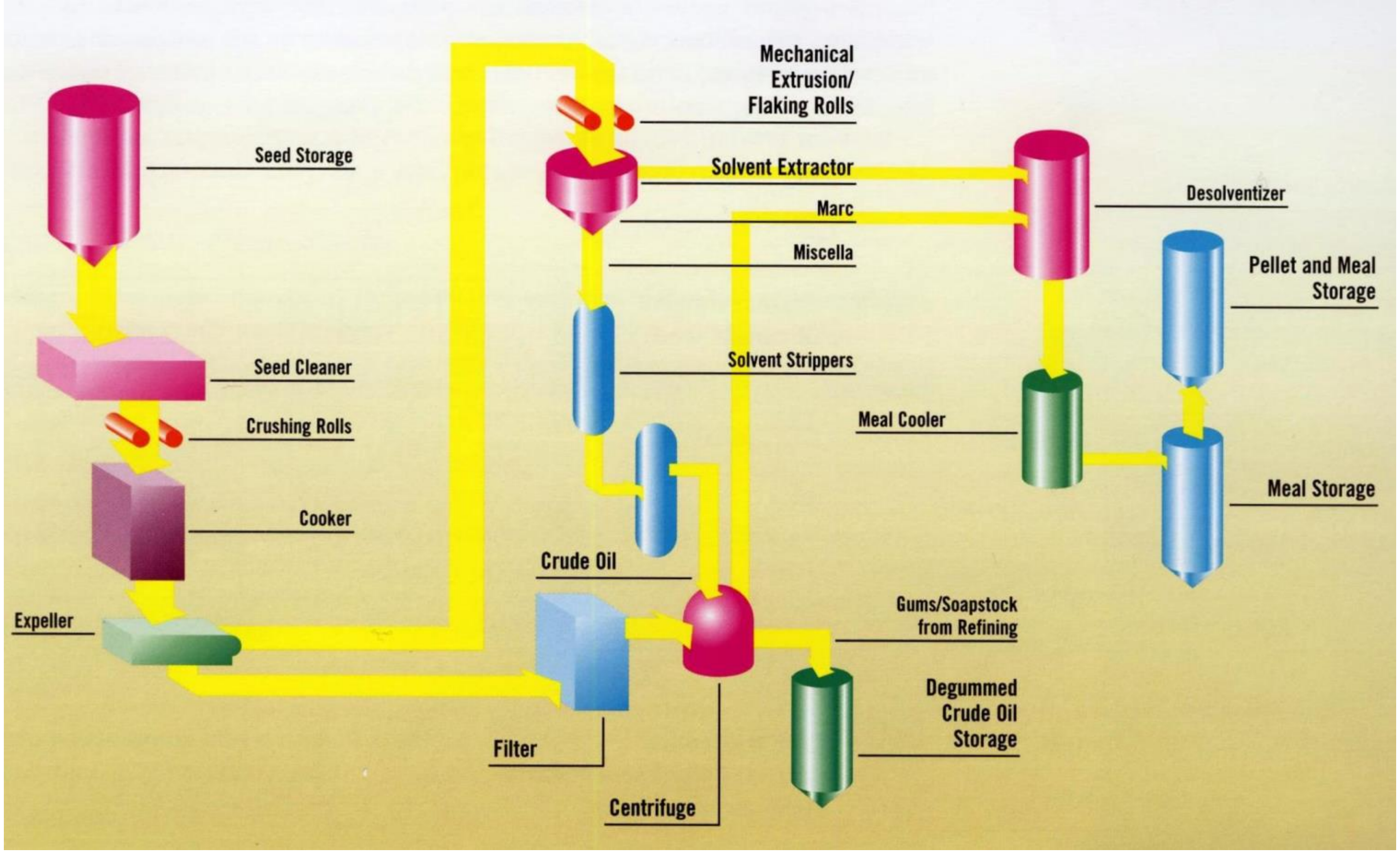
Important Considerations

- Dietary inclusion levels of CM/RSM in poultry and swine diets are limited to 5-10% due to concerns related to high fiber content and the presence of glucosinolates.

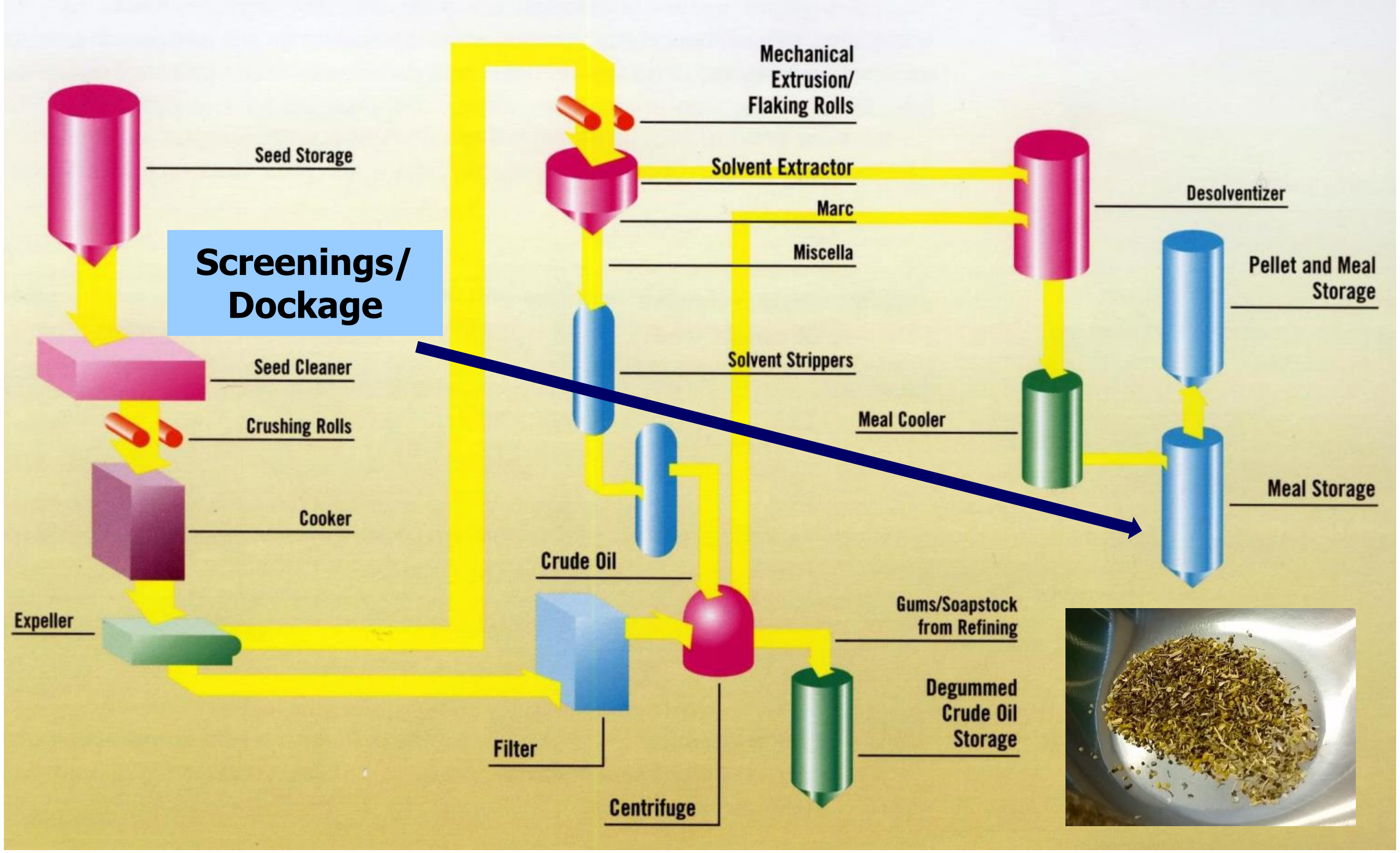
- The maximum allowable inclusion rates are often restricted by variability in the nutritive contents of CM/RSM.

- Processing conditions appear to be the biggest source of variability.

Factors contributing to the variation in CM/RSM quality



Factors contributing to the variation in CM/RSM quality



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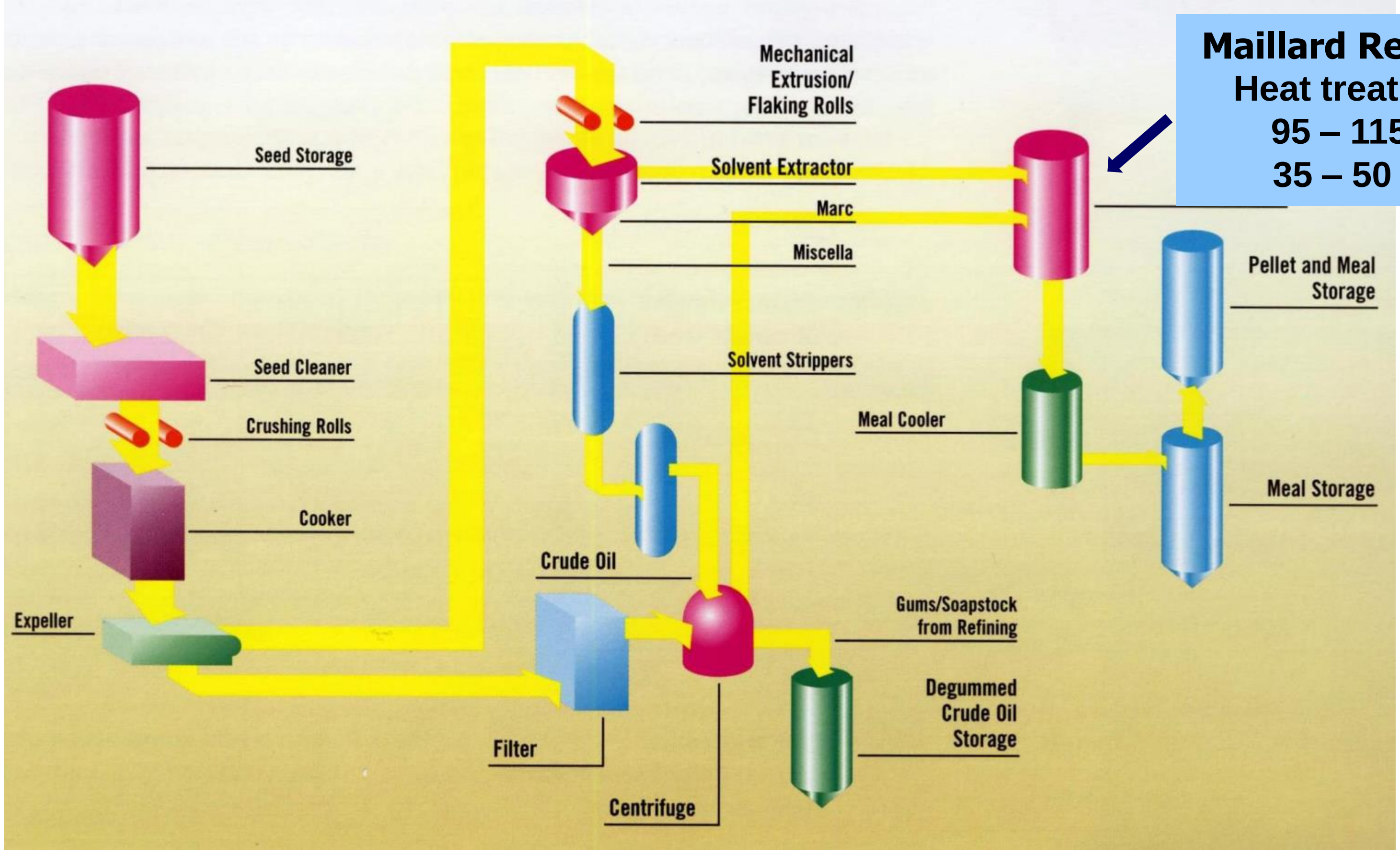
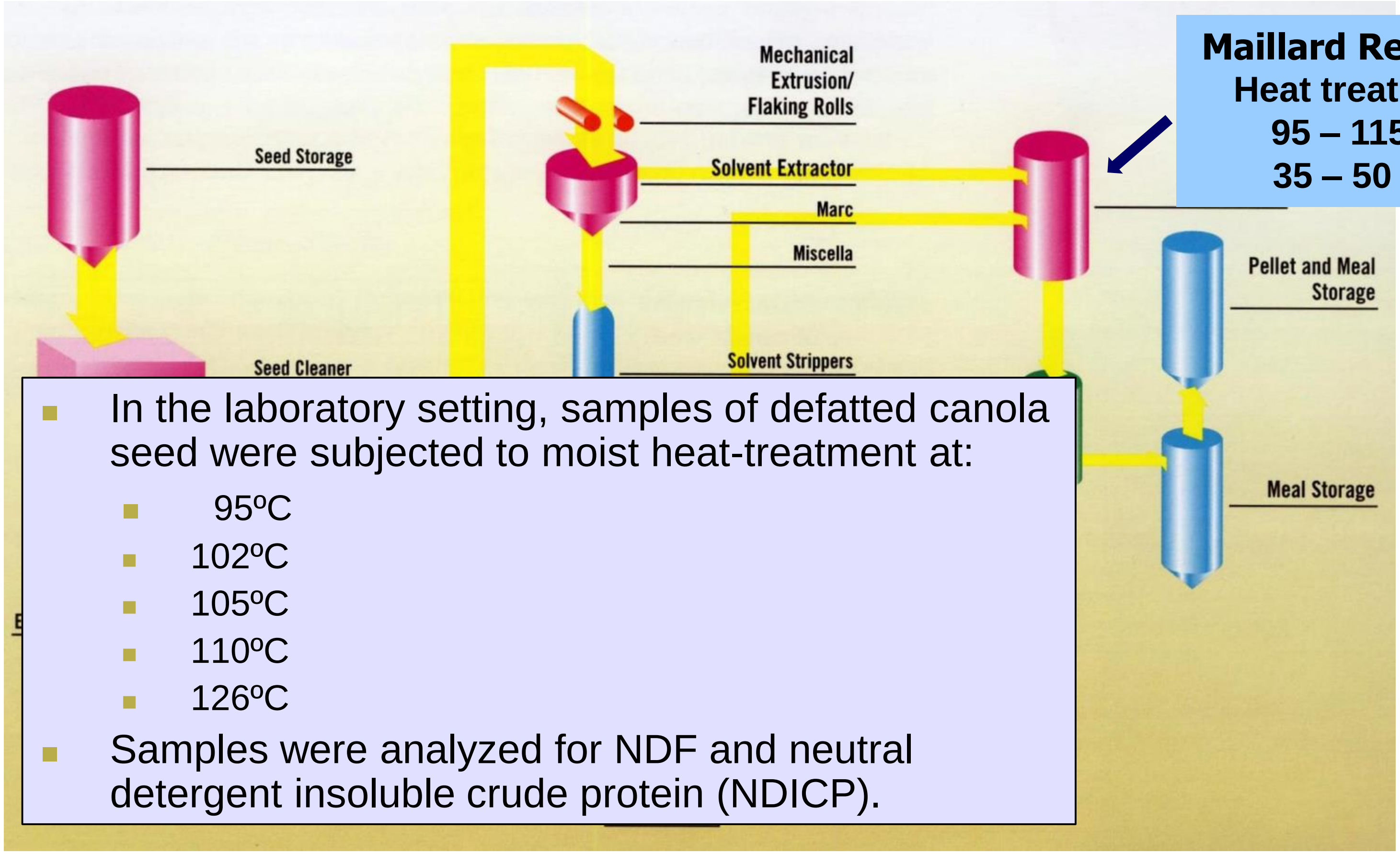


Maillard Reaction
Heat treatment
95 – 115ºC
35 – 50 min

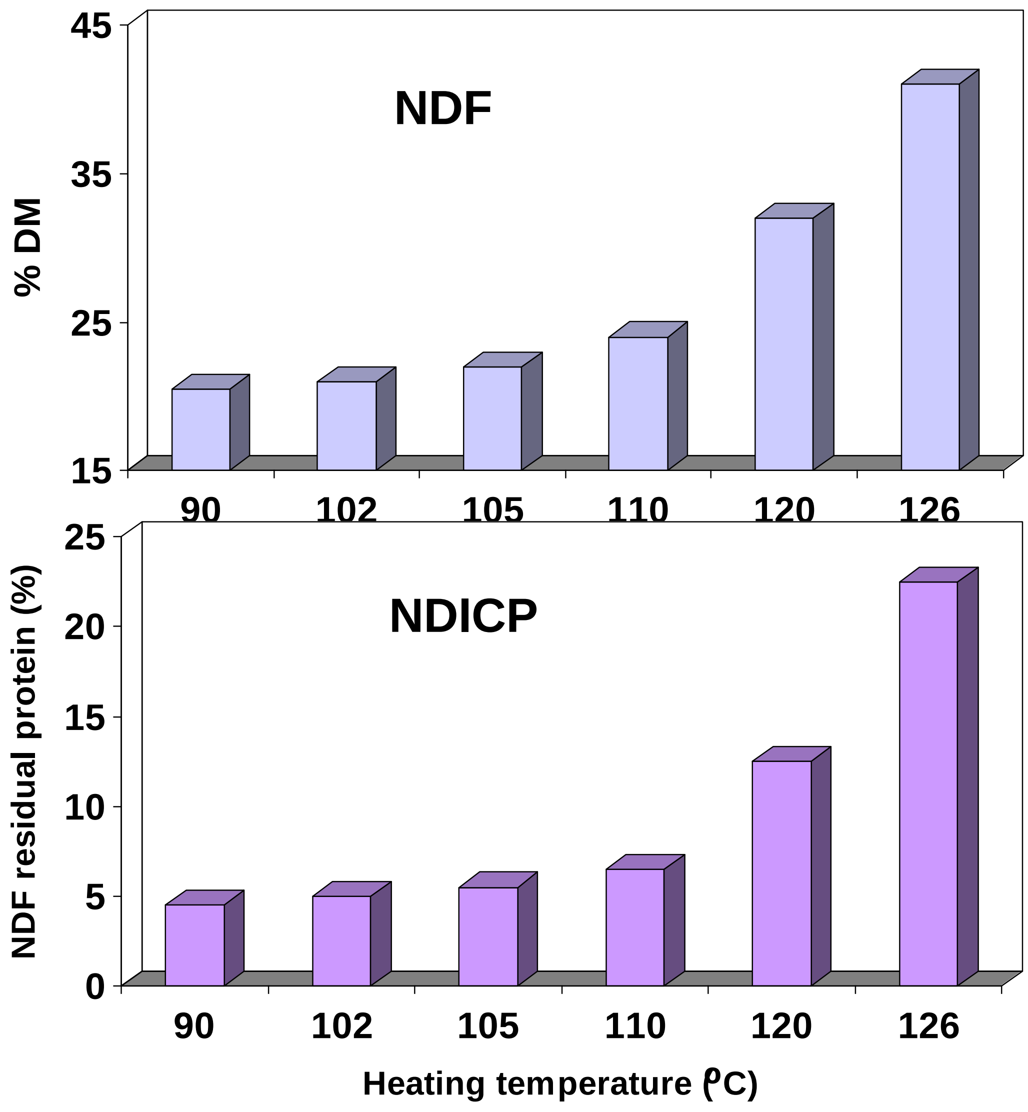
Factors contributing to the variation in CM/RSM quality



Maillard Reaction
Heat treatment
95 – 115ºC
35 – 50 min

- In the laboratory setting, samples of defatted canola seed were subjected to moist heat-treatment at:
  - 95ºC
  - 102ºC
  - 105ºC
  - 110ºC
  - 126ºC
- Samples were analyzed for NDF and neutral detergent insoluble crude protein (NDICP).

Effect of heat treatment on NDF and NDF residual protein (NDICP) content of canola meal



Canola meal Survey 2011-2017

Seven annual surveys. Over 260 samples of CM analysed

Canola Crushing Plants Location

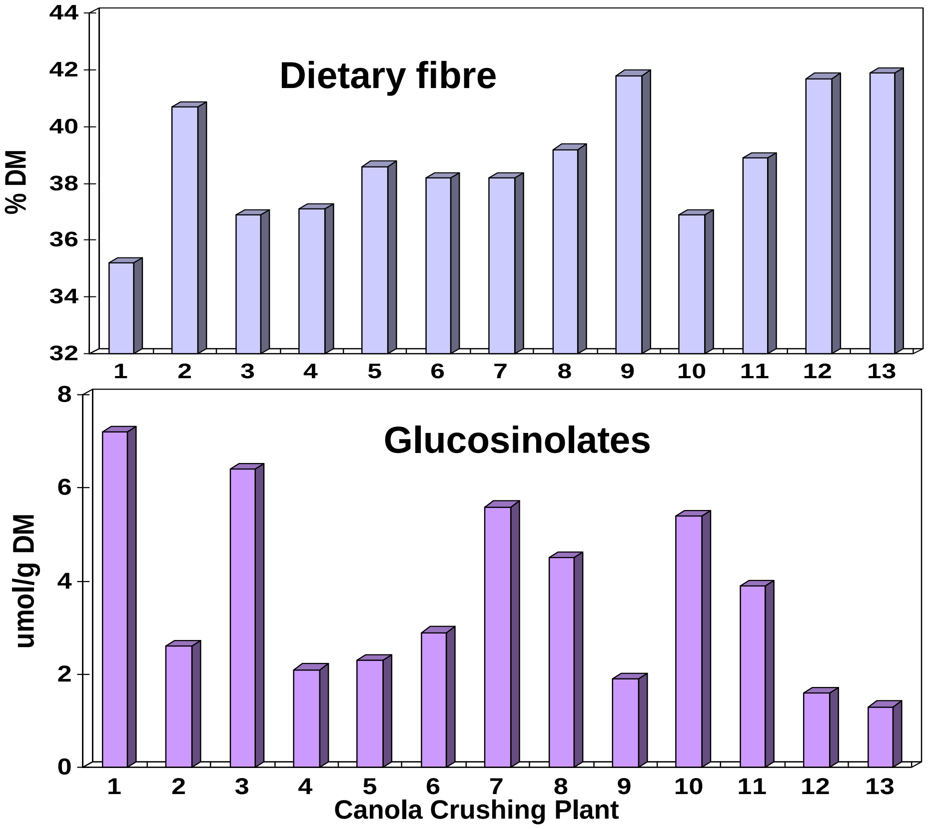
→

→

Analysed for CP, NDF, TDF, NSP, glycoproteins, lignin and polyphenols, fat, AA, sugars, total and non-phytate P, glucosinolates.

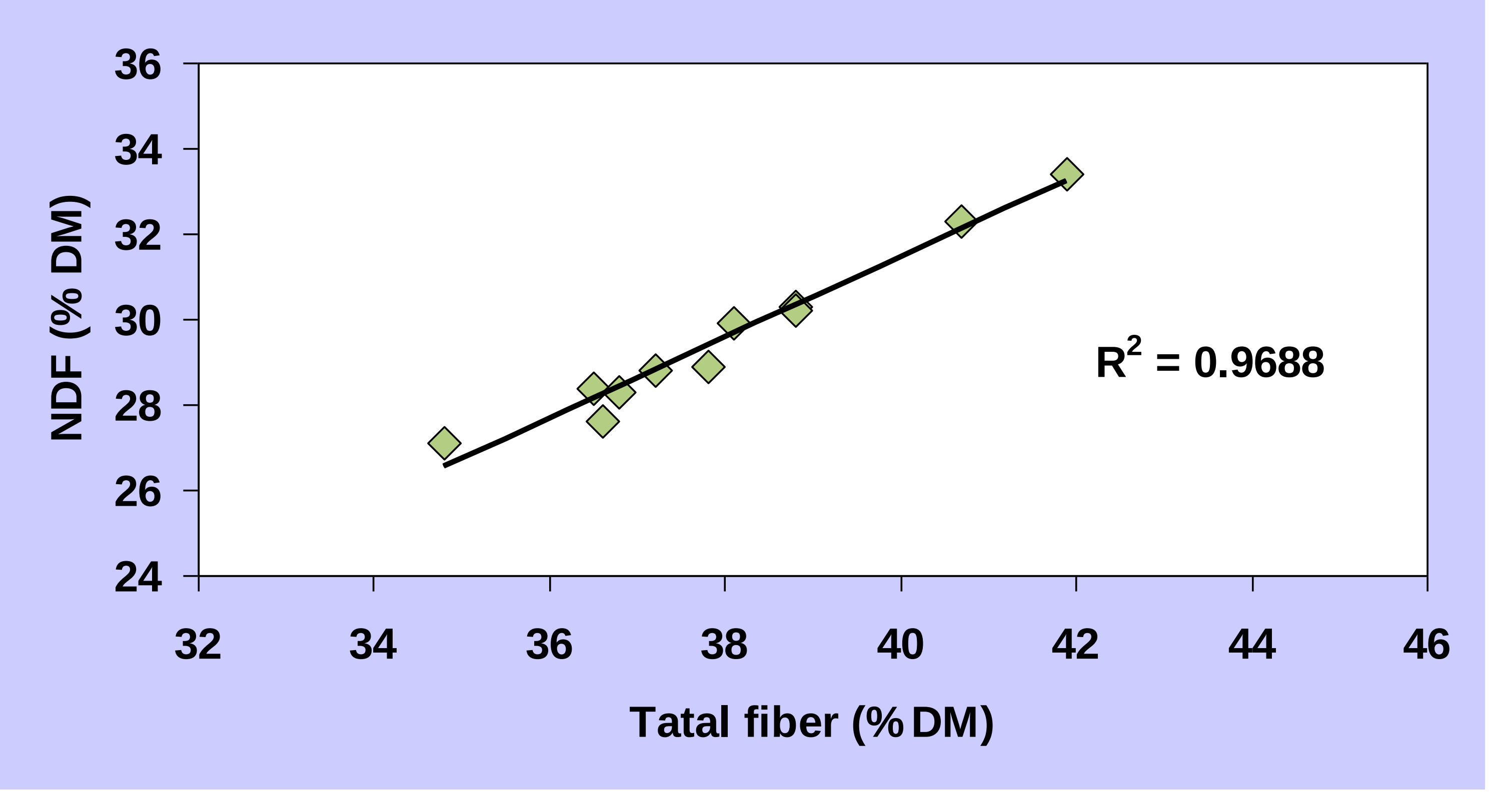
Canola meal Survey 2011-2017

Dietary fibre vs. glucosinolates



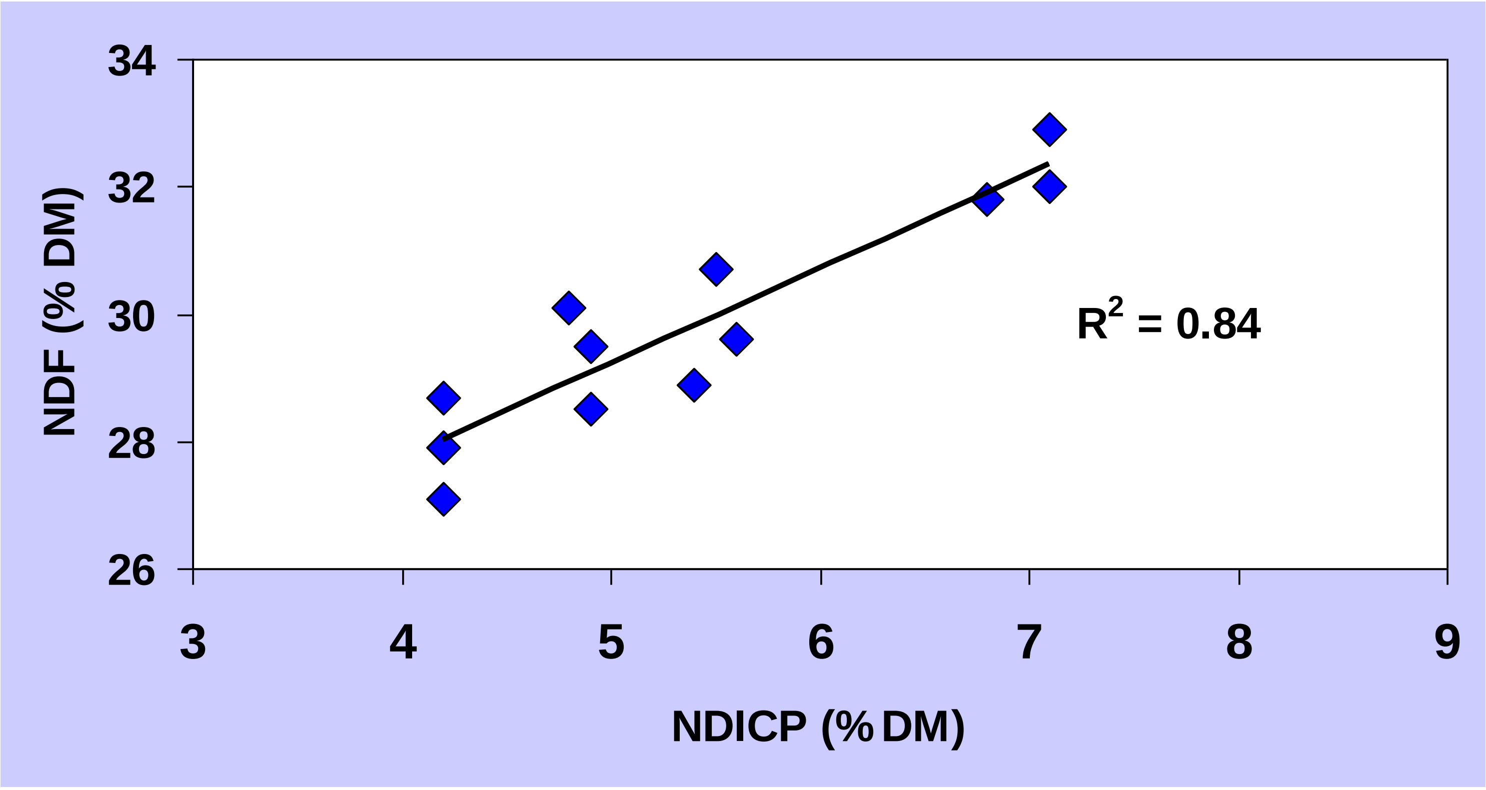
Canola meal Survey 2011-2017

Total dietary fiber vs. NDF

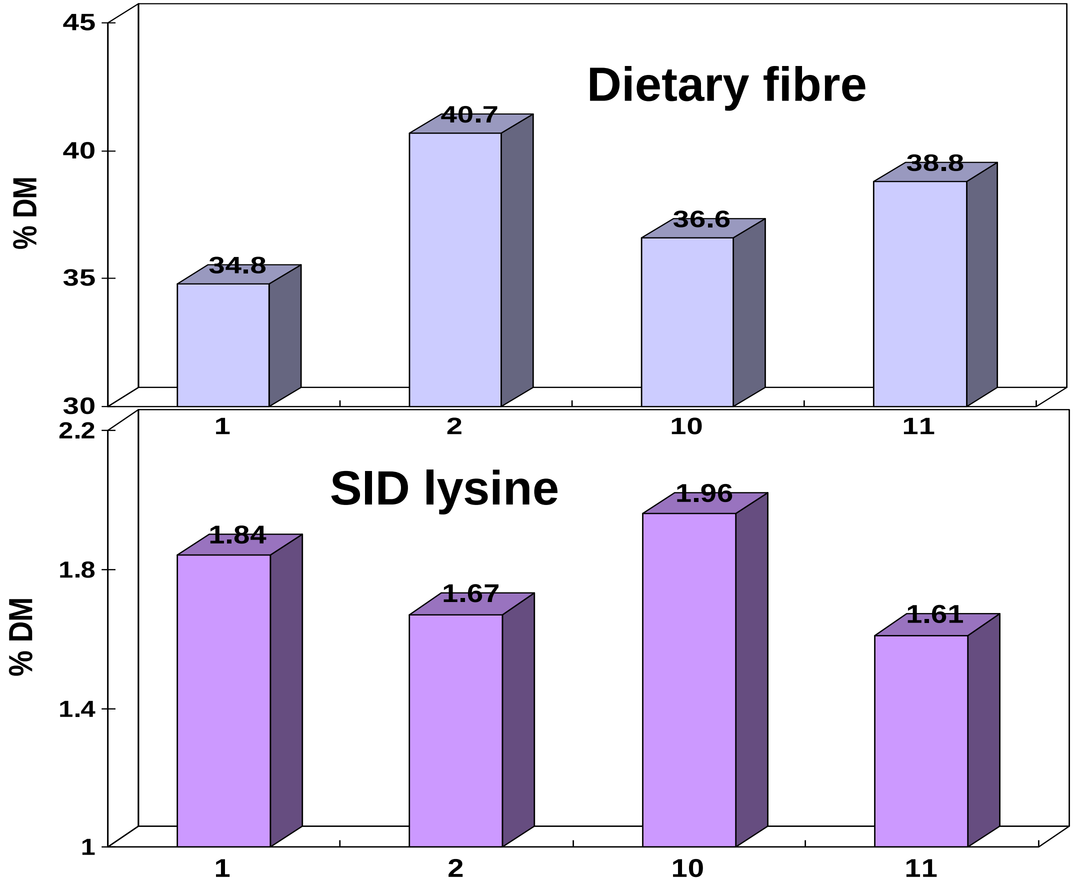


Canola meal Survey 2011-2017

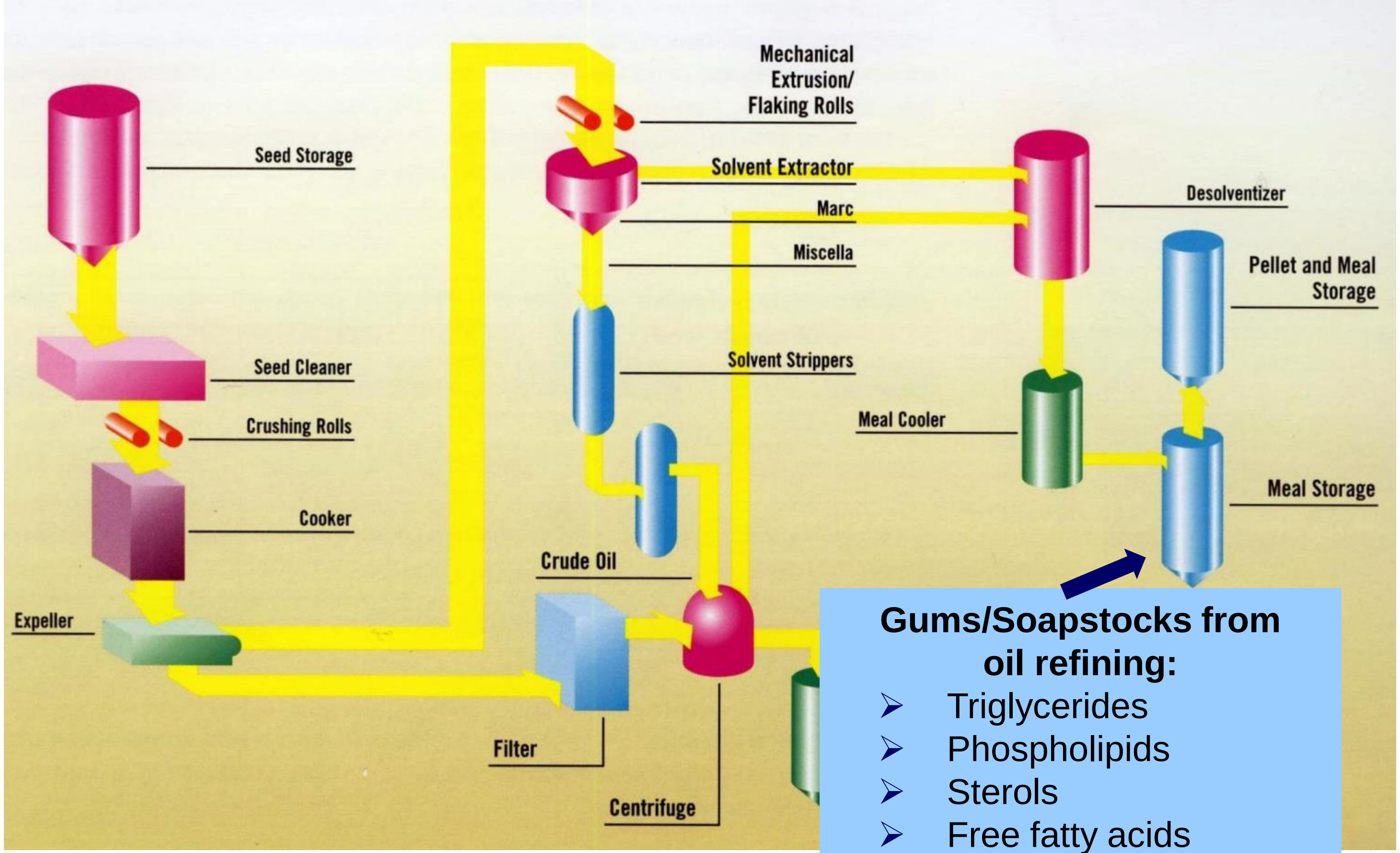
NDF vs. NDICP



Dietary fibre vs. SID lysine



Factors contributing to the variation in CM/RSM quality

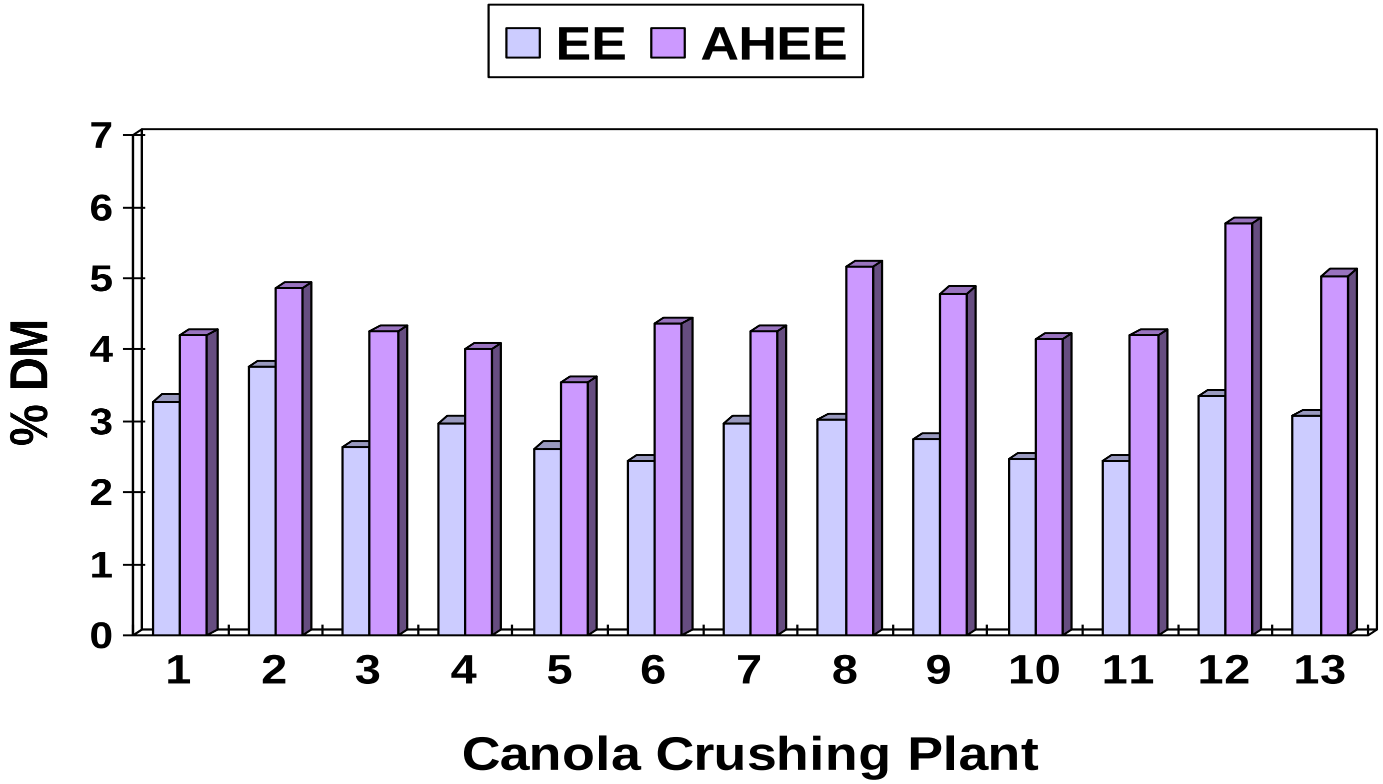


Gums/Soapstocks from oil refining:

- Triglycerides
- Phospholipids
- Sterols
- Free fatty acids
- Fat-soluble vitamins
- Spent bleaching clay

Canola meal Survey 2017

Ether extract (EE) and acid hydrolyzed ether extract (AHEE) contents of CM



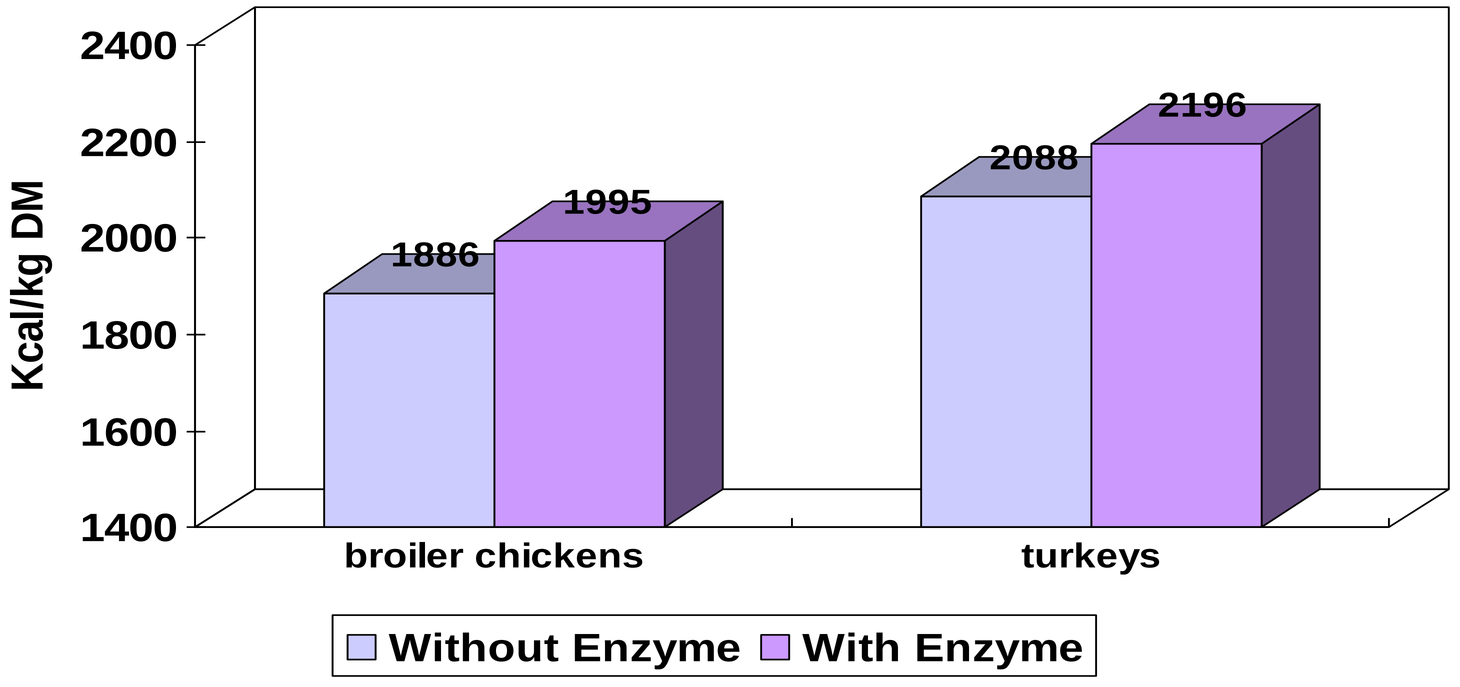
Canola meal Survey 2017

Ether extract (EE) and acid hydrolysed ether extract (AHEE) digestibilities in broiler chickens (%)

EE digestibility	Digestible EE content (% DM)	AHEE digestibility	Digestible AHEE content (% DM)	Digestible soapstocks content (% DM)
81.1	**2.1**	**53.0**	**3.1**	**0.9**

- Soapstocks and gums are poorly digested and contribute less energy to the AME_n content of CM than EE.

Apparent metabolizable energy (AME_n) and enzyme supplementation in poultry



High inclusion levels of canola meal in poultry diets

Broiler chickens

Turkeys

Laying hens

Summary of feeding trials with poultry fed diets containing different levels of CM

Species	Length (d)	CM level (% diet)	BWG (kg/bird)	FCR (feed/gain)	Reference
Broilers	35	0	2.32	1.53	Rad-Spice et al., 2018
		15	2.30	1.51	
Broilers	10	0	0.29	1.24	Mejicanos et al., 2017
		15	0.29	1.19	
Broilers	28	0	1.32	1.45	Ariyibi et al., 2018
		6	1.37	1.45	
		18	1.40	1.45	
		30	1.36	1.49	
Turkeys	56	0	3.90	1.71	Kozlowski et al., 2018
		20	3.89	1.73	
Turkeys	56	0	3.67	2.16	Zdunczyk et al., 2013
		3	3.69	2.12	
		12	3.69	2.08	
		18	3.69	2.11	

Broiler chicken growth performance study

- One day old Ross 308 male broiler chickens.
- Diets were balanced for digestible AA and available energy contents.
- Dietary treatments:

Diet	Pre-starter 0-7 d	Starter 8-14 d	Grower 1 15-21 d	Grower 2 22-28 d
	% of Canola Meal			
1	0	0	0	0
2	3	4	5	6
3	6	8	10	12
4	9	12	15	18
5	12	14	20	24
6	15	18	25	30

Broiler chicken growth performance study

Experimental diets

Item	**Pre-starter**	**Starter**	**Grower 1**	**Grower 2**
CP, %	23	22	21	20
ME, kcal/kg	2950	3000	3100	3150
Dig. Lysine, %	1.40	1.32	1.21	1.09
Dig. Methionine, %	0.59	0.48	0.45	0.41

Effect of incremental levels of CM on growth performance of broiler chickens

(1-28 d of age)

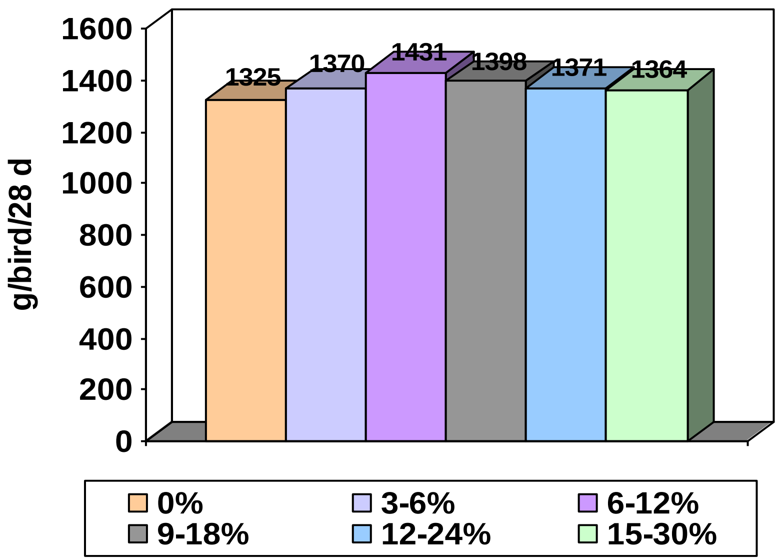
Diet	Level of CM %	Feed intake g/bird	BWG g/bird	FCR
1	0	1921[b]	1325[b]	1.45[ab]
2	3-6	1986[ab]	1370[ab]	1.45[ab]
3	6-12	2051[a]	1431[a]	1.43[b]
4	9-18	2023[ab]	1398[ab]	1.45[b]
5	12-24	2006[ab]	1371[ab]	1.46[ab]
6	15-30	2031[ab]	1364[ab]	1.49[a]

[ab] $P<0.05$

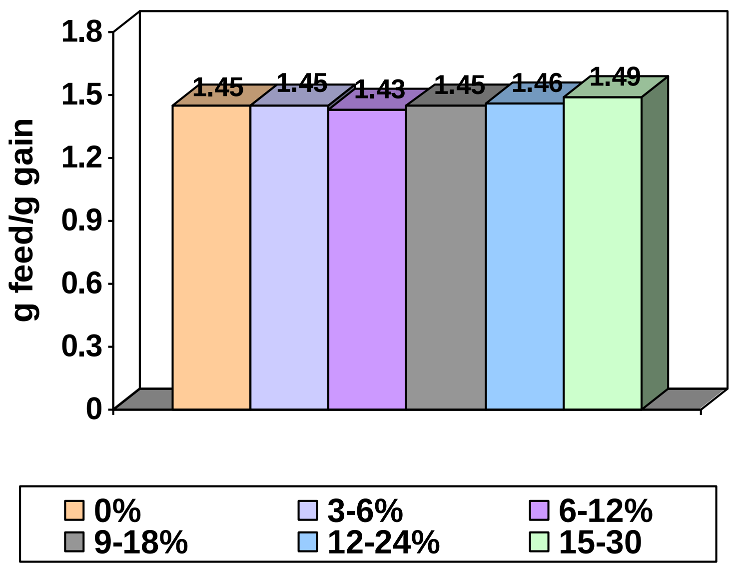
Effect of incremental levels of canola meal in broiler diets on performance parameters

(1-28 d of age)

Body Weight Gain



FCR



Laying hen study

Lohmann LSL hens of 35 to 59 weeks of age

- Diets balanced for digestible AA content.

Phase 1	Phase 2
35-47 wk of age	48-59 wk of age
2800 kcal/kg ME,	2700 kcal/kg ME,
17.0% CP	16.4% CP

- Treatments: **0, 4, 8, 12, 16 and 20% of canola meal**
- Two experimental periods of 12 weeks each.
- 6 replicate cage units of 18 birds each.

Glucosinolates content of experimental diets (μmol/g)

Diet	Canola meal, %	Glucosinolates
1	0	0.10
2	4	0.28
3	8	0.52
4	12	0.97
5	16	1.30
6	20	1.49

The level of glucosinolates of approximately 1.5 μmol/g of the diet has been proposed as a “no-adverse effect” when fed to laying hens (Khajali and Slominski, 2012)

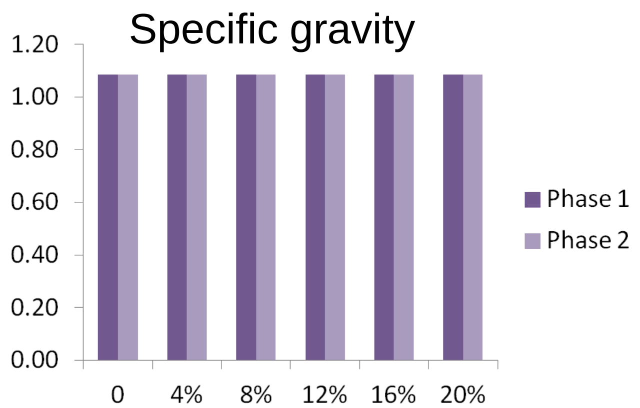
The effect of different levels of canola meal on laying hen performance

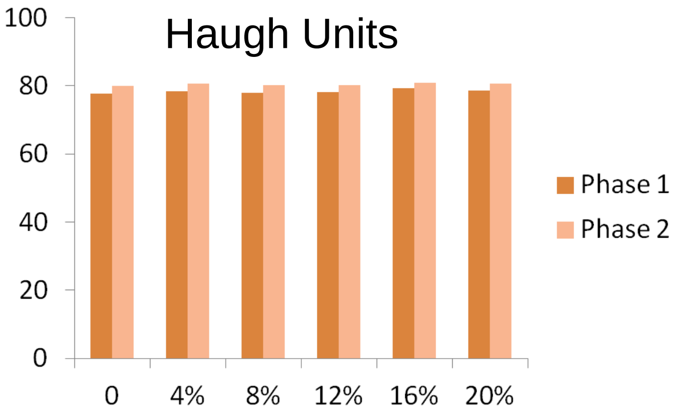
35-59 weeks of age

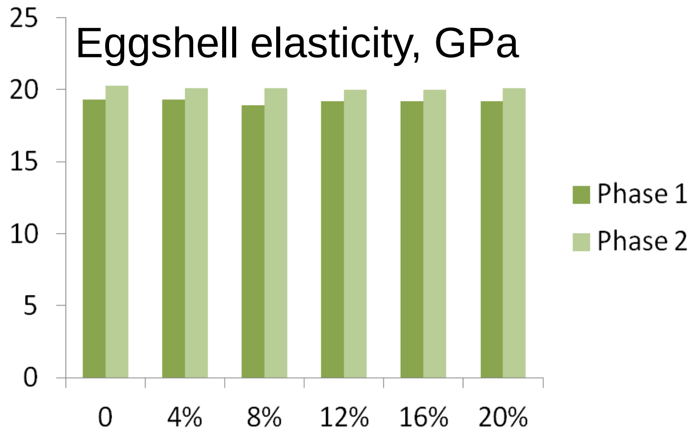
Dietary level of CM	Hen-day production %	Egg weight g	Egg mass g/hen/day	Feed consumption g/hen/day	Feed efficiency g feed/g egg
0%	97.2	64.2[a]	62.3[a]	120	1.92[a]
4%	96.2	63.3[ab]	60.9[b]	120	1.97[b]
8%	96.9	63.4[ab]	61.4[ab]	120	1.95[ab]
12%	97.6	63.5[ab]	61.9[ab]	120	1.93[ab]
16%	96.1	63.3[b]	60.8[b]	119	1.95[ab]
20%	97.2	63.1[b]	61.3[ab]	119	1.94[ab]

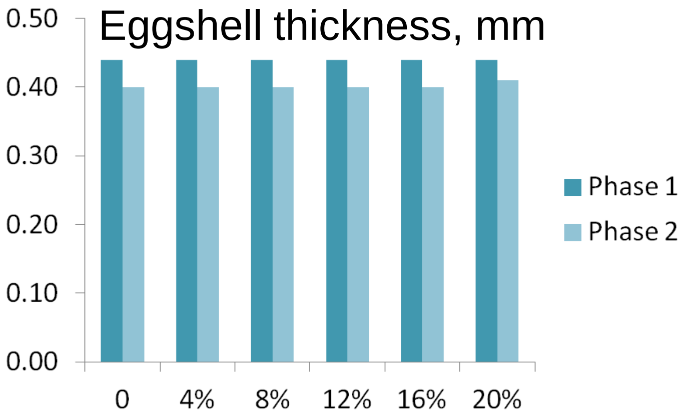
[ab] Means within a column with no common letters differ significantly ($P<0.05$)

The effect of different level of canola meal on egg quality

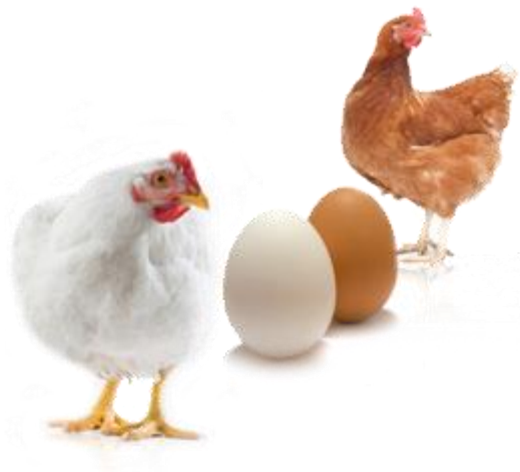






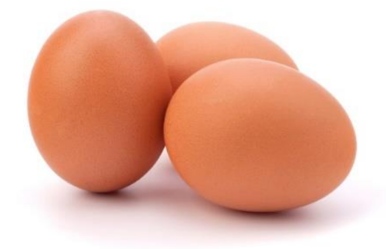


Sinapine and a “fishy” taint in brown-shelled eggs

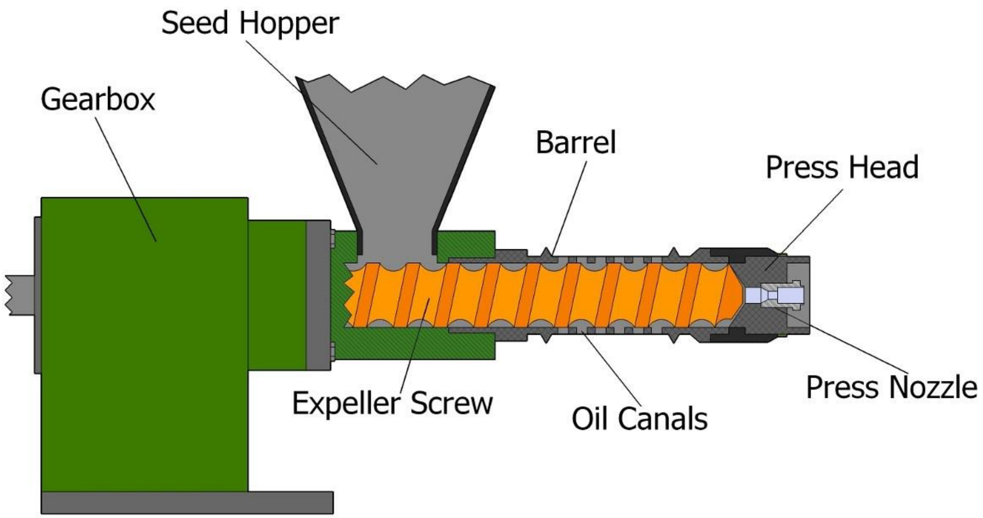


- The “fishy” flavor is due to the presence of trimethylamine (TMA), which results from a genetic defect among laying hens of Rhode Island Red.

    - No longer a problem due to breeding chickens (Lohmann) free of defective gene involved in the conversion of sinapine to odorous TMA.



Expeller/cold pressed canola



Expeller Press (screw press) diagram

Screw press KEK P0500 (Egon Keller)

Chemical Composition of CM/RSM (% DM)

Component	Conventional CM/RSM	Expeller-pressed canola
Crude protein	41.6	37.9
Ether extract	3.3	12.2
Sugars[1]	6.6	5.6
Oligosaccharides[2]	3.0	2.9
NDF	29.6	27.2
Total dietary fiber	38.4	34.4
Total P	1.12	1.04
Non-phytate P	0.41	0.38
Glucosinolates, µmol/g	3.6	9.2
AMEn, poultry	1987	2506

[1] Includes glucose, fructose, and sucrose; [2] Includes raffinose and stachyose

Limitations of Expelling

- Incomplete rupture of the cells.
- High glucosinolate content.
- Active myrosinase.
- Potential effects of heat due to friction.
- The biggest source of variability (i.e., oil content may range from 8.5 to 20%).

The effect of different levels of rapeseed cake on laying hens performance

Lohmann Brown laying hens of 22-46 weeks of age

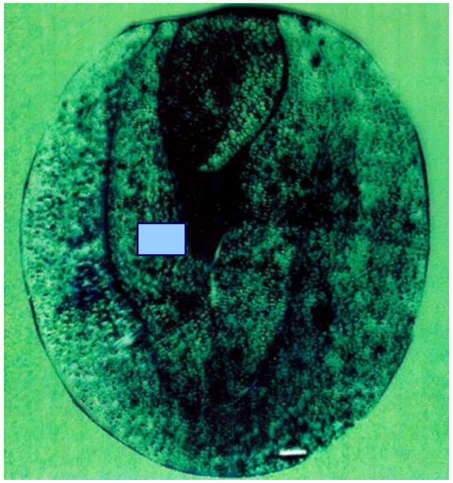
Rapeseed cake contained 15.8% crude fat and 21 μmol/g of glucosinolates

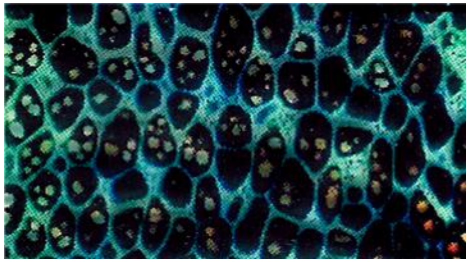
Expeller cake level	**Hen-day production** %	**Egg weight** g	**Egg mass** g/hen/day	**Feed consumption** g/hen/day	**Feed efficiency** g feed/g egg	**C 18:3 n-3** %
5%	96.4	58.8	56.8	107	1.90	1.10
10%	96.5	57.8	55.8	106	1.90	1.61
15%	95.7	58.3	55.8	104	1.88	2.03

Halle and Schone. 2013, J. Verbr. Lebensm. DOI 10.1007/s00003-013-0822-3

Nutrient encapsulating effect of cell walls

Expelled canola





- **Limited utilization of oil due to encapsulating effect of cell wall/ non-starch polysaccharides (NSP)**

Effect of particle size and enzyme supplementation on energy utilization

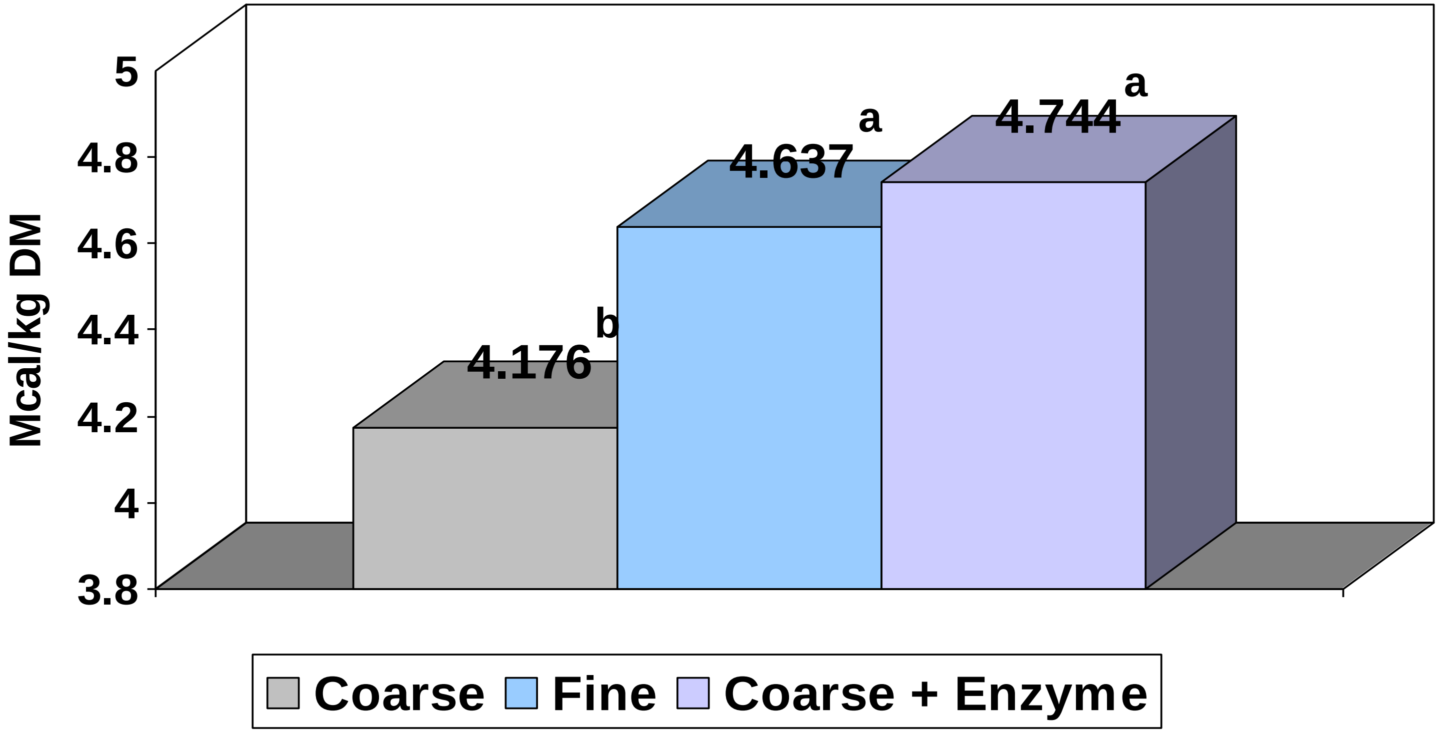
Canola Seed

Sample provided by Triple S Farms, Manitoba, Canada

- As is (coarse)
- Reground (fine)
- As is (coarse) + Enzyme

TME assay

Effect of particle size and enzyme supplementation on energy utilization



Development of yellow-seeded canola

Seed coat

➢ Breeding for low-fiber canola have resulted in the quantitative changes as evidenced by increased oil, protein, and sucrose contents rather than any significant improvements in nutrient utilization due to the decreased fiber content.

➢ Rad-Spice, M., A. Rogiewicz, J. Jankowski, B.A. Slominski. 2018. ***Yellow-seeded Canola. Part 1. Nutritive value of the meal for broiler chickens.*** Anim. Feed Sci. Technol. 240:66-77.

➢ Kozlowski, K., D. Mikulski, A. Rogiewicz, Z. Zdunczyk, M. Rad-Spice, H. Jeroch, J. Jankowski, B.A. Slominski. 2018. ***Yellow-seeded Canola. Part 2. Nutritive value of the meal for turkeys.*** Anim. Feed Sci. Technol. 240: 102-116.

Conclusions

1. Canola seed processing conditions contribute to the variation in meal quality.
2. Excessive heating in the desolventizer/toaster would result in reduced digestibility of some amino acids, particularly lysine.
3. The NDF and ADF measurements could be indicators of CM meal quality.
4. CM/RSM could be used effectively at 15-20% in poultry diets, providing the diets are formulated based on digestible AA and available energy contents.

Conclusions

5. Due to the low GLS content, high inclusion levels of canola meal would not adversely affect the animal health and growth.
6. Expeller/cold pressed canola utilization could be improved by dietary enzyme supplementation.
7. Most of canola fiber would have a minimal effect on nutrient utilization.

Acknowledgements

canolacouncil

Agriculture and Agri-Food Canada

cbs CANADIAN BIO-SYSTEMS

UNIVERSITY OF MANITOBA

Thank you!