EFFECTS OF CONVENTIONAL AND NOVEL PROCESSING ON THE FEED VALUE OF CANOLA MEAL FOR POULTRY

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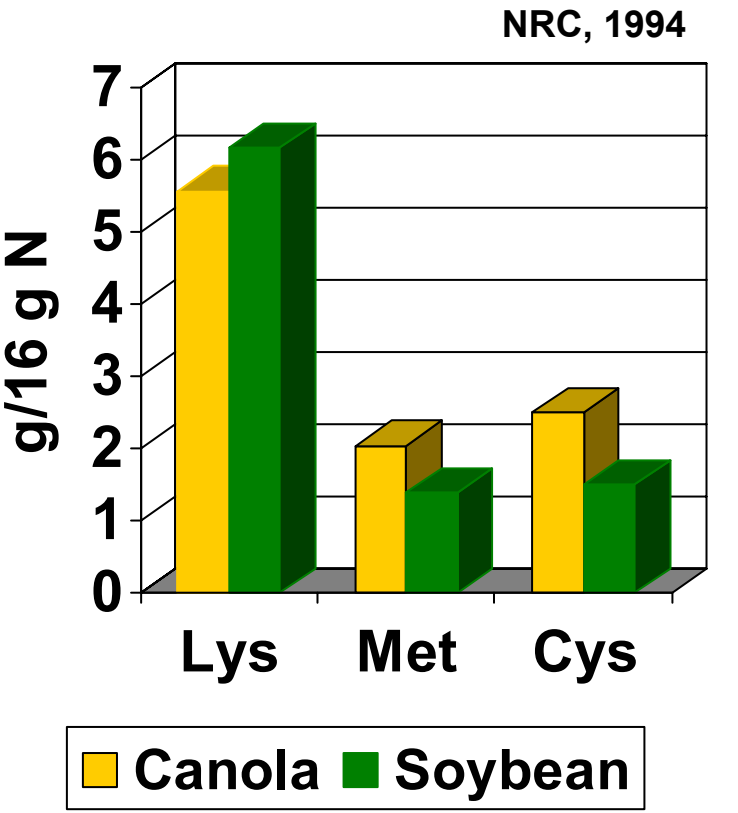
Outline

- Introduction
- Conventional processing
- Novel canola processing

- Nutritional significance of canola simple phenolics
- Dietary fibre in canola meal

Meal nutritional characteristics

- 34-39% well balanced protein
- High Lys content
- Enriched in Met and Cys
- Low AME_n for poultry
  - Canola meal - 8.37 MJ/kg
  - Soybean meal - 10.21 MJ/kg

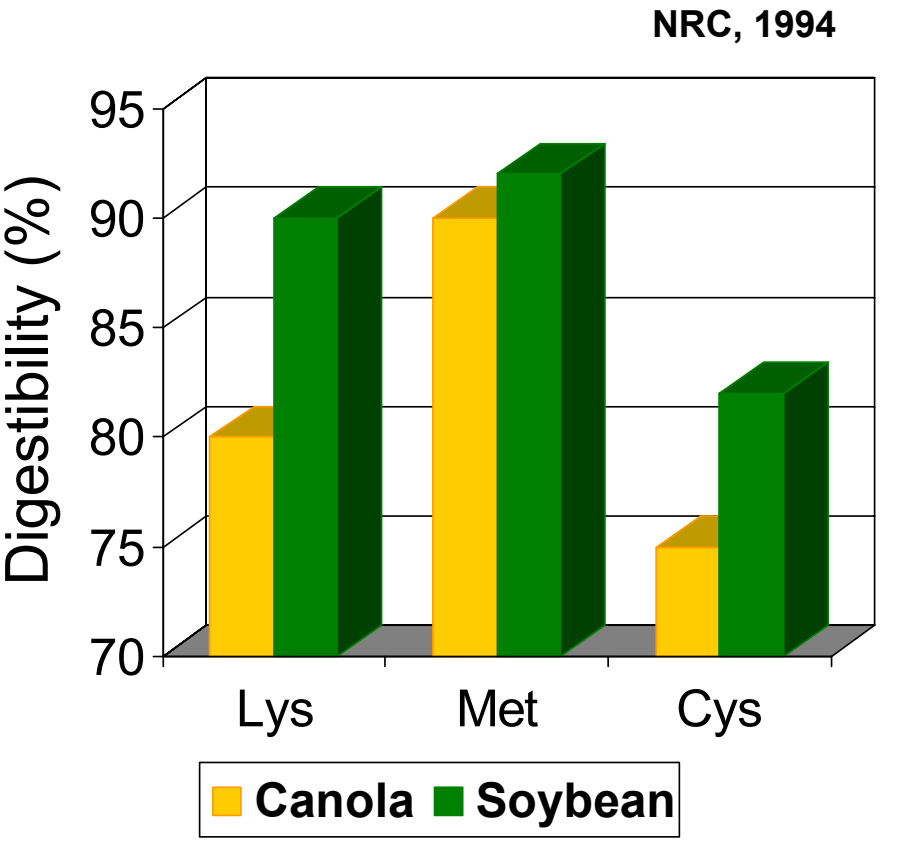


Meal nutritional characteristics

- **Anti-nutritional factors**
  - **<2% erucic acid**
    - **Not an issue**
  - **<30 µmol/g total aliphatic glucosinolates**
    - **Some debate but generally accepted to be of no or minor importance**
  - **~3.2% phytate**
    - **Environmental issues**
  - **~1.0% sinapine**
    - **Some negative consequences**

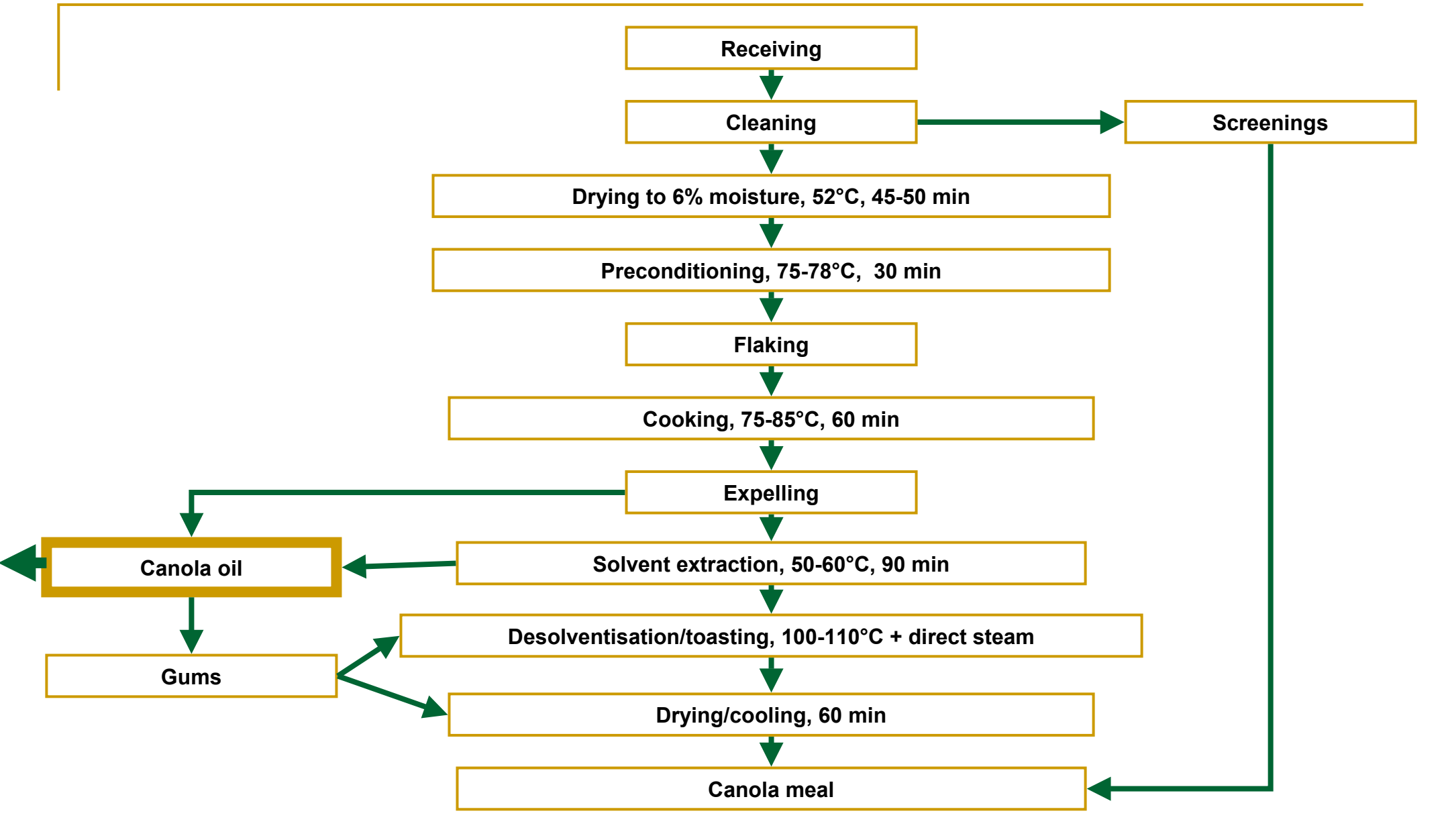
Meal quality - poultry

- Lower amino acid digestibility than soybean meal
- More variable amino acid digestibility
- Contains 75% of the protein of soy, often sells at 60% of the price
- Effect of processing on meal quality poorly understood



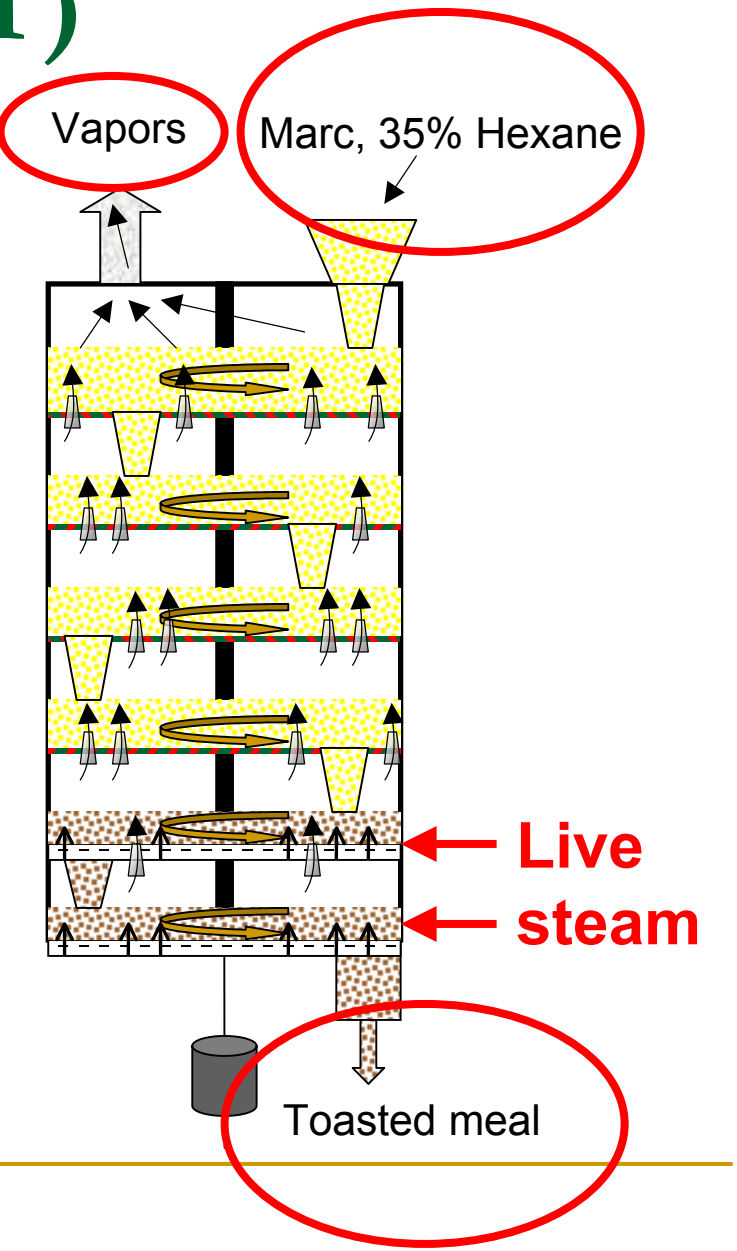
Canola processing

Pre-press solvent extraction


Receiving
Cleaning
Screenings
Drying to 6% moisture, 52°C, 45-50 min
Preconditioning, 75-78°C, 30 min
Flaking
Cooking, 75-85°C, 60 min
Expelling
Canola oil
Solvent extraction, 50-60°C, 90 min
Gums
Desolventisation/toasting, 100-110°C + direct steam
Drying/cooling, 60 min
Canola meal

Desolventiser-toaster (DT)

- Hexane laden marc enters top and passes over heated trays
- Hexane evaporates and is drawn through top of DT
- Live (sparge) steam is injected into the two bottom trays
  - Enhance hexane evaporation
  - Toast meal
- Meal exits bottom of DT

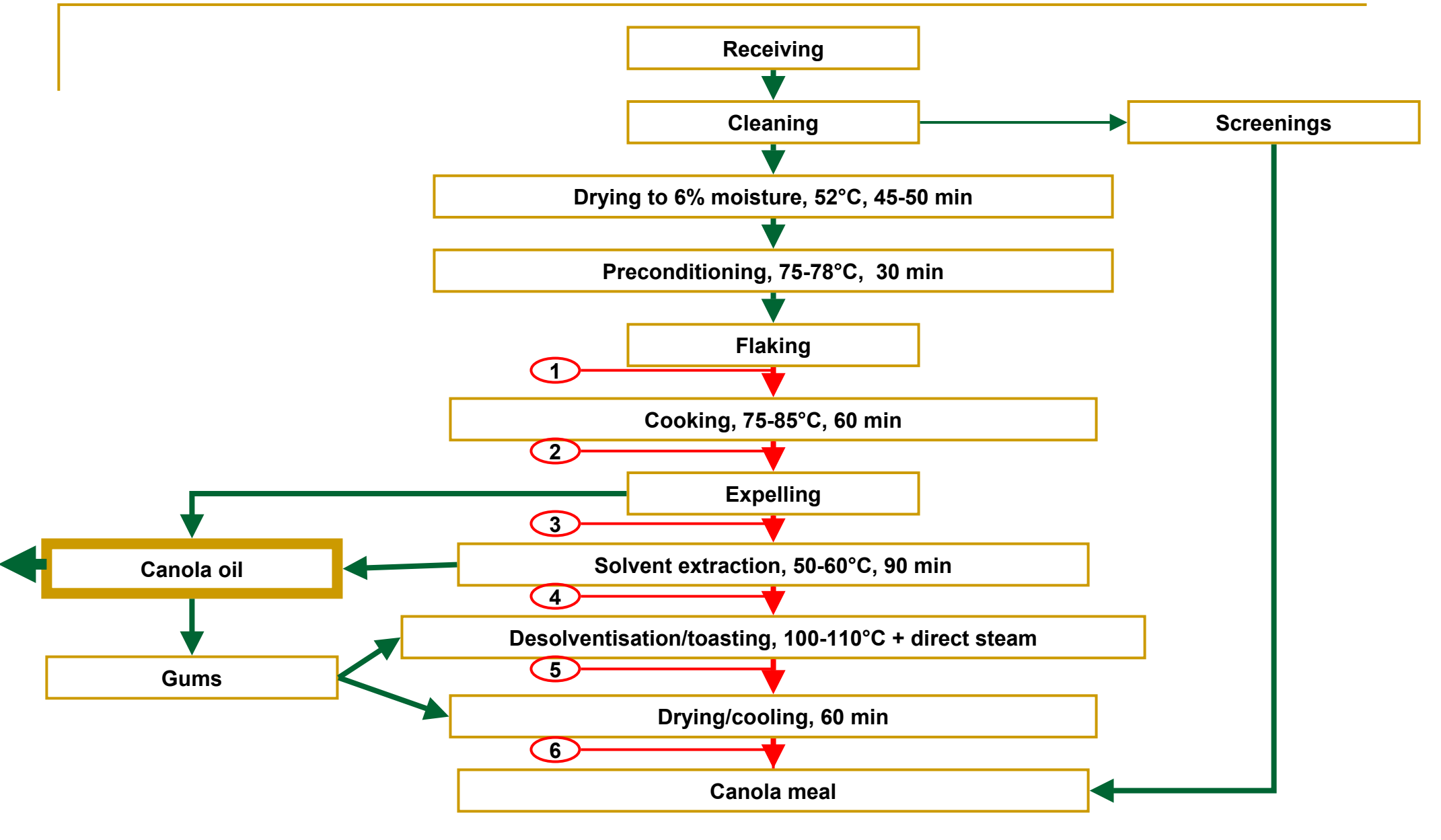


Effect of processing stage on nutritional value of meal

Objective and experimental design

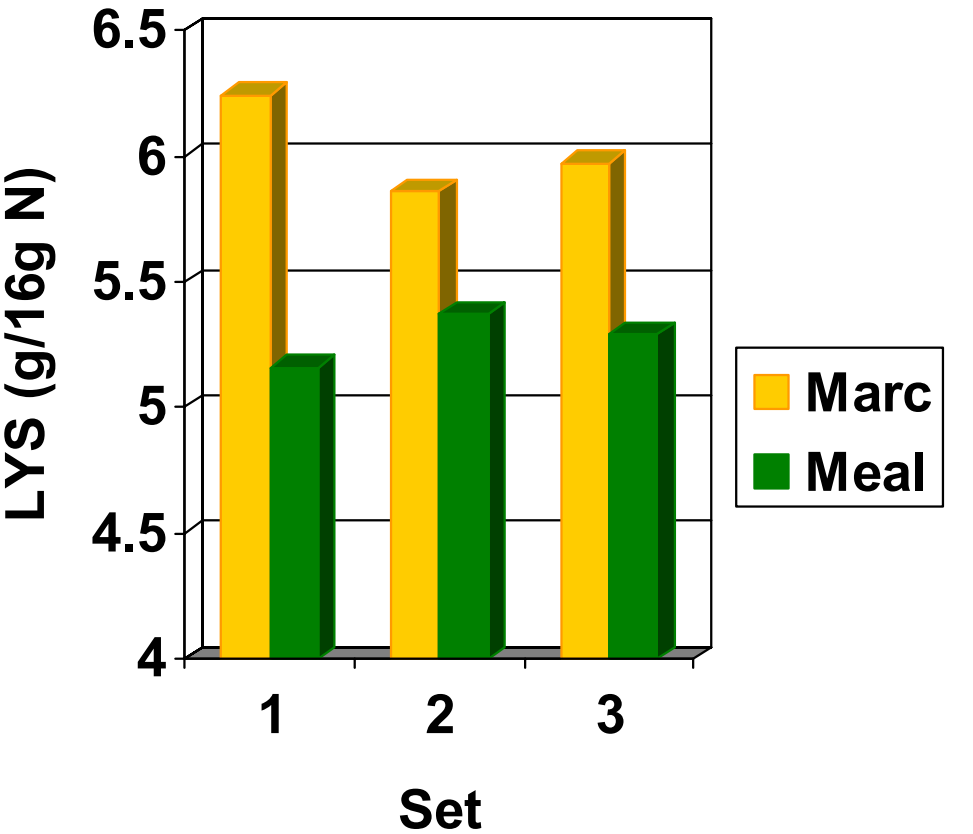
- **Objective:**
  - **To study the effect(s) of commercial prepress-solvent extraction on the nutritional value of canola meal**
- **Meal collected from a single commercial processing plant**
- **Samples were collected after six stages on three separate occasions**

Newkirk et al. (2003a)


Receiving
Cleaning
Screenings
Drying to 6% moisture, 52°C, 45-50 min
Preconditioning, 75-78°C, 30 min
Flaking
1
Cooking, 75-85°C, 60 min
2
Expelling
3
Canola oil
Solvent extraction, 50-60°C, 90 min
4
Desolventisation/toasting, 100-110°C + direct steam
Gums
5
Drying/cooling, 60 min
6
Canola meal

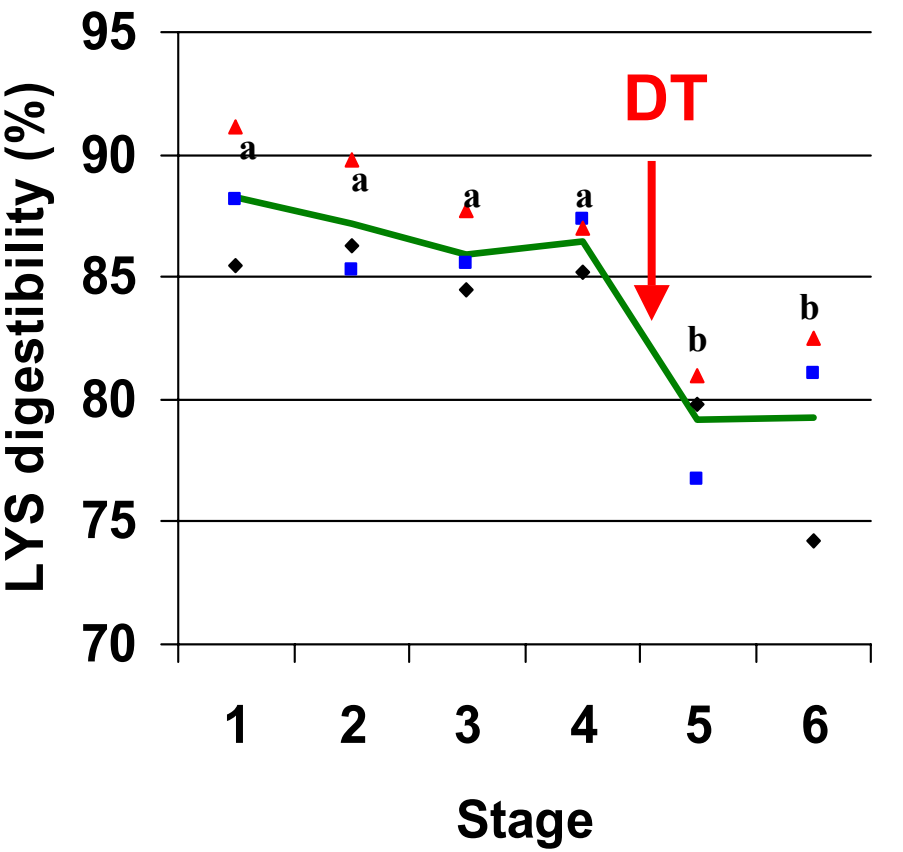
Amino acid content

- Content (DM oil free basis) was unaffected up to and including oil extraction
- Toasting reduced content
- Effect on meal colour

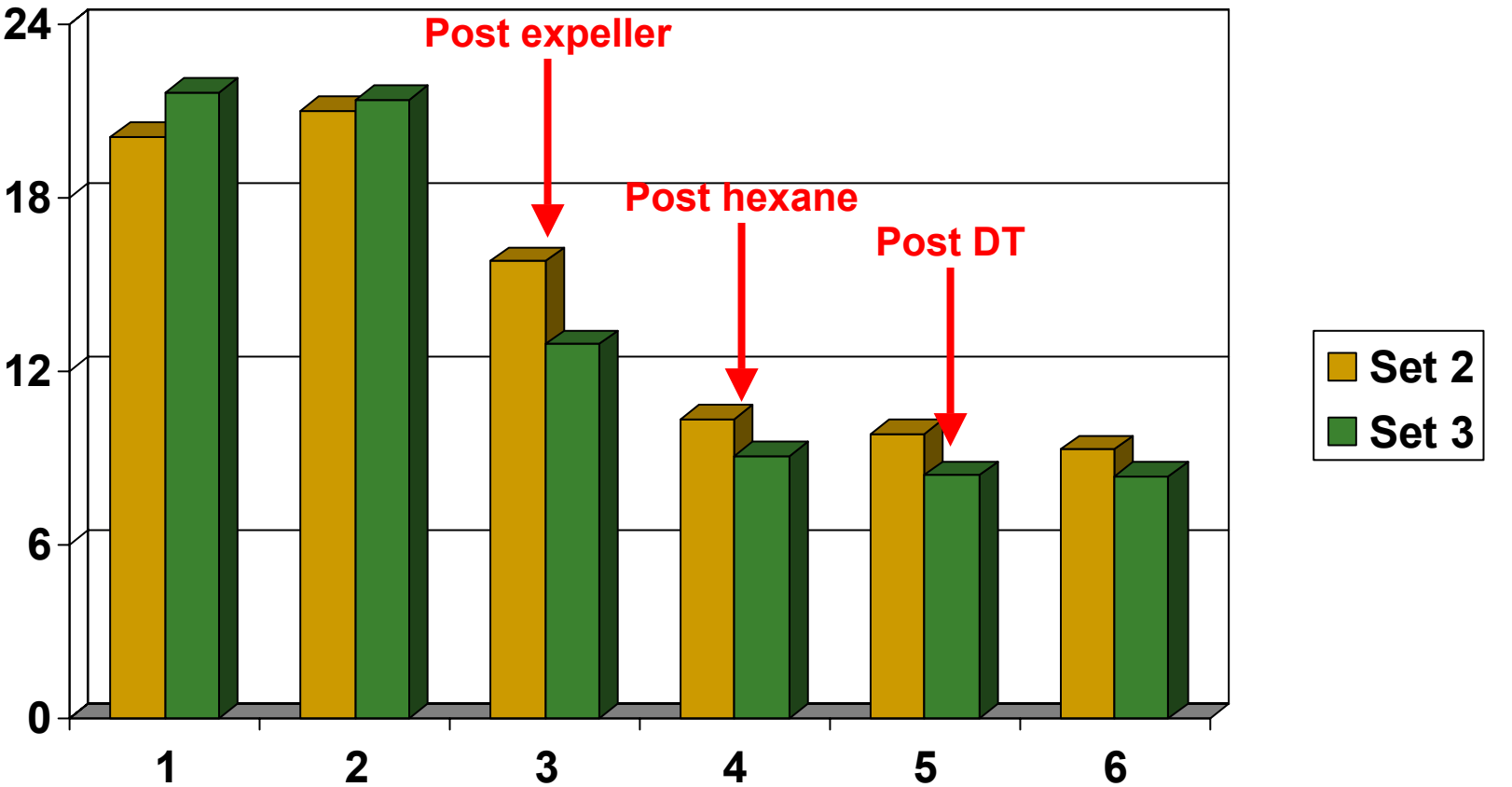


Amino acid digestibility

- Desolventisation/toasting decreased LYS digestibility
- Desolventisation/toasting decreased digestibility (P<0.05) of most amino acids (CYS, GLU, GLY, ASP, THR, ALA, VAL, ILE, LEU, PHE, HIS, ARG, PRO, & ASN)



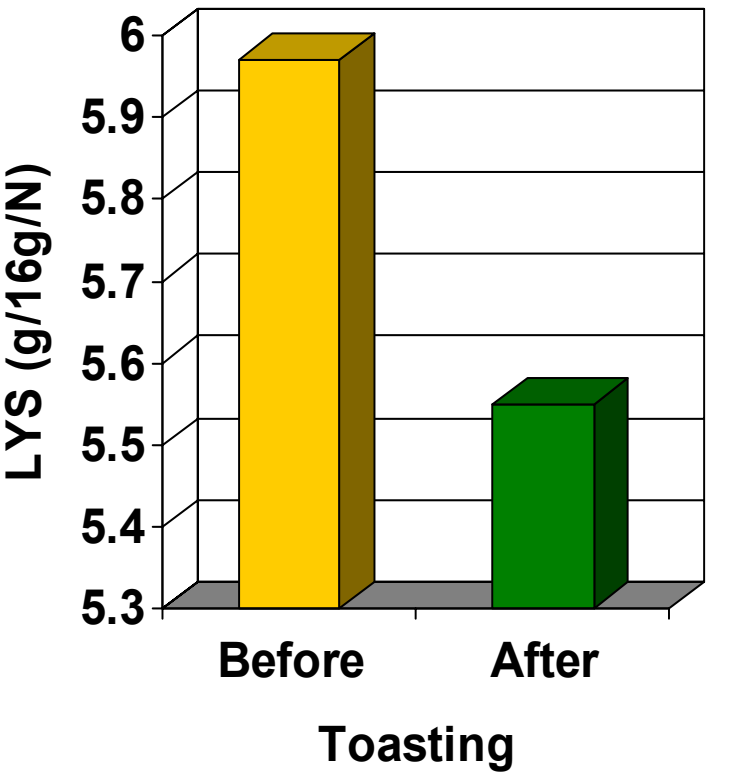
Effect of stage of processing on canola meal AME (MJ/kg)



Survey of toasted and non-toasted canola meal samples from across western Canada

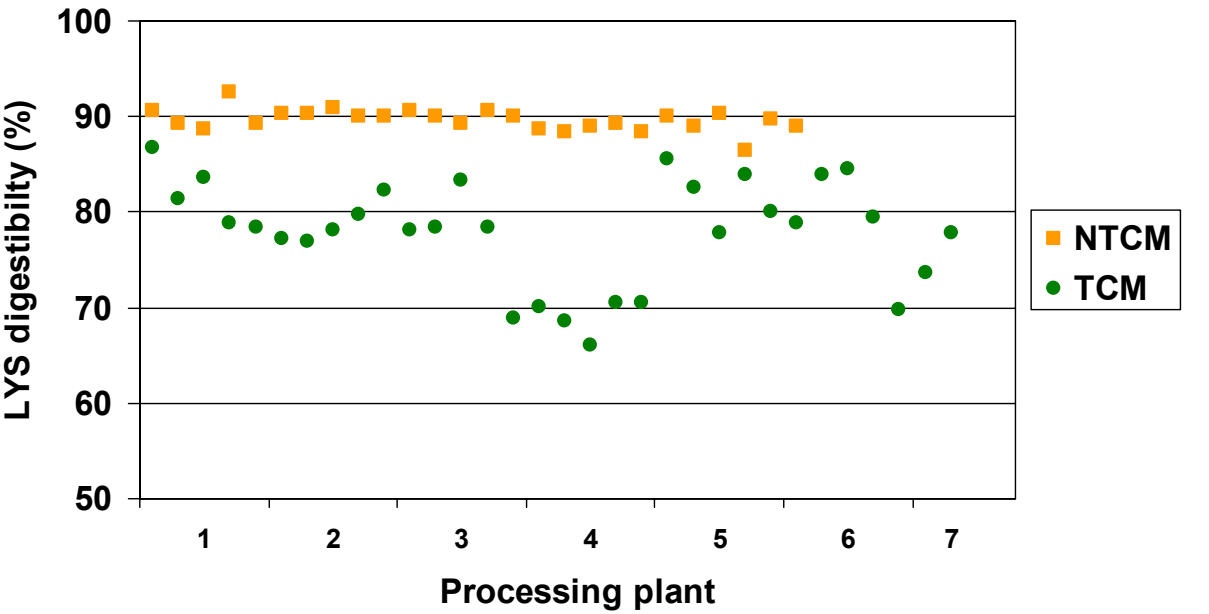
Amino acid content

- **Toasting reduced**
  - **Lysine content**
  - **Content of most AA**



Amino acid digestibility

- **Prior to toasting**
  - Highly available
  - Consistent quality
  - Light colour
- **After toasting**
  - Inconsistent quality
  - Dark colour



LYS content and digestibility

	Meal	Mean	Range
LYS content (g/16gN)	NTCM	6.0	5.7-6.3
	TCM	5.6	5.3-5.9
LYS digestibility (%)	NTCM	90	87-92
	TCM	79	66-86

Reduced digestible content of most amino acids

Prior to toasting 1 mt of canola meal = 307 kg available AA

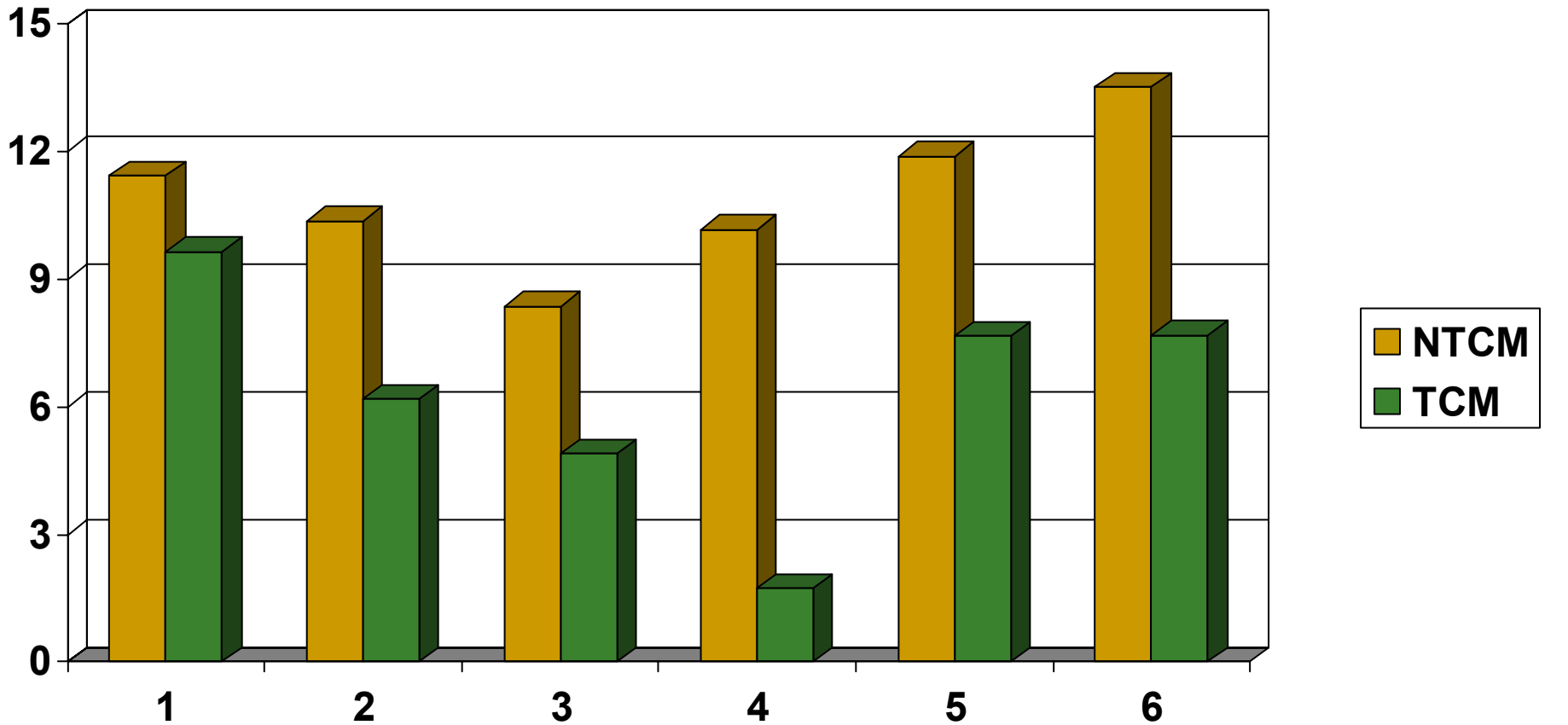
After toasting 1 mt of canola meal = 270 kg of available AA

Overall 12% reduction in digestible amino acid content

Non-toasted and toasted canola meal in broiler diets

Objective: To determine if toasting is required to reduce meal ANF toxicity or optimize broiler performance

Aliphatic glucosinolates (µmol/g)



Experimental meals

- **Meal collected from a commercial crushing plant**
  - **TCM**
- **Solvent laden extracted meal collected from the same plant on the same day**
  - **Desolventised in Crown DT without sparge steam**
  - **100ºC exit temperature**
  - **NTCM**

Composition of starter diet

20% CP, 12.24 MJ/kg

	% Soybean meal replacement					
%	0	20	40	60	80	100
Wheat	73.5	71.0	67.9	63.2	58.6	53.9
SBM	20.8	16.6	12.8	8.3	4.2	0
CM	0.0	6.3	12.5	20.8	28.9	36.9
Canola oil	1.0	1.6	2.3	3.3	4.3	5.3

Meal characteristics

	NTCM	TCM
Colour	Yellow	Light Brown
Neutral detergent insoluble nitrogen (%)	11.3	19.7
Aliphatic glucosinolates (µ/g)	11.5	7.8

Effects of toasting

	Body Weight (kg)		Feed Intake (kg)		Gain/Feed (kg/kg)
	19 d	39 d	0-19 d	19-39 d	0-19 d
NTCM	0.618[a]	2.181[a]	0.905[a]	3.193	0.642[a]
TCM	0.606[b]	2.148[b]	0.891[b]	3.140	0.637[b]

Discussion - toasting

- **Desolventisation without sparge steam and using 100ºC exit temperature**
  - **Prevented browning**
  - **Provided effective desolventisation**
  - **Improved broiler performance**
  - **May reduce processing costs?**
- **Caution in extrapolating these results to other animal species**

Measuring digestible amino acid content in canola meal *in-vitro*

Objective: To establish methods of measuring digestible amino acid content in canola meal

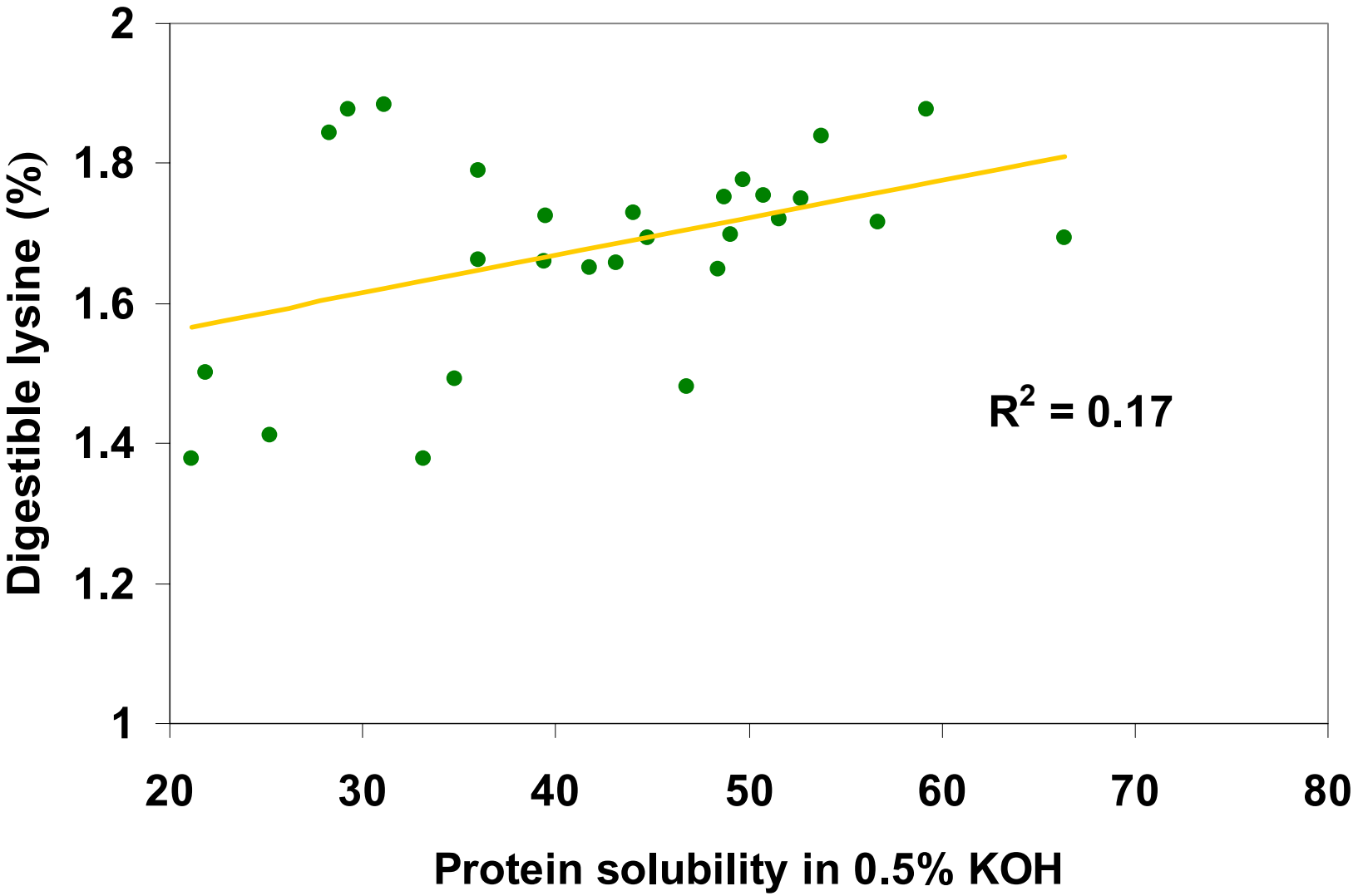
Background

- *In vitro* predictive assay to monitor canola meal
  - Quality control at processing plant
  - Quality control at feed manufacturers
    - Allow nutritionists to formulate and pay based on quality

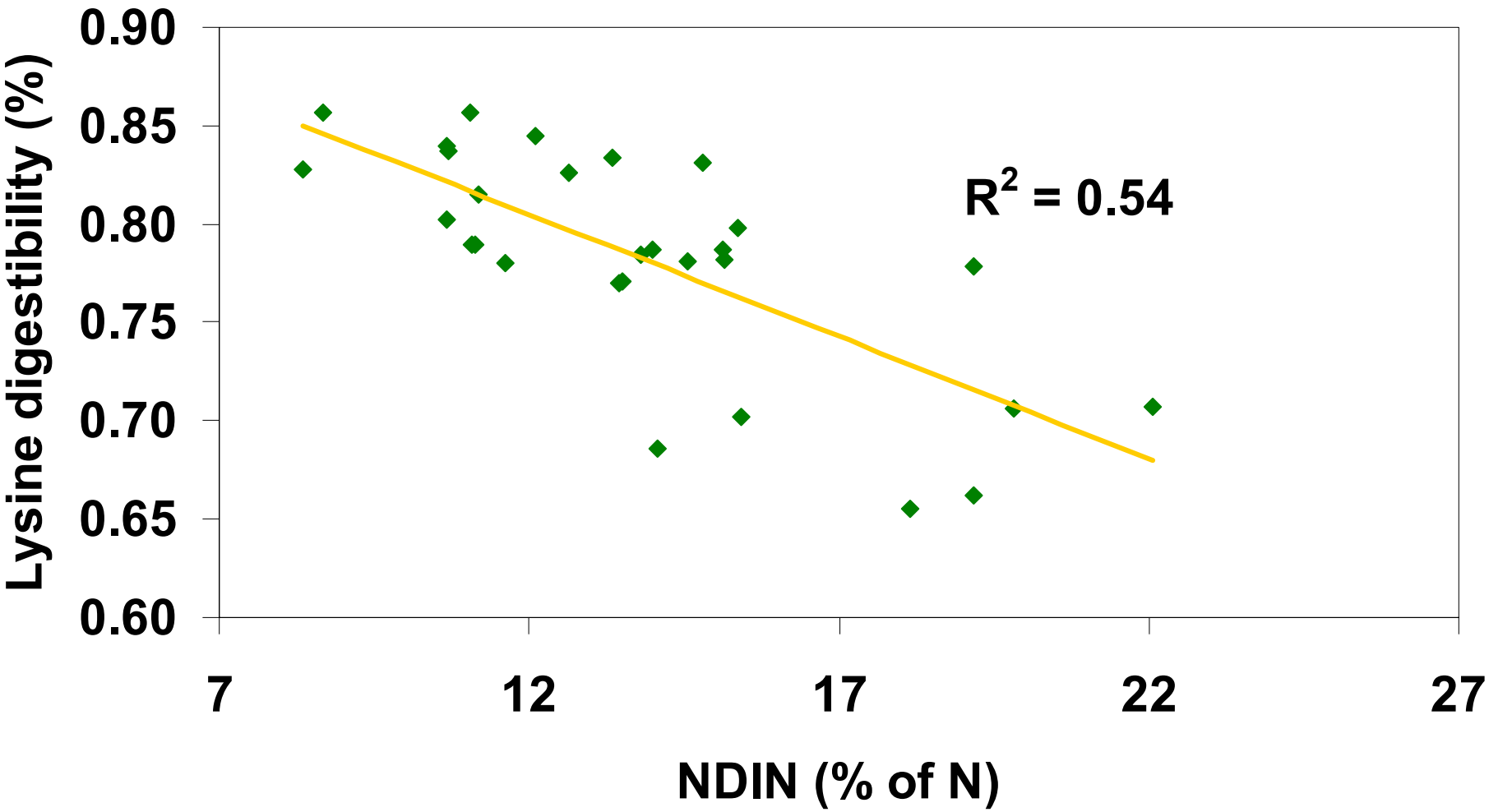
In-vitro assays

- **Protein solubility**
  - Heating denatures protein and reduces solubility
  - Use KOH solubility in soybean (0.2% KOH) and canola meal (0.5% KOH) to estimate heat application
- **Neutral detergent insoluble nitrogen (NDIN)**
  - Protein so insoluble it remains in fibre fraction
  - Expressed as a proportion of protein
- **Near infrared reflectance spectroscopy**
  - Scan sample for reflectance at infrared range
  - Used widely for moisture and protein
  - Potentially used for amino acid content and digestibility
- **Meal colour (not presented)**

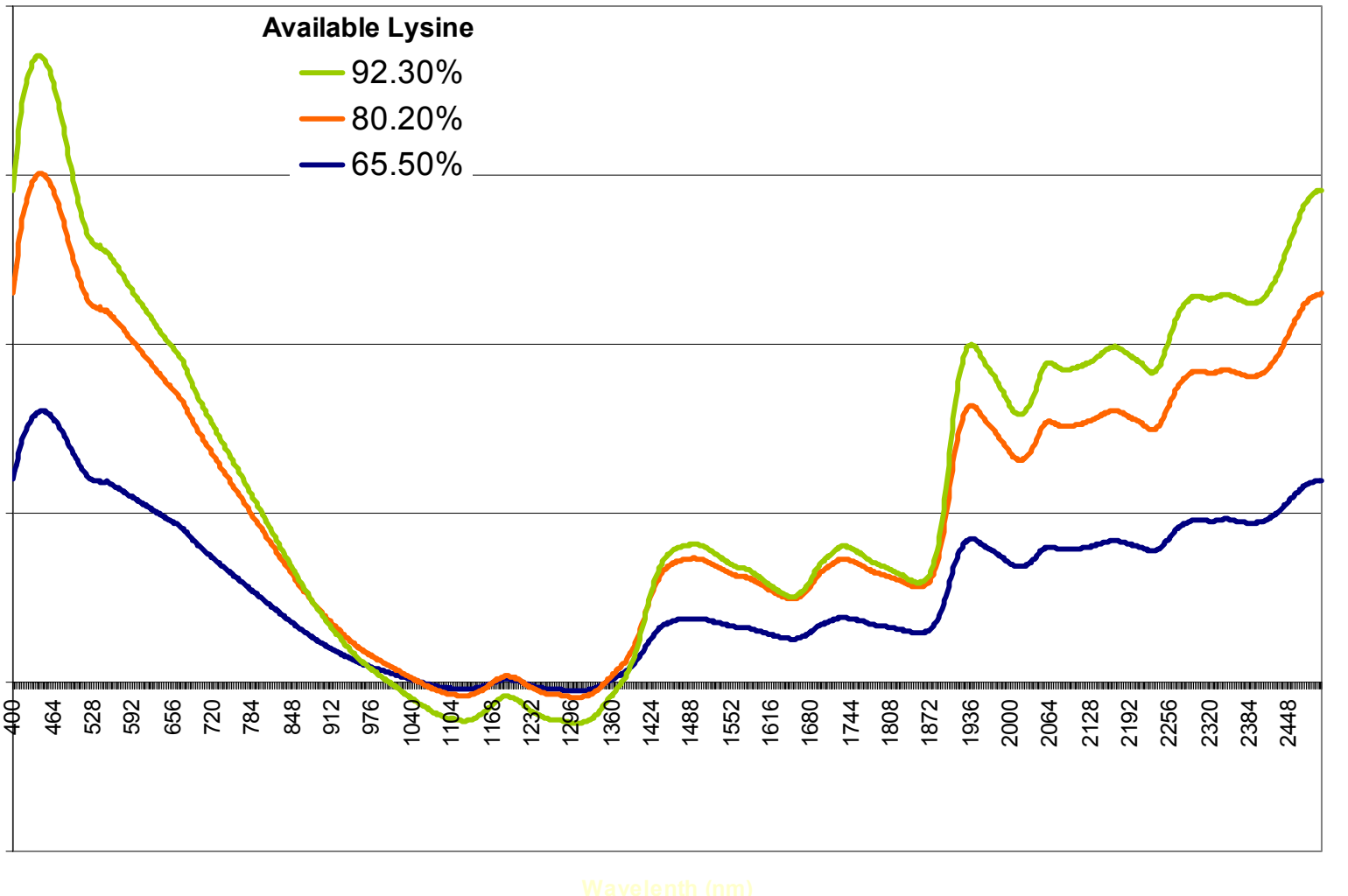
Protein solubility in KOH



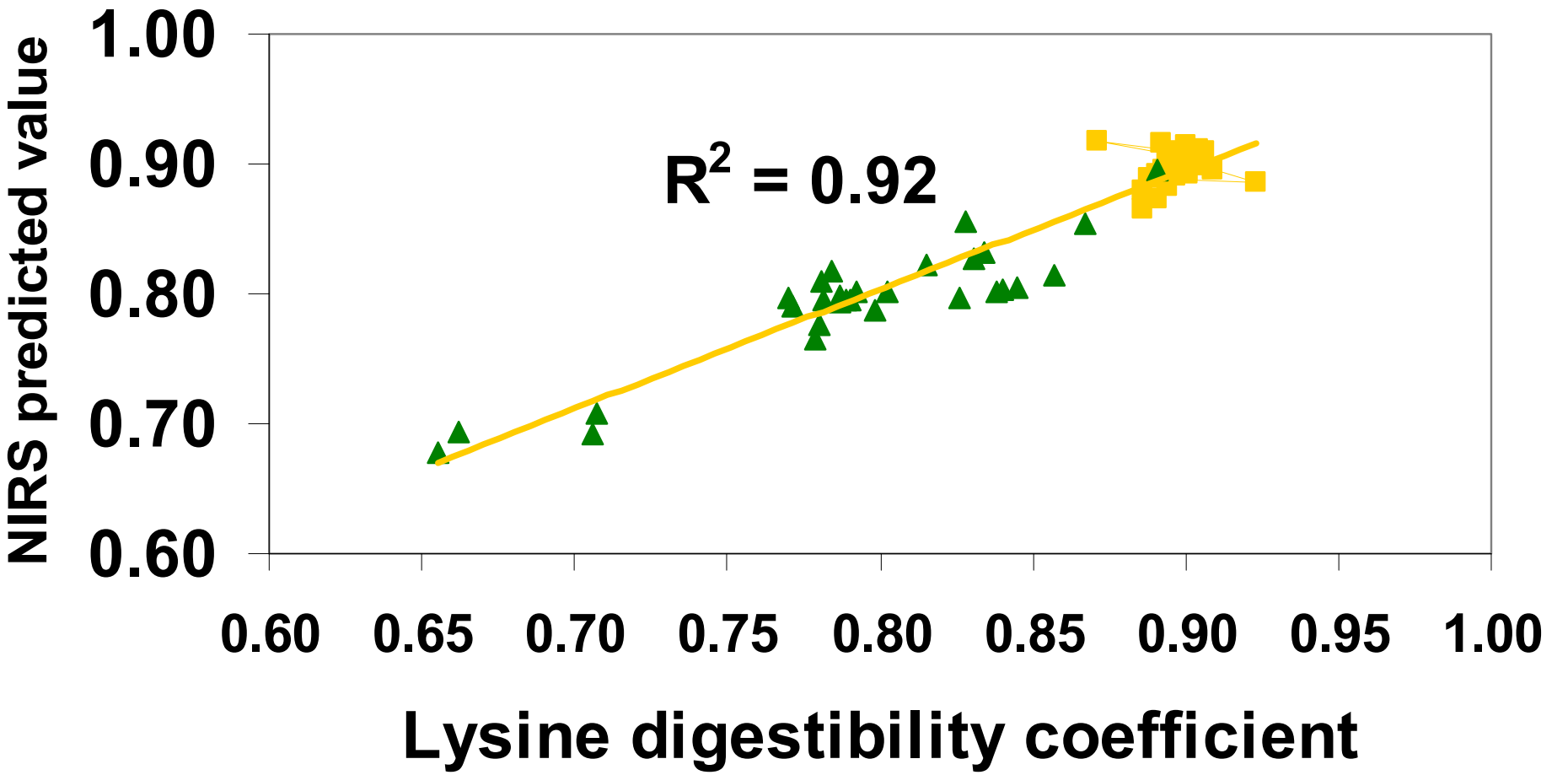
NDIN


0.90
0.85
0.80
0.75
0.70
0.65
0.60
Lysine digestibility (%)
R^2 = 0.54
7
12
17
22
27
NDIN (% of N)

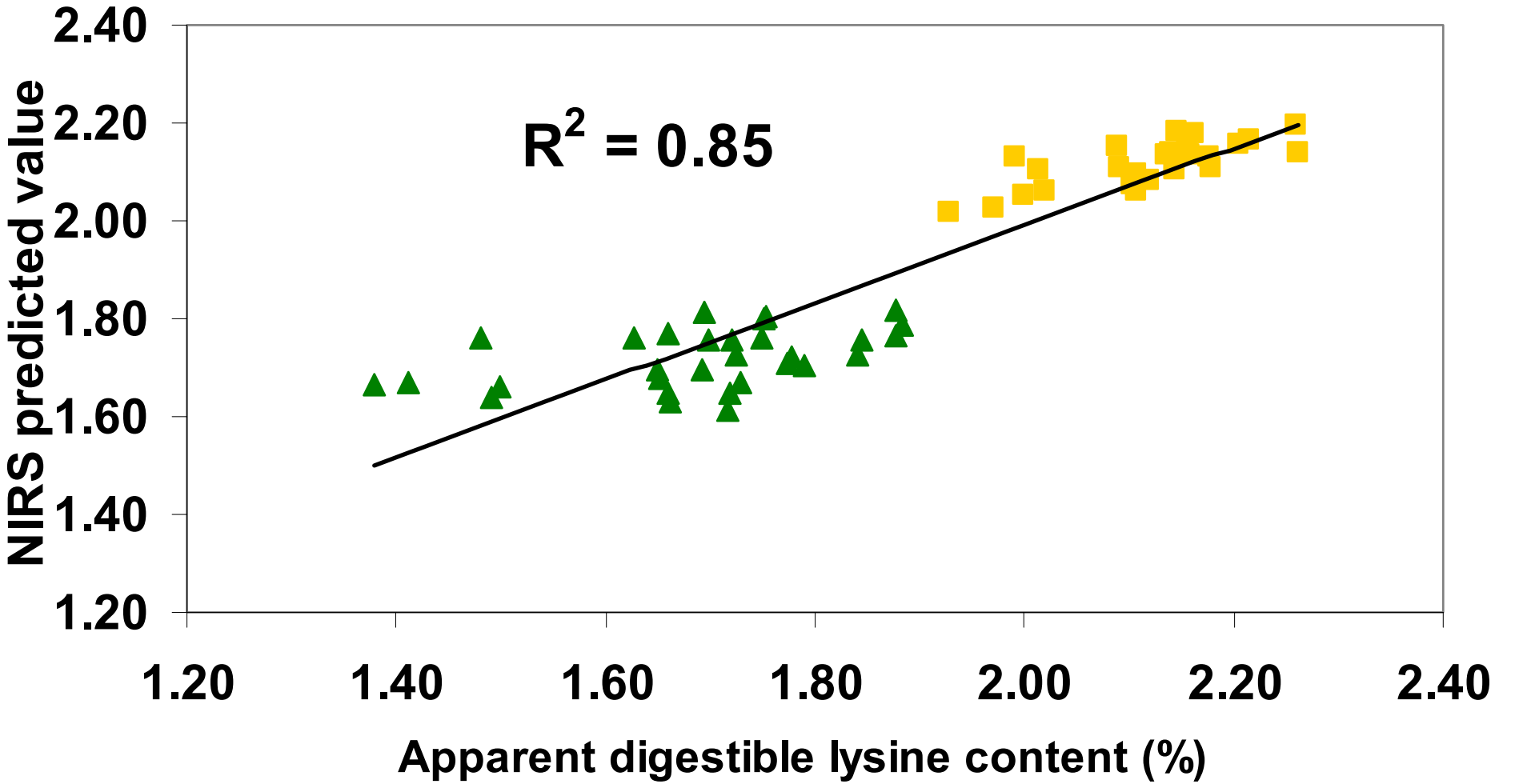
NIRS


Available Lysine
92.30%
80.20%
65.50%
400
464
528
592
656
720
784
848
912
976
1040
1104
1168
1232
1296
1360
1424
1488
1552
1616
1680
1744
1808
1872
1936
2000
2064
2128
2192
2256
2320
2384
2448
Wavelenth (nm)

NIRS- digestibility



NIRS – digestible LYS content



Conclusions – prediction of nutritional value

- **Protein solubility in 0.5% KOH poorly correlated with amino acid digestibility**
- **NDIN content correlated with lysine digestibility and content, and can be used until a better assay becomes available**
- **NIRS shows most promise, but requires a larger calibration set and constant revalidation**

Processing conditions affecting meal quality

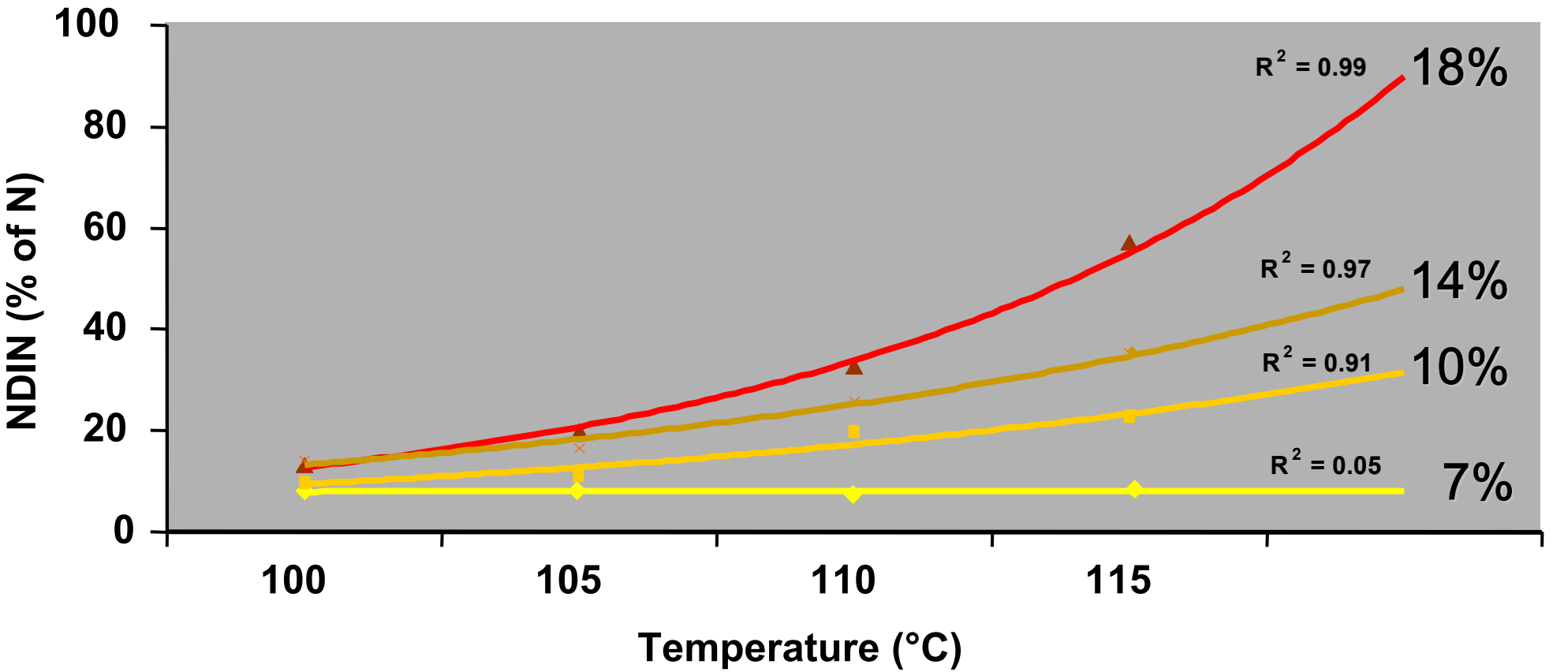
To determine the effect of temperature, time and moisture during processing on protein quality

Heat and moisture affect protein reactivity

- Meal heated to between 100 and 115°C during desolventisation
- Moisture increased from 7% to 18%
- Studied the effects of temperature and moisture during toasting on:
  - Amino acid availability (predicted)
  - Amino acid content
  - Colour

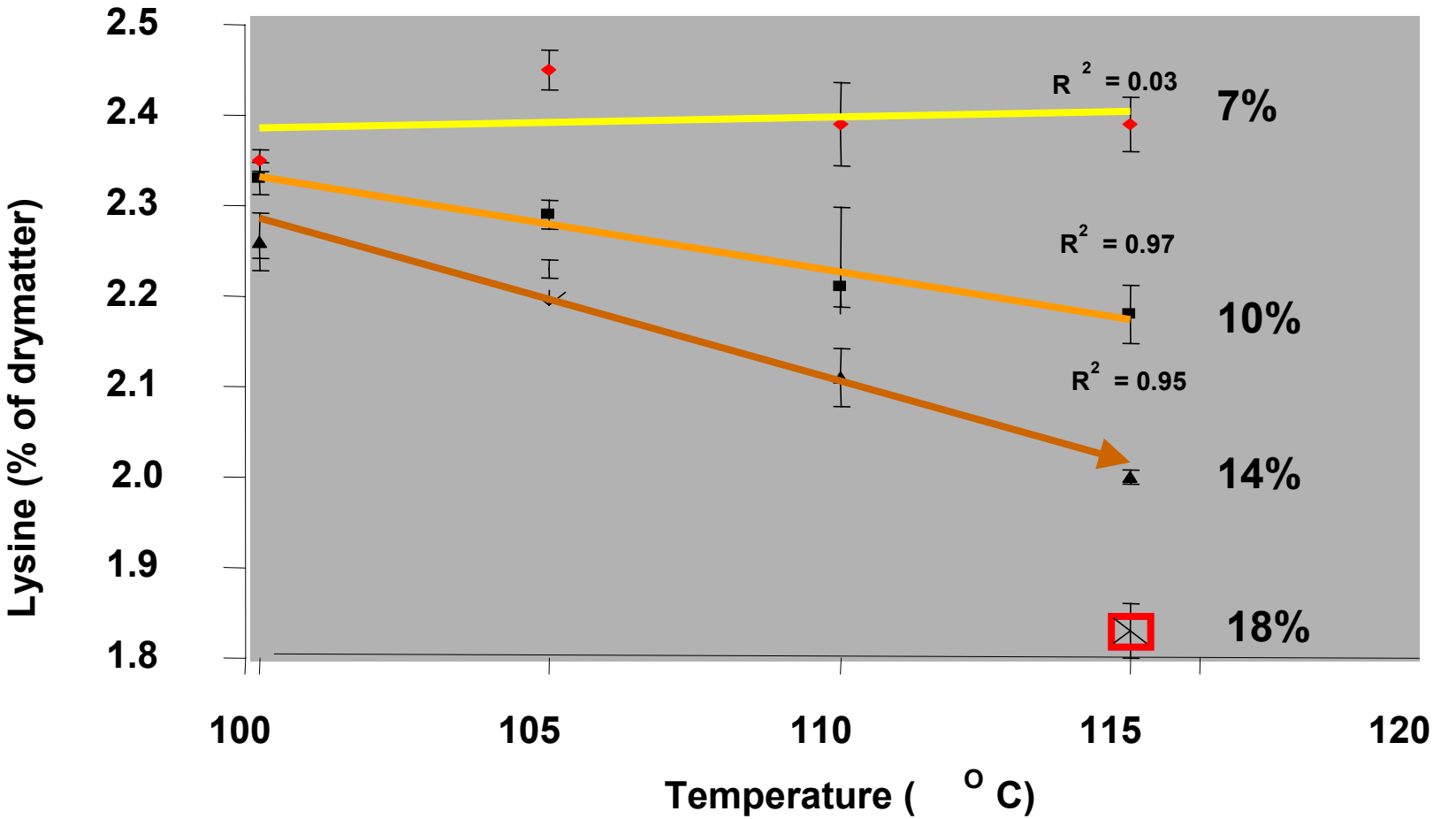
Effect of moisture and temperature

(NDIN content after 10 minutes toasting)

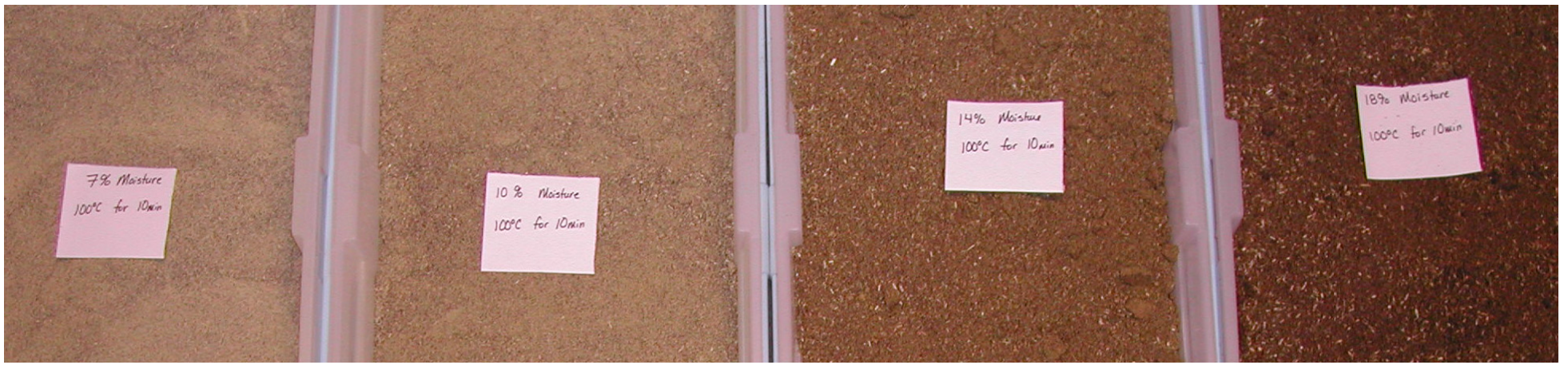


Effect of moisture

(LYS content after 10 minutes toasting)



Effects of moisture on meal colour



7% 10% 14% 18%

100°C for 10 minutes

Methods of desolventising at without added moisture?

- **Sources of moisture**
  - **Air desolventized marc ~6% moisture**
  - **Scrubber mist above top tray**
  - **Condensation of sparge steam**
  - **CIP water with gums (if added to DT)**
- **Can we effectively desolventize without added moisture?**

Conventional processing discussion

- **Toasting can reduce nutrient content and digestibility. Why toast?**
  - **Accepted practice**
  - **Reduce glucosinolate content**
  - **Reduce residual hexane content**
  - **Eliminate myrosinase**
- **Toasting required? Swine? Poultry? Dairy?**

Discussion

- Commercial desolventizaton practices are the largest factor contributing to the variability and quality of canola meal
- Need constant residence to produce a consistent product
- Toasting reduces glucosinolate content, but may not be necessary

Novel processing of canola meal

Limitations of solvent extracted canola meal in non-ruminant species

- **Fibre digestion does not occur in poultry, young pigs and fish and is limited in older pigs**
- **Low energy can affect level of canola meal use**
- **Phytate-P is poorly digested by chickens, pigs and fish**
  - **Increases cost of diet formulation**
  - **Undigested phytate-P is damaging to ecosystems**

Limitations of solvent extracted canola meal in ruminant species

- Ruminant animals extract energy from the degradation of fibre in the rumen
- Phytate is efficiently hydrolyzed by bacteria in the rumen
- Good source of by-pass protein

HOWEVER

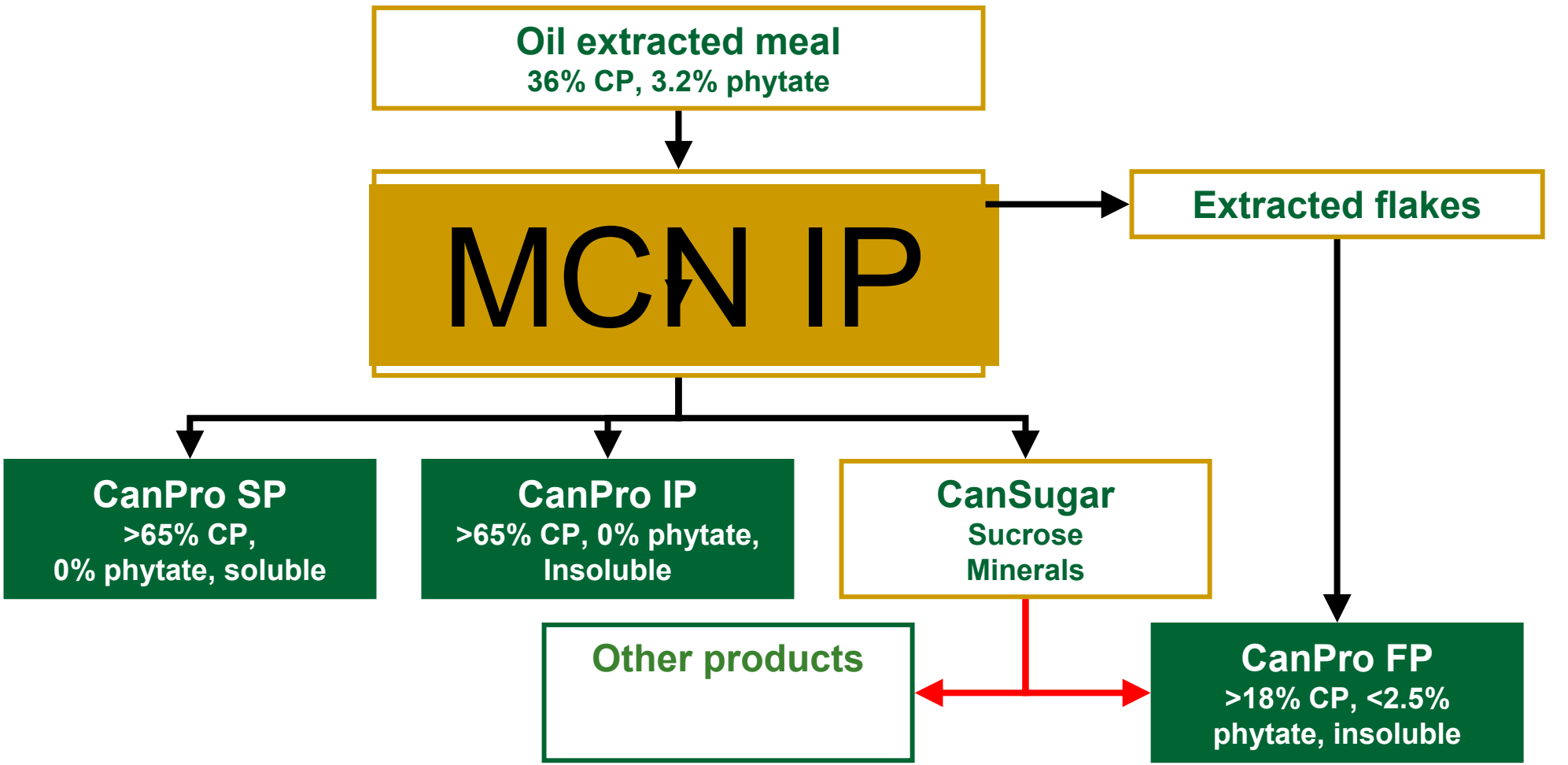
- Soluble high quality protein found in canola meal may be an expensive form of nitrogen for bacterial fermentation

Opportunity

- **Fractionate and process the non-oil portion of the canola seed to generate protein concentrates and other higher valued products**
  - **Optimise for non-ruminant and ruminant species**
- **Fill the market demand for vegetable-based replacements for fishmeal and other animal products used as animal feed ingredients**
- **Improve and stabilise crush margins**


BIOPRODUCTS INC.

Basic fractionation- processing scheme



Target high end animal nutrition

- **Soluble protein**

  - Alternative to:
    - Dairy proteins
    - Hydrolised plant proteins
  - Calf milk replacers

- **Insoluble protein**

  - Alternative to:
    - Fish meal
      - Aquaculture feed
      - Poultry, swine
    - Animal based proteins
    - Soy protein concentrates

- **Fibre protein**
  - By pass protein

Total product utilization

- **Sugar**
  - Energy supplement
  - Pellet binder
- **FP / Sugar**
  - Ruminants
  - Alfalfa – like profile
- **Inositol**
  - Aquaculture – shrimp
  - Potential human food use

No waste streams

Novel canola processing conclusions

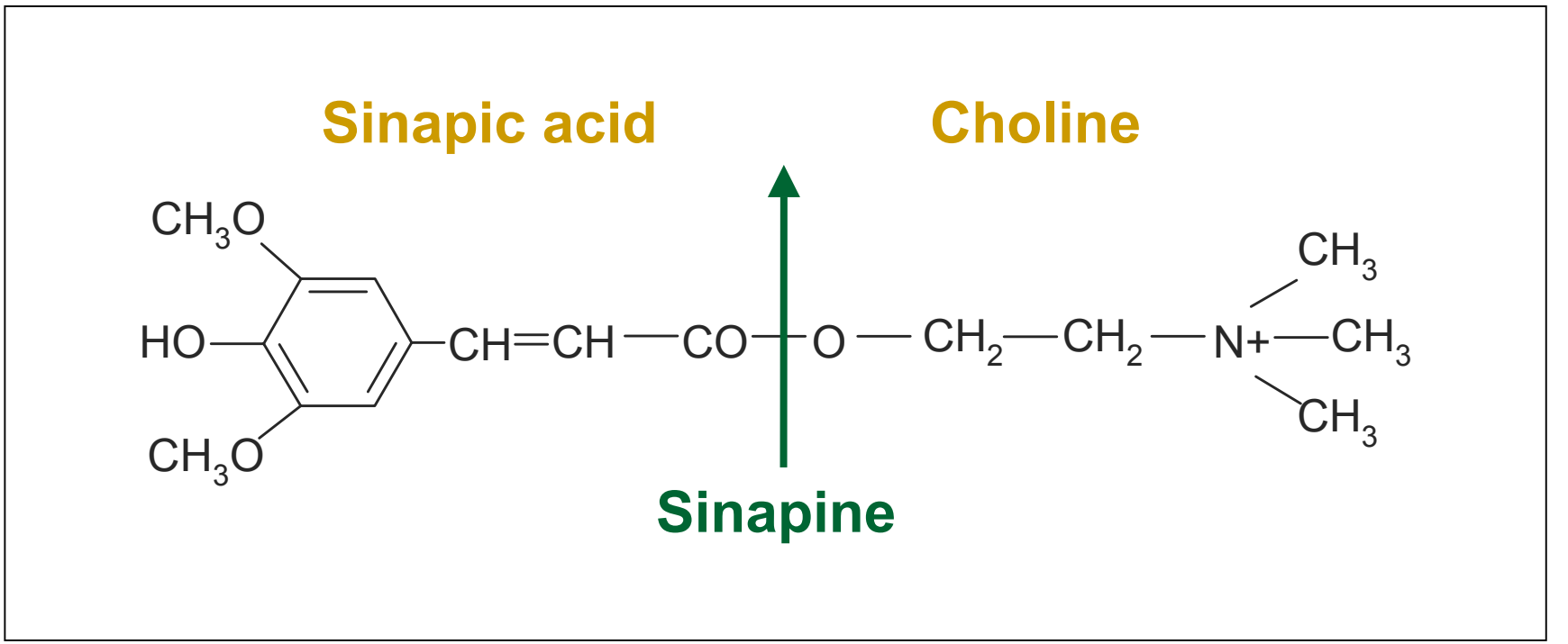
- A process had been developed and tested at the pilot scale level to fractionate canola meal into valuable products for animal feeding
- High protein products developed in this process have good feeding value for a wide range of non-ruminant species including poultry

Questions

Metabolism and effects of canola simple phenolics in poultry

H.L. Classen and H.Y. Qiao

Chemical structure of sinapine and sinapic acid



General conclusions

- **Simple phenolics in RSM have no negative impact on palatability and do not serve as an antinutritional factor in broiler chickens**
- **Low levels of simple phenolics may have a beneficial effect on nutrient utilization and performance in broiler chickens**
- **One major metabolic site of simple phenolics is the hind gut**

Canola meal fibre