

## POULTRY CRC

### FINAL REPORT

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**Sub-Project Title:**  
**Inclusion levels and economic benefits of  
canola meals on egg production of laying hens**

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*Inclusion levels and economic benefits of canola meals on egg production of laying hens*  
*Sub-Project No. 2.1.17*

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## Executive Summary

Canola meal (CM) has been available for layer feeds in Australia for over 30 years. However “fishy taint” caused by trimethylamine (TMA) in egg yolk has limited its inclusion. Genetic changes have removed the defective, recessive FMO3 gene in popular commercial strains of brown shelled layers resulting in elimination of the problem. The industry however is still reluctant to use high levels of CM. Two experiments were conducted to determine the optimum inclusion rate of CM in brown shell layer diets and to compare various sources of locally produced canola meal in the diets. The first experiment was based on cold pressed canola meal incorporated at 0, 100 or 200 g/kg of diet. The canola meal contained 110.0 g/kg oil, 11.09 MJ/kg AME, 355 g/kg CP and 16.2 g/kg SID lysine as measured by NIR (Evonik, Singapore, 2016). Ninety nine Hy-Line brown laying pullets (aged 21 weeks at 50% production) were placed into single cages randomized across the three treatments. Wheat-based diets were formulated commercially acceptable nutrient levels for birds 21 to 41 weeks of age. There were 33 replicates in each treatment group. Initial and final body weight, egg number, egg weight (daily), feed intake and FCR (monthly) and egg quality (shell breaking strength, shell deformation, shell reflectivity, albumen height, yolk colour and shell thickness) were measured. Egg quality was measured at the beginning and end of the experiment. Data were analysed with SPSS version 22. No significant differences ( $P > 0.05$ ) were found for feed intake (117.5, 117.8, 116.0 g/b/d), FCR (1.90, 1.90, 1.92 g feed/g egg), hen day egg production (97.7, 97.4, 97.2%), egg size (63.7, 63.9, 62.4 g) and daily egg mass (62.1, 62.2, 60.6 g/b/d) during the period measured between the 0, 100 and 200 g/kg treatments. Similarly, no changes ( $P > 0.05$ ) were observed between treatments for egg quality including shell breaking strength, shell reflectivity, shell deformations, albumen height, Haugh unit, yolk colour, shell weight and shell thickness. The second experiment was conducted with 96 hens (hens from trial 1) using three dietary treatments containing cold pressed canola meal (CPCM), expeller canola meal (ECM) and solvent extracted canola meal (SCM) at an inclusion level of 150 g/kg. Each treatment had 32 replicates with one bird per cage and the experiment was continued for 20 weeks (from 46 week to 65 weeks of age). Similar performance and egg quality measurements were taken and statistically analysed as in the first experiment. Significant differences were found for FI ( $P < 0.02$ ; 112.8, 115.0 and 117.7 g/b/d) and FCR ( $P < 0.01$ ; 1.93, 1.92, 2.06 g feed/g egg mass) between CPCM, ECM and SCM treatments (150 g/kg diet) during the 20 week experimental period. No differences ( $P > 0.05$ ) were observed between treatments for HDEP (93.8, 95.1, 92.0%), egg size (62.9, 63.2, 63.5 g/egg), egg mass (59.0, 60.1, 58.5 g/d). Higher yolk colour scores ( $P < 0.03$ ) however were observed in eggs from hens fed ECM as compared to CPCM diets (ECM 11.47, SCM 11.23, CPCM 10.87). Sensory evaluation egg samples from the both studies revealed zero presence of “fishy taint”. Differences in initial and final body weight of pullets and hens in each study period were not different ( $P > 0.05$ ). No mortality was observed in either experiment. It is concluded that any source of CM can be added up to 150 g/kg

in brown laying hen diets with significant feed cost savings up to \$25/t without compromising production performance or egg quality.

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# Chapter 1: Introduction

Canola meal (CM) derived from the crop species *Brassica napus* is a potentially competitive alternative to soybean meal in poultry layer feed formulation. It has been used at moderate inclusion levels (50 to 100 g/kg) in Australian broiler feeds for decades but at lower inclusion levels (10 to 20 g/kg) in layer feeds. In Australia there has been little work examining limits of practical inclusion in layer diets due to fear of fishy taint in yolks of brown layers when fed CM (Fenwick and Curtis, 1980). Genetic researchers found that the taint was conditional on the presence of an autosomal semi-dominant mutant gene with variable expression in the hen depending on environmental factors (Bolton *et al.*, 1976). This gene has been specifically identified as the flavin-containing monooxygenase-3 (FMO3) gene (Honkatukia *et al.*, 2005). It was revealed that eggs from brown layers in general do not smell unless hens with the inherited genetic defect have been fed ingredients with high levels of choline or sinapine (an ester of choline and sinapic acid). Excess choline in the gut triggers the taint due to formation of trimethyl amine (TMA) through bacterial fermentation of choline in the small intestine and caeca (March and MacMillan, 1979). The liver converts TMA via the enzyme trimethylamineoxidase into the nonodorous TMA N-oxide. Hens with the defective FMO3-gene do not produce enough enzyme to oxidise TMA into the odourless TMA-oxide.

Researchers have suggested limiting CM to 110 g/kg in brown layers mainly due to its high content of choline and sinapine (Ward *et al.*, 2009). The ISA R & D department started removing the defective FMO3-gene from their brown lines using a patented selection method. In 2010, ISA confirmed all grandparents stock (GPS) to be free of the fishy taint phenotype (ISA, 2010). Lohmann and Hy-Line have also confirmed removal of the defective FMO3 gene from their genetics brown egg lines. As of 2015 all laying stock derived from these genetic lines in Australia are devoid of the defective FMO3 gene and can be fed high levels of CM. This allows higher levels of sinapine, choline and betaine (metabolised to TMA by gut bacterial fermentation) to be fed without any adverse consequences. CM is a highly digestible protein source with higher levels of methionine and cysteine than soybean meal. In addition, it has higher levels of crude fibre than soybean meal that may be considered beneficial in layer diets.

Australia is a large canola producer, harvesting around 3.5 m tonnes of seed annually (Australian Oilseeds Federation, 2014). Around 2 m tonnes are exported and over 1 m tonnes is processed into oil with around 490,000 mt of 350-380 g/kg protein CM being produced in Australia in a typical year. Yet in 2014 Australia imported 675,000 mt of expensive soybean meal with a significant portion used for layer feed. Research conducted by Perez-Maldonado in 2005 recommended maximum CM inclusion up to 100 g/kg in layers; however the FMO3 gene problem had not been completely



eliminated from the Australian laying hen flock at that time. Canola meal may be made even more digestible by incorporating enzyme supplements into the diet (Slominski and Campbell, 1990).

Canola meals are produced in Australia by three different methods, solvent extracted, expeller extracted and cold expeller pressed (Australian Oilseeds Federation, 2004). These result in meals of different composition and perhaps nutritional quality due to pre-press conditioning temperature, second presses and de-solventising and toasting (Woyengo *et al.*, 2010). Processing is known to impact the quality of expeller extracted meals in broiler chickens (Toghyani *et al.*, 2015) but the possible impact of processing conditions has not been verified in layer hens. If successful, food security would be improved in Australia and value would be added to canola producing and crushing as well as layer producing sectors.

Therefore it needs to be determined how much canola meal can be used in layer diets, while maintaining high levels of performance.

Also there is now have a relatively new type of canola meal, called cold pressed canola meal. This meal was not previously available in large quantities. Cold pressed canola meal is relatively new in the Australian market and differs from ECM and SCM in that it is subjected to lower processing temperatures. Maximum are 60°C, compared with over 140°C for both ECM and SCM. This lower temperature means less damage to the protein, as shown in consistently higher reactive lysine assays for this meal. The meal typically contains about 110 g/kg oil, a high ME level of 11.13 (MJ/kg) and total lysine of 20 g/kg.

The experiments described in this report were designed to examine 100 to 200 g/kg inclusion of CPCM and compare CPCM, ECM and SCM at 150 g/kg inclusion on performance of layer.

# Chapter 2: Effect of graded levels of cold pressed canola meal on egg production parameters

## 2.1 Objective

The specific objectives of this experiment were:

- To examine performance of Hy-Line Brown hens fed 0, 100 and 200 g/kg inclusion of CPCM
- To assess the economics of CPCM in layers
- To assess effects of feeding CPCM on egg quality including fishy taint.

## 2.2 Materials and Methods

### 2.2.1 Cold pressed canola meal (CPCM) Collection

Fresh CPCM was collected from Cootamundra Oil Seed Company, NSW 2390. Upon receipt of the CPCM in 25 kg bags, subsamples were obtained from spatially separated sections of each of the bags using a sampling probe, and a thrice-rifled representative composite sample for CM was used for the chemical analyses (conducted in duplicate). A homogenous subsample of CPCM and other main ingredients such as wheat and soybean meal were analysed for dry matter, crude protein, ether extract and ash (Table 2.1).

**Table 2.1 Dry matter (DM), crude protein (CP) and ether extract (EE) contents of three main ingredients (wheat, cold press canola meal and soybean meal) used in this feeding trial**

Ingredients	DM (g/kg)	CP (g/kg)		EE (g/kg)	
		As is	basis	As is	basis
Wheat	900.0	131.7	146.4	30.4	33.8
CPCM	910.0	336.0	369.3	136.2	149.7
Soybean meal	895.0	462.4	516.6	33.0	36.9

### 2.2.2 Birds and Housing

The UNE cage layer facility at Laureldale was cleaned, washed, hosed and fumigated before placing pullets. Single cage feeders were fabricated to measure feed intake of individual birds. In total, 100, 15 week old Hy-Line Brown started pullets (1385.8 ±8.8 g) were obtained from Glenron commercial layer farm in Tamworth, NSW. Pullets were reared and housed in open sided shed in Laureldale, in cages (one bird/cage) with standard constant 16 hrs lighting as per breeder's recommendation. A single wheat based commercial diet (a peak lay feed from 15 weeks without any pre-lay) was offered

until birds were introduced to experimental diets at 21 weeks of age. Feed and water were supplied ad libitum. Water supply, health, temperature and feed were monitored regularly, feed added whenever needed, logbook entered and signed daily. Eggs were collected and weighed daily.

At 21 weeks of age, when at 50% hen day egg production (HDEP), 99 birds were randomized and divided into three dietary treatment groups, 33 replicates per treatment. Hens were housed individually in commercial laying cages (50 × 55 × 50cm) (Figure 2.1). The control (group A) was fed a wheat-soybean based commercial layer mash feed, group B was fed with inclusion of 100 g/kg CPCM and group C was fed diet with 200 g/kg CPCM. The feed was formulated (Table 2.2) by a practicing commercial nutritional consultant. Diets were iso-energetic and iso-nitrogenous. All diets were mixed at the UNE feed mill every four weeks and offered as mash. Birds were given ad libitum access to feed and water. Initial and final body weights were recorded. Eggs were collected, weighed and recorded on daily basis to achieved HDEP, egg size and egg mass. Feed intake was recorded on a monthly basis. Birds were monitored closely and the “daily record of care sheet” filled and signed daily. The feeding study was continued for 20 weeks until birds reached at 41 weeks of age. The following formulas were used to calculate the HDEP, egg mass and FCR:

$$\text{HDEP} = \frac{\text{Total number of eggs produced during the period}}{\text{Total number of hen-days in the same period}} \times 100$$

$$\text{Average egg mass (Per hen per day in g)} = \frac{\text{Per cent HDEP} \times \text{Average egg weight in g}}{\text{kg of feed consumed}}$$

$$\text{FCR (per kg egg mass)} = \frac{\text{kg of feed consumed}}{\text{kg of egg produced}}$$



**Figure 2.1: Initial set up with 99 pullets at 21 weeks of age at Laureldale cage shed UNE.**

**Table 2.2: Ingredient and calculated nutrient composition of experiments diets used for Part A feeding study**

Ingredient (g/kg)	AU\$/t*	Zero CPCM <sup>1</sup> diet 1	100 (g/kg) CPCM <sup>1</sup> diet 2	200 (g/kg) CPCM <sup>1</sup> Diet 3
Wheat 11 (xylanase)	270	715.9	684.1	652.3
Soybean meal Argentina	720	175.0	108.0	41.0
Cold pressed canola meal	450	-	100.0	200.0
Dicalcium phosphate <sup>2</sup>	700	1.5	1.5	1.5
Limestone powder	110	46.0	45.5	45.0
Limestone chips (>2mm)	110	46.0	45.5	45.0
Canola oil	1150	8.0	8.0	8.0
Salt	240	2.4	2.5	2.5
Sodium bicarbonate	540	1.0	1.0	1.0
L-lysine HCL	2,000	0.9	1.2	1.4
D,L-methionine	5,500	1.6	1.1	0.8
L-Threonine	2,750	0.5	0.4	0.3
Econase XT (xylanase)	2,000	0.06	0.06	0.06
Quantum Blue (phytase)	16,000	0.12	0.12	0.12
Premium layer premix <sup>3</sup>	5,000	1.00	1.00	1.00
Pigment red	75,000	0.04	0.04	0.04
Pigment yellow	85,000	0.03	0.03	0.03
Total, g		1000.0	1000.0	1000.0
Feed cost (\$/kg)		0.3653	0.3509	0.3375
<b>Calculated nutrients</b>				
ME, MJ/kg			11.72	
SID, (%)				
Lysine			0.76	
Methionine			0.35	
M+C			0.69	
Tryptophan			0.16	
Threonine			0.57	
Arginine			0.79	
Isoleucine			0.59	
Valine			0.70	
Calcium (g/kg)			38.0	
Av Phosphorous (g/kg)			3.0	
Sodium (g/kg)			1.9	

<sup>1</sup> CPCM: Cold Pressed Canola meal

<sup>2</sup> Dicalcium phosphate contained: phosphorus, 180 g/kg; calcium, 210 g/kg.

<sup>3</sup> Vitamin concentrate supplied per kg of diet: Vitamin A, 10,000 iu; Vitamin D, 3,000 iu; Vitamin E, 20 mg; Vitamin K, 3 mg; Nicotinic acid 35 mg; Pantothenic acid, 12 mg; Folic acid, 1 mg; Riboflavin B2, 6 mg; Cyanocobalamin, 0.02 mg; Biotin, 0.10 mg; Pyridoxine (B6), 5mg; Thiamine B1, 2 mg. Trace mineral concentrate supplied per kg of diet: Copper, 8 mg; Cobalt, 0.2 mg; Molybdenum, 0.5 mg; Iodine, 1 mg; Selenium, 0.3 mg; Iron, 60 mg; Zinc, 60 mg; Manganese, 90 mg; Antioxidant, 20 mg.

\* Costs are based on local market prices in August 2015.

## 2.2.3 Animal ethics

All experimental procedures were reviewed and approved by the Animal Ethics Committee of the University of New England, Armidale, NSW, Australia with an approval number of AEC 15-070.

## 2.2.4 Egg quality measurements

Internal and external egg quality was measured at 41 weeks age. Whole lots of fresh eggs were collected and labelled on a cage basis for analysis at the UNE Egg Quality Laboratory, Armidale,

NSW, Australia (Figure 2). Eggs were scored for translucency (0 lowest to 5 highest) using an egg candler and then analysed for customary egg shell quality measurements: shell colour by reflectivity, egg weight, egg shell breaking strength by quasi-static compression, shell deformation to breaking point and shell weight (egg quality equipment, Technical Services and Supplies, Dunnington, York, UK). Shell thickness was measured using a custom-made gauge based on a Mitutoyo Dial Comparator gauge Model 2109-10 (Kawasaki, Japan). Percentage of shell was calculated from shell weight and egg weight.



Figure 2.2: Egg quality analyses at UNE egg laboratory.

## 2.2.5 Sensory Evaluation

Sensory evaluation was conducted using a two person panel. Each smelled each opened egg yolk based on method described by Perez-Maldonado and Treloar (2005) with little modification. Briefly, the actual evaluation, fresh eggs were collected in the morning and brought to the egg laboratory. Then each egg was cracked and opened into a 50ml plastic container and labelled on a cage basis. Then the yolk was slightly crushed with a fork and the lid of the container quickly closed. The two panellists assessed each egg by deep sniffing (Figure 3) and scored separately. Each panellist had a labelled control egg as well as fishy taint samples to compare whether they were scoring consistently or not. The temperature of the egg lab during assessment was 20°- 22°C. The level of fishy odour was scored on a category scale defined as:

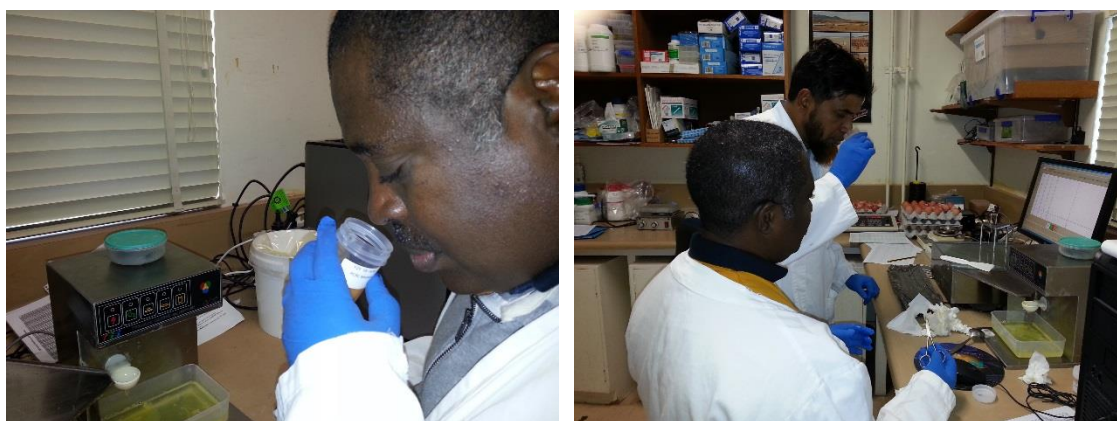
None: No fishy odour detectable

Trace: Slight fishy odour detectable

+: Moderate fishy odour detectable

++: Strong fishy (like real fish) odour detectable.

The sensory evaluation was conducted on full sets of freshly collected eggs two times, at the beginning and at the end of data collection.



**Figure 2.3: Dr Maikano M Ari and Dr Momen Bhuiyan were investigating egg yolk for fishy taint by deep sniffing at UNE egg Laboratory.**

## 2.2.4 Cost benefit analysis

Feed cost benefits were calculated based on available ingredients at local/wholesale market price as at August 2015 (Table 2.2). The following formula was used to calculate the feed cost per kg of eggs:

Feed cost per kg egg (\$) = Diet cost (\$/kg) × FCR.

## 2.2.5 Statistical analysis

Data for each 4 weeks were analysed separately. The performance data such as FI, FCR, BW, HDEP, egg size, egg mass, feed cost per kg egg, egg quality parameters were analysed using the General Linear Models (GLM) procedures of SPSS options, Version 22 (SPSS Inc, 2016) for the main effects of different inclusion levels of canola meal. Separation of means within a significant effect was done by the Duncan's Multiple Range Test (DMRT) through post hoc procedure of SPSS. Significance levels were set at  $P < 0.05$  unless otherwise specified.

## 2.3 Results

### 2.3.1 Gross performance

#### Gross response (body weight, feed intake, FCR, HDEP, egg size and egg mass)

Feed intake (FI), FCR, HDEP, egg size and egg mass were not significantly different ( $P > 0.05$ ) among the dietary treatment groups (Table 2.3) up to 29 weeks of laying period. However, numerically lower FCR and higher HDEP were observed in layers fed diets containing 200 g/kg CM compared to zero and 100 g/kg CM. However, there was a significant decrease in daily egg mass ( $P < 0.011$ ) in layers fed 200 g/kg CM diet compared to 100 g/g and zero CM diets (59.5 vs 62.2 and 62.2 g/day respectively) during the 30 to 34 week period (Table 2.4). These egg mass differences ( $P < 0.018$ ) continued up to 16 weeks of feeding (Table 2.6) being lower in the 200 g/kg CM treatment (59.6 vs 61.5 and 62.2 g/day respectively).

**Table 2.3: Influence of different inclusion levels of CPCM on the performance of Hy-Line brown layers from 21 weeks to 29 weeks of age (0-8 weeks of feeding period).**

	Zero CM	100 g/kg	200 g/kg	SEM	P values
Performance parameter		CPCM	CPCM		
Initial BW (21weeks,g/b)	1908.4	1963.8	1925.7	11.6	0.139
FI (g/b/day)	117.4	116.7	114.1	0.93	0.309
FCR (g feed/g egg mass)	2.00	2.02	2.00	0.02	0.827
HDEP (%)	97.5	96.3	96.8	0.42	0.516
Egg weight (g/egg)	60.5	60.3	59.1	0.36	0.258
Egg mass (g/d)	59.0	58.1	57.2	0.41	0.212

Initial BW = Initial body weight; FI = feed intake; FCR = feed conversion ratio; HDEP = hen day egg production; SEM = standard error of mean.



**Table 2.4: Influence of different inclusion levels of CPCPM on the performance of Hy-Line brown layers from 30 weeks to 33 weeks of age (9-12 weeks of feeding period)**

	<b>Zero CM</b>	<b>100 g/kg</b>	<b>200 g/kg</b>	<b>SEM</b>	<b>P values</b>
<b>Performance parameter</b>		<b>CPCM</b>	<b>CPCM</b>		
FI (g/b/d)	119.3	118.4	115.0	0.96	0.151
FCR (g feed/g egg mass)	1.92	1.91	1.94	0.02	0.813
HDEP (%)	98.5	98.6	97.3	0.31	0.164
Egg weight (g/egg)	63.1	63.1	61.2	0.39	0.068
Egg mass (g/day)	62.2 <sup>a</sup>	62.2 <sup>a</sup>	59.5 <sup>b</sup>	0.42	<0.011

FI = feed intake; FCR = feed conversion ratio; HDEP = hen day egg production; SEM = standard error of mean; <sup>a, b</sup> Values with unlike superscripts within each row are significantly different (P<0.05).

**Table 2.5: Influence of different inclusion levels of CPCPM on the performance of Hy-Line brown layers from 21 weeks to 33 weeks of age (0-12 weeks of feeding period).**

	<b>Zero CM</b>	<b>100 g/kg</b>	<b>200 g/kg</b>	<b>SEM</b>	<b>P values</b>
<b>Performance parameter</b>		<b>CPCM</b>	<b>CPCM</b>		
Feed intake (g/b/d)	118.3	117.6	114.5	0.88	0.178
FCR (g feed/g egg mass)	1.96	1.97	1.96	0.02	0.967
HDEP (%)	98.0	97.5	97.0	0.26	0.324
Egg weight (g/egg)	61.8	61.7	60.2	0.37	0.124
Egg mass (g/day)	60.6 <sup>a</sup>	60.1 <sup>a</sup>	58.4 <sup>b</sup>	0.38	<0.041

FI = feed intake; FCR = feed conversion ratio; HDEP = hen day egg production; SEM = standard error of mean; <sup>a, b</sup> Values with unlike superscripts within each row are significantly different (P<0.05).

**Table 2.6: Influence of different inclusion levels of CPCPM on the performance of Hy-Line brown layers from 21 weeks to 37 weeks of age (0-16 weeks of feeding period).**

	<b>Zero CM</b>	<b>100 g/kg</b>	<b>200 g/kg</b>	<b>SEM</b>	<b>P values</b>
<b>Performance parameter</b>		<b>CPCM</b>	<b>CPCM</b>		
Feed intake (g/b/d)	119.6	117.7	116.1	0.85	0.234
FCR (g feed/g egg mass)	1.93	1.93	1.96	0.02	0.687
HDEP (%)	98.6	97.5	97.2	0.29	0.147
Egg weight (g/egg)	63.1	63.0	61.3	0.37	0.083
Egg mass (g/day)	62.2 <sup>a</sup>	61.5 <sup>a</sup>	59.6 <sup>b</sup>	0.39	<0.018

FI = feed intake; FCR = feed conversion ratio; HDEP = hen day egg production; SEM = standard error of mean; <sup>a, b</sup> Values with unlike superscripts within each row are significantly different (P<0.05).



The significant effect of canola meal on egg mass disappeared in the cumulative 0-20 week production period. Other parameters such as finish body weight, FI, FCR, HDEP, egg size were also non-significant (Table 2.7) in this period. No mortality was observed during the whole 20 weeks of study period.

**Table 2.7: Influence of different inclusion levels of CPCM on the performance of Hy-Line brown layers from 21 weeks to 41 weeks of age (0-20 weeks of feeding period).**

<b>Performance parameter</b>	<b>Zero CM</b>	<b>100 g/kg CPCM</b>	<b>200 g/kg CPCM</b>	<b>SEM</b>	<b>P values</b>
BW at 41weeks of age (g)	2271.5	2279.7	2236.4	22.2	0.702
Feed intake, g/bird/day	117.5	117.8	116.0	0.85	0.665
FCR (g feed/g egg)	1.90	1.90	1.92	0.01	0.734
HDEP (%)	97.6	97.4	97.2	0.27	0.853
Egg weight (g/egg)	63.7	63.9	62.4	0.36	0.189
Egg mass (g/day)	62.1	62.2	60.6	0.36	0.133

FI = feed intake; FCR = feed conversion ratio; HDEP = hen day egg production; SEM = standard error of mean

## 2.6.2 Egg quality measurements

Including cold pressed canola meal at 100 and 200 g/kg feed had no effects ( $P > 0.5$ ) on external egg shell quality (such as translucency score, shell reflectivity, breaking strength, deformation, shell weight, shell % and shell thickness) or internal egg quality (such as albumen height, Haugh unit and yolk colour score) (Table 2.8). Sensory evaluation on samples of eggs from the 3 treatments did not reveal presence of “fishy taint”.

## 2.3.3 Economics of using canola meal in layer diet

The feed cost in \$/kg of egg is shown in Table 2.9. It was less expensive ( $P < 0.001$ ) to feed hens diets with 100 and 200 g/kg CPCM compared to 0 g/kg controls during the 20 week experiment. Calculating cost per kg egg for each pen as a discrete observation allowed statistical analysis of economic data.

**Table 2.8: Measures of egg quality parameters (internal and external) fed diets based on three different inclusion levels of canola meal at mid lay (41 weeks of age) production period for Hy-Line Brown hens.**

	At 41 weeks of age (Last lot of eggs)				
Performance parameter	Zero CM	100 g/kg CPCM	200 g/kg CPCM	SEM	P values
<b>Shell Quality</b>					
Translucency score	2.52	2.54	2.54	0.02	0.87
Shell reflectivity (%)	18.4	17.6	17.8	0.28	0.45
Egg weight (g)	65.2	64.5	63.2	0.49	0.26
Breaking strength (N)	39.6	40.2	39.5	0.55	0.87
Deformation (µm)	266.9	271.6	272.5	2.75	0.67
Shell weight (g)	5.77	5.73	5.62	0.05	0.48
Shell (%)	8.86	8.90	8.92	0.07	0.93
Shell thickness (µm)	393.5	393.3	391.0	2.46	0.90
<b>Internal Quality</b>					
Albumen height (mm)	10.31	10.01	10.16	0.11	0.54
Haugh unit	99.9	98.6	99.5	0.47	0.51
Yolk colour score	10.28	10.19	10.16	0.11	0.88
Egg yolk sensory evaluation*	None	None	None	-	-

CM: Canola meal; SEM: Standard Error of mean; \*Egg yolk scored for Fishy Taint (0 none to 3 strong) by sniffing.

**Table 2.9: Feed cost (\$) per kg egg production for brown egg layers with three different inclusion levels of CPCM at mid lay production period (21 to 41 weeks of age).**

Performance parameter	Zero CM	100 g/kg CPCM	200 g/kg CPCM	SEM	P values
	Cost (\$/ kg egg )	Cost (\$/ kg egg)	Cost (\$/ kg egg)		
Weeks					
0-4	0.777 <sup>a</sup>	0.748 <sup>a</sup>	0.705 <sup>b</sup>	0.009	<0.002
5-8	0.708 <sup>a</sup>	0.673 <sup>b</sup>	0.652 <sup>b</sup>	0.006	<0.000
0-8	0.739 <sup>a</sup>	0.709 <sup>ab</sup>	0.681 <sup>b</sup>	0.007	<0.002
9-12	0.711 <sup>a</sup>	0.669 <sup>b</sup>	0.659 <sup>b</sup>	0.006	<0.001
0-12	0.725 <sup>a</sup>	0.689 <sup>b</sup>	0.670 <sup>b</sup>	0.006	<0.001
13-16	0.704 <sup>a</sup>	0.659 <sup>b</sup>	0.662 <sup>b</sup>	0.008	<0.024
0-16	0.715 <sup>a</sup>	0.674 <sup>b</sup>	0.666 <sup>b</sup>	0.006	<0.002
17-20	0.688 <sup>a</sup>	0.657 <sup>b</sup>	0.641 <sup>b</sup>	0.006	<0.010
0-20	0.701 <sup>a</sup>	0.666 <sup>b</sup>	0.654 <sup>b</sup>	0.005	<0.001

CPCM: Cold pressed canola meal; SEM: Standard Error of mean; <sup>a, b</sup> values across a row with different letters are significantly different (P<0.05).

## 2.4 Discussion of Results

The results clearly show that inclusion of CM in brown egg layers diets up to 200 g/kg had no effect on overall performance and no effect on egg quality during the 20 week experimental period compared to the control diet with soybean meal. Similar results were observed by Lesson *et al.*

(1986) who acknowledged that canola meal could replace soybean meal without any adverse effects on performance in layers.

Fishy taint was not detected in egg yolks from hens fed diet contains up to 200 g/kg CM. This is further evidence that the defective FMO3-gene from brown lines using a patented selection method has been removed successfully (ISA, 2010). Thus the barrier to include CM in commercial layer diets with higher rates is now gone.

The economics of using cold pressed canola meal in layer diets depend on comparative canola and soybean meal market prices. These of course may vary over time. At the time of the experiment, and using delivered feed mill prices of \$450/mt and \$650/mt for cold pressed canola meal and soybean meal, using 200 g/kg cold pressed meal would reduce cost of feed by \$25/mt. This experiment shows conclusively that dietary inclusion of CPCM at levels up to 200 g/kg is economically favourable in production of commercial brown eggs.

## **2.5 Conclusion**

It can be concluded from the 96 birds used in this experiment that the problem of “fishy taint”, which previously prevented use of canola meal at high levels, is no longer present in eggs produced from Hy-Line Brown hens. This suggests that CPCM may be successfully used at levels of 200 g/kg in Hy-Line Brown diets without compromising production performance or egg quality and could reduce cost of feed by \$25/mt based on prevailing ingredient prices.

## **Chapter 3: Effect of different Canola meals on egg production parameters at mid lay period (45 to 65 weeks of age)**

### **3.1 Objective**

This experiment was designed to compare hen performance, egg quality and presence of fishy taint in eggs when diets containing CPCM, ECM and SCM at 150 g/kg inclusion.

### **3.2 Material and Methods**

#### **3.2.1 Collection and initial analysis of Canola meal**

Three types of canola meals, CPCM, ECM and SCM were collected fresh from Cootamundra Oil Seed Company, NSW 2390; MSM Milling, Manildra, NSW 2865 and Cargill Australia oilseed crush plant, Kooragang Island, Newcastle (through Baiada Tamworth, NSW) respectively. Upon receipt of the meals, subsamples were obtained from spatially separated sections of each of the bags using a sampling probe, and a thrice-rifled representative composite sample for each CM was used for the chemical analyses (conducted in duplicate). Homogenous subsamples of main ingredients were analysed for dry matter, crude protein, ether extract and gross energy (Table 3.1). Wheat and soybean meal was obtained from Riverina Stockfeed and stored in vermin proof feed storage facilities at UNE. All other ingredients were also obtained locally and stored at UNE feed mill and used from the same lots to overcome any changes of nutrient composition or quality in between batches.

#### **3.2.2. Birds and Housing**

A total of 96 Hy-Line brown layers were housed for this experiment. These hens were from the previous feeding experiment described in Chapter 2. At the end data collection of first experiment at 41 weeks of age, hens were fed a commercial control diet for five weeks. At 46 weeks of age 96 hens were randomly re-distributed to the three dietary treatments group (150 g/kg CPCM, 150 g/kg ECM and 150 g/kg SCM) and offered test diets. There were 32 replicates in each group. Hens were reared and housed in the same open sided shed in Laureldale, in cages (one bird/cage) with standard constant 16 hrs lighting as per breeder's recommendation. Water supply, health, temperature and feed were checked on a daily basis, top up feed whenever needed and filled logbook and signed and eggs were collected on a daily basis.

**Table 3.1: Dry matter (DM), crude protein (CP), ether extract (EE) and gross energy (GE) composition of main ingredients (wheat, three types of canola meal and soybean meal) used in this feeding trial.**

Ingredients	DM (g/kg)	CP (g/kg), as is basis	EE (g/kg), as is basis	GE (MJ/kg), as is basis
Wheat, Wet Chem UNE	900.0	132.0	30.4	-
CPCM				
Wet Chem UNE	902.0	345.0	129.0	20.4
NIR Evonik/Creswell	927.3	355.0	110.0	-
ECM				
Wet Chem UNE	961.0	395.0	92.0	20.6
NIR Evonik/Creswell	909.0	360.0	80.0	-
SCM				
Wet Chem UNE	878.0	379.0	35.0	17.8
NIR Evonik/Creswell	962.0	370.0	20.0	-
Soybean meal,				
Wet Chem UNE	893.0	462.4	33.0	-

Wheat based diets were formulated (Table 3.2) using appropriate nutrient specifications for the three canola meals (Appendix 1) to meet nutrient requirements of the hens. The diets were formulated by a practicing commercial nutrition consultant and mixed at UNE feed mill every four weeks. All diets were formulated to contain 150 g/kg of the various canola meals and to have reasonably similar energy and protein content using David Creswell's ingredient nutrient matrix database. All diets were offered as mash. Birds were given *ad libitum* access to feed and water. Initial and final body weight was recorded. Eggs were collected, weighed and recorded on a daily basis to be obtained hen day egg production (HDEP), egg size and egg mass. Feed intake was recorded monthly. Birds were monitored closely and a "daily record of care" log book filled and signed daily including temperature. HDEP, egg mass and FCR were calculated as per formula described in section 2.2.2. The total data collection period was 20 weeks (46 to 65 weeks of age).

### 3.2.3 Animal ethics

All experimental procedures were reviewed and approved by the Animal Ethics Committee of the University of New England, Armidale, NSW, Australia with an approval number of AEC 15-070.

### 3.2.4 Egg assays

Eggs were analysed at 65 weeks of age for internal and external quality. Measurements were taken at UNE Egg Quality Laboratory as described in section 2.2.3.

**Table 3.2: Ingredient and calculated nutrient composition of experiments diets used for feeding study**

Ingredient (g/kg)	AU\$/mt*	150 g/kg CPCM	150 g/kg ECM	150 g/kg SCM
Wheat 11 (xylanase)	270	713.9	721.8	717.8
Soybean meal Argentina	720	39.0	32.0	30.0
Cold pressed canola meal	450	150.0	-	-
Expeller canola meal	450	-	150.0	-
Solvent canola meal	450	-	-	150.0
DCP 18	700	1.6	1.7	1.8
Limestone powder	110	43.0	42.5	43.0
Limestone grit/chips	110	43.0	42.5	43.0
Canola oil	1150	2.0	2.0	8.0
Salt	240	2.3	2.0	1.9
Sodium bicarbonate	540	1.0	1.0	1.0
l Lysine	2,000	1.8	2.1	2.1
dl methionine	5,500	0.80	0.86	0.85
l Threonine	2,750	0.40	0.33	0.32
Econase XT (xylanase)	2,000	0.06	0.06	0.06
Quantum Blue (phytase)	16,000	0.12	0.12	0.12
Vitamins/trace minerals *	5,000	1.00	1.00	1.00
Pigment Red	75,000	0.04	0.04	0.04
Pigment Yellow	85,000	0.03	0.03	0.03
Total, g		1000.00	1000.00	1000.00
Feed cost (\$/kg)		0.3240	0.3217	0.3259
Calculated nutrients <sup>¶</sup>				
ME, MJ/kg			11.72	
SID, %				
Lysine			0.73	
Methionine			0.33	
M+C			0.63	
Tryptophan			0.15	
Threonine			0.54	
Arginine			0.75	
Isoleucine			0.55	
Valine			0.65	
Calcium (g/kg)			36.0	
Available Phosphorus (g/kg)			3.0	
Sodium (g/kg)			1.8	

CPCM= Cold pressed canola meal; ECM= expeller canola meal; SCM= Solvent canola meal

\* Vitamin concentrate supplied per kg of diet: Vitamin A, 10,000 iu; Vitamin D, 3,000 iu; Vitamin E, 20 mg; Vitamin K, 3 mg; Nicotinic acid 35 mg; Pantothenic acid, 12 mg; Folic acid, 1 mg; Riboflavin B2, 6 mg; Cyanocobalamin, 0.02 mg; Biotin, 0.10 mg; Pyridoxine (B6), 5mg; Thiamine B1, 2 mg. Trace mineral concentrate supplied per kg of diet: Copper, 8 mg; Cobalt, 0.2 mg; Molybdenum, 0.5 mg; Iodine, 1 mg; Selenium, 0.3 mg; Iron, 60 mg; Zinc, 60 mg; Manganese, 90 mg; Antioxidant, 20 mg.

\* Costs are based on local market prices in August 2015

<sup>¶</sup> Nutrients are based on the nutrient matrix of David Creswell.

### **3.2.4 Sensory Evaluation**

Sensory evaluation was conducted as described in Chapter 2 (section 2.2.4).

### 3.2.5 Statistical analysis

Data for each month were analysed separately as main effects. The performance data such as FI, FCR, BW, HDEP, egg size, egg mass, egg quality parameters were analysed using the General Linear Models (GLM) procedures of SPSS options, Version 22 (SPSS Inc, 2016) for the main effects of three different types (cold pressed, expeller and solvent) canola meals. Separation of means within a significant effect was done by the Duncan's Multiple Range Test (DMRT) through post hoc procedure of SPSS. Significance levels were set at  $P < 0.05$  unless otherwise specified.

## 3.3 Results

### 3.3.1 Performance

#### Body weight, feed intake (FI), FCR, HDEP, egg size and egg mass

Feed intake was higher ( $P < 0.01$ ) in layers fed 150 g/kg ECM and SCM based diets compared to CPCM (117.3, 113.8 vs 110.7 g/b/d respectively) for the 4 week production period (Table 3.3). However, no difference ( $P > 0.05$ ) was found for FCR, HDEP, egg size and egg mass for this production period for 150 g/kg CPCM, 150 g/kg ECM and 150 g/kg SCM treatments.

**Table 3.3: Influence of three different types of CM on the performance of Hy-Line brown layers from 46 weeks to 49 weeks of age (0-4 weeks of feeding period)**

	150 g/kg	150 g/kg	150 g/kg	SEM	P values
Performance parameter	CPCM	ECM	SCM		
Initial BW (45 weeks, g/d)	2155.9	2167.2	2178.1	22.1	0.921
FI (g/b/day)	110.7 <sup>b</sup>	113.8 <sup>ab</sup>	117.3 <sup>a</sup>	0.87	<0.01
FCR (g feed/g egg mass)	1.93	1.92	1.95	0.02	0.77
HDEP (%)	94.0	95.4	95.9	0.71	0.53
Egg weight (g/egg)	62.1	62.5	62.8	0.37	0.76
Egg mass (g/day)	58.4	59.5	60.1	0.53	0.40

Initial BW= Initial body weight; FI = feed intake; FCR= feed conversion ratio; HDEP= hen day egg production; SEM= standard error of mean; <sup>a, b</sup> Values with unlike superscripts within each row are significantly different ( $P < 0.05$ ).

The feed intake difference observed early continued through 16 weeks of production for CPCM, ECM and SCM treatments (Table 3.4). Feed intake was higher ( $P < 0.01$ ) in hens fed SCM and ECM than CPCM (117.2, 113.9 and 111.7 g/b/d respectively). No differences ( $P > 0.05$ ) were found for FCR, HDEP, egg size and egg mass between the three dietary treatments groups during the 16 weeks of production period.



**Table 3.4: Influence of three different types of CM on the performance of Hy-Line brown layers from 46 weeks to 61 weeks of age (0-16 Weeks of feeding period)**

	150 g/kg	150 g/kg	150 g/kg	SEM	P Values
Performance parameter	CPCM	ECM	SCM		
FI (g/b/day)	111.7 <sup>b</sup>	113.9 <sup>ab</sup>	117.2 <sup>a</sup>	0.76	<0.01
FCR (g feed/g egg)	1.91	1.90	1.98	0.02	0.11
HDEP (%)	94.1	95.5	93.8	0.53	0.39
Egg weight (g/egg)	62.9	63.3	63.6	0.39	0.79
Egg mass (g/day)	59.2	60.4	59.6	0.46	0.56

FI = feed intake; FCR= feed conversion ratio; HDEP= hen day egg production; SEM= standard error of mean; <sup>a, b</sup> Values with unlike superscripts within each row are significantly different (P<0.05).

FCR was significantly lower in layers fed CPCM and ECM than SCM (2.03, 2.03 vs 2.37 respectively; P < 0.01) from 62 to 65 weeks of age. Similarly, higher HDEP (92.6, 93.8 and 85.0% respectively) and higher egg mass (58.1, 59.1 and 53.9 g/d respectively; P < 0.01) were also observed in the same treatment group hens. No differences body weight (at 65 weeks of age), FI or egg size were observed during this period (P<0.05).

**Table 3.5: Influence of three different types of CM on the performance of Hy-Line brown layers from 62 to 65 weeks of age (17-20 weeks of feeding period)**

	150 g/kg	150 g/kg	150 g/kg	SEM	P values
Performance parameter	CPCM	ECM	SCM		
Finish BW (at 65 weeks, g/b)	2169.7	2219.4	2236.5	22.60	0.462
FI (g/b/day)	117.0	119.4	120.1	0.85	0.28
FCR (g feed/g egg mass)	2.03 <sup>b</sup>	2.03 <sup>b</sup>	2.37 <sup>a</sup>	0.06	<0.01
HDEP (%)	92.6 <sup>a</sup>	93.8 <sup>a</sup>	85.0 <sup>b</sup>	1.17	<0.00
Egg weight (g/egg)	62.8	63.1	63.1	0.48	0.96
Egg mass (g/day)	58.1 <sup>a</sup>	59.1 <sup>a</sup>	53.9 <sup>b</sup>	0.78	<0.01

BW= Body weight; FI = feed intake; FCR= feed conversion ratio; HDEP= hen day egg production; SEM= standard error of mean; <sup>a, b</sup> Values with unlike superscripts within each row are significantly different (P<0.05).

A difference was observed for cumulative FI (P < 0.02) and FCR (P < 0.01) for the CPCM, ECM and SCM treatments during the entire 20 week production period (Table 3.6). Significantly lower FI (112.8, 115.0 vs 117.7 g/b/d respectively) and lower FCR (1.93, 1.92 vs 2.06 g feed/ g egg mass respectively) found in layers fed diets contains 150 g/kg CPCM and ECM compared to layers fed 150 g/kg SCM for this period. However no differences (P > 0.05) in HDEP, egg size and egg mass were observed between the treatments during the 20 week production period. No mortality was observed.

**Table 3.6: The cumulative influence of three different types of CM on the performance of Hy-Line brown layers from 46 to 65 weeks of age (0-20 Weeks of feeding period)**

	150 g/kg	150 g/kg	150 g/kg	SEM	P values
Performance parameter	CPCM	ECM	SCM		
FI (g/b/d)	112.8 <sup>b</sup>	115.0 <sup>ab</sup>	117.7 <sup>a</sup>	0.75	<0.02
FCR (g feed/g egg mass)	1.93 <sup>b</sup>	1.92 <sup>b</sup>	2.06 <sup>a</sup>	0.02	<0.01
HDEP (%)	93.8	95.1	92.0	0.57	0.08
Egg weight, (g/egg)	62.9	63.2	63.5	0.41	0.83
Egg mass (g/day)	59.0	60.1	58.5	0.47	0.33

BW= Body weight; FI = feed intake; FCR= feed conversion ratio; HDEP= hen day egg production; SEM= standard error of mean; <sup>a, b</sup> Values with unlike superscripts within each row are significantly different (P<0.05).

### 3.3.2 Egg Quality

No effects on external egg shell quality (such as translucency score, shell reflectivity, breaking strength, deformation, shell weight, shell % and shell thickness) or internal egg quality (such as albumen height and Haugh unit) due to added three different types of canola meals at 150 g/kg inclusion were observed (P > 0.05; Table 3.7). However yolk colour score was higher in eggs from hens fed SCM and ECM compared to CPCM (11.23, 11.47 vs 10.87 respectively; P < 0.03). Sensory evaluation on samples of eggs from any treatment did not reveal the presence of “fishy taint”.

### 3.3.3 Economics of using different types canola meal in layer diet

Feed cost per kg of egg production are given in Table 3.8. Feed cost per kg/egg was lowest in hens fed ECM followed closely by CPCM and finally SCM. The greatest differences were found between at 5 - 8 weeks (P < 0.00), 0 - 8 weeks (P < 0.004), 9 - 12 weeks (P < 0.002), 0 - 12 weeks (P < 0.001), 13 - 16 weeks (P < 0.007), 0 - 16 weeks (P < 0.001), 17 - 12 weeks (P < 0.003) and 0 - 20 weeks (P < 0.00). Feeding layers with CPCM or ECM at 150 g/kg inclusion level was more economically beneficial than SCM at the same inclusion level.

**Table 3.7: Measures of egg quality parameters (internal and external) fed diets based on three different canola meals at 150 g/kg inclusion level at late lay (65 weeks of age) production period for Hy-Line Brown hens.**

Performance parameter	At 65 weeks of age (last lot of eggs)			SEM	P values
	150 g/kg CPCM	150 g/kg ECM	150 g/kg SCM		
Shell Quality					
Translucency score	3.25	3.25	3.31	0.04	0.76
Shell reflectivity (%)	18.7	19.0	18.1	0.33	0.53
Egg weight (g)	62.4	61.7	63.3	0.52	0.49
Breaking strength (N)	39.1	36.9	38.7	0.73	0.43
Deformation (µm)	245.0	235.7	248.0	3.71	0.37
Shell weight (g)	5.75	5.66	5.93	0.05	0.11
Shell (%)	9.24	9.19	9.41	0.08	0.50
Shell thickness (µm)	405.7	398.0	412.0	2.89	0.14
Internal Quality					
Albumen height (mm)	9.12	8.96	8.58	0.17	0.43
Haugh Unit	93.9	94.2	90.6	1.16	0.38
Yolk colour score	10.87 <sup>b</sup>	11.47 <sup>a</sup>	11.23 <sup>ab</sup>	0.09	<0.03
Egg yolk sensory evaluation*	None	None	None	-	-

CPCM: Cold pressed canola meal; ECM: Expeller canola meal; SCM: Solvent pressed canola meal; SEM: Standard Error of mean; a, b Values with unlike superscripts within each row are significantly different (P<0.05). \*Egg yolk scored for Fishy Taint (0 none to 3 strong) by sniffing.

**Table 3.8: Feed cost (\$) per kg egg production for brown egg layers for 0-20 weeks feeding period (46 to 65 weeks of age) with three different types of canola meals.**

Weeks	150 g/kg CPCM* Cost (\$/ kg egg )	150 g/kg ECM* Cost (\$/ kg egg)	150 g/kg SCM* Cost (\$/ kg egg)	SEM	P value
0-4	0.616	0.613	0.644	0.007	0.111
5-8	0.595 <sup>b</sup>	0.603 <sup>b</sup>	0.647 <sup>a</sup>	0.006	<0.000
0-8	0.605 <sup>b</sup>	0.608 <sup>b</sup>	0.645 <sup>a</sup>	0.006	<0.004
9-12	0.592 <sup>b</sup>	0.601 <sup>b</sup>	0.643 <sup>a</sup>	0.006	<0.002
0-12	0.601 <sup>b</sup>	0.606 <sup>b</sup>	0.645 <sup>a</sup>	0.005	<0.001
13-16	0.642 <sup>ab</sup>	0.610 <sup>b</sup>	0.677 <sup>a</sup>	0.009	<0.007
0-16	0.611 <sup>b</sup>	0.607 <sup>b</sup>	0.653 <sup>a</sup>	0.006	<0.001
17-20	0.650 <sup>b</sup>	0.649 <sup>b</sup>	0.783 <sup>a</sup>	0.019	<0.003
0-20	0.619 <sup>b</sup>	0.615 <sup>b</sup>	0.679 <sup>a</sup>	0.007	<0.000

CPCM: Cold pressed canola meal; ECM: Expeller canola meal; SCM: Solvent pressed canola meal; SEM: Standard Error of mean; a, b values across a row with different letters are significantly different (P<0.05). \*Considered same price of \$450/mt for all processed CM.

### 3.4 Discussion of results (compared with the objectives)

There were no differences in HDEP, egg size or egg mass between the three different types of CM at 150 g/kg during the 20 week production period. However, FI was increased and FCR higher in the SCM relative to hens fed CPCM and ECM. This may be due to differences in diet AME (SCM diet lower AME than CPCM and ECM), the various processing techniques, or variable quality of CM as

observed in broilers by Toghyani *et al.* (2015). Cold pressed canola meal appears to have more available nutrients to support FI and FCR compared to other two CM.

Egg quality was not affected by CM source (in both external and internal) for three treatments except yolk colour score being lower in the CPCM treatment. This may be due to higher ether extract content compared to other meal sources.

In this study, no fishy taint was detected in yolk through sensory evaluations for any of the meals tested.

From this study, it is apparent that both ECM and CPCM are more economical to use compared to SCM (at the nutrient specifications for ingredients and diets used) in terms of feed cost per kg of egg production using the same price for each meal.

### **3.5 Implications**

The two experiments conducted clearly confirm that CPCM can be added up to 200 g/kg and all CM can be added up to 150 g/kg in feed for Hy-Line Brown egg layers without compromising production performance. No fishy taint was detected with the small numbers of hens used (99 in the experiment 1 and 96 in experiment 2). While this is favourable, it might not be considered comprehensive evidence given the low incidence of fishy taint (5 to 10% of hens) before elimination of the defective FMO3 gene. The CPCM and ECM appeared to give more favourable economics than the SCM however further work is required to ascertain whether this is due to formulation or actual meal quality and nutrient content. Yolk scores were highest with ECM. This was unexpected as the reduced heat applied to CPCM would have been expected to maintain any xanthophyll present. At the time of the experiment, and using delivered feed mill prices of \$450/mt and \$650/mt for cold pressed canola meal and soybean meal, using 200 g/kg CPCM would reduce finished feed cost by \$25/mt.

### **3.6 Recommendations**

It can be concluded that the problem of “fishy taint”, which previously prevented use of canola meal at high levels, appears to be no longer present in the Hy-Line brown egg strain and likely other commercially popular strains. CPCM may be successfully included at levels of at least 200 g/kg in commercial brown-egg laying hen diets without compromising production performance or egg quality and may reduce cost of feed by \$25/mt. Similarly, ECM and SCM may be included at levels

of at least 150 g/kg. Higher inclusions levels may be safe and economic but were not evaluated in this study. These results should be disseminated in a series of seminars inviting key layer nutritionists and producers.

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As part of the Final Report requirements, authors need to provide a one page, plain English Compendium summary along with each Final Report in electronic and hard copy format. These compendium summaries are published in Poultry CRC's Annual Report. A template for the summary can be found below, following the completed example.

Note that this one-page summary will be read by people without expertise in the field of study. It should therefore be as easy to read and understand as possible

### Plain English Compendium Summary

Sub-Project Title:	Inclusion levels and economic benefits of canola meals on egg production of laying hens
Poultry CRC Sub-Project No.:	2.1.17
Researcher:	Robert A Swick
Organisation:	University of New England, Armidale, NSW 2351
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Sub-Project Overview	Increase profitability of layers fed relatively higher canola meal
Background	As of 2015 all laying stock derived from these genetic lines in Australia are devoid of the defective FMO3 gene and can be fed high levels of CM. This allows higher levels of sinapine, choline and betaine to be fed without any adverse consequences. CM is a highly digestible protein source with higher levels of methionine and cysteine than soybean meal. In addition, it has higher levels of crude fibre than soybean meal that is considered beneficial in layer diets. Australia is a large canola producer, harvesting around 3.5 million tonnes of seed annually (Australian Oilseeds Federation, 2014). Around 2 m tonnes are exported and over 1 m tonnes is processed into oil and around 490,000 mt of 350-380 g/kg protein CM. Yet in 2014 Australia imported 675,000 mt of expensive soybean meal with a significant portion used for layer feed. So therefore, there is a clear possibility to use CM at higher level instead of expensive soybean meal to reduce feed costs and perhaps increase profitability.
Research	The present study confirmed an opportunity to include CM in the Hy-Line Brown strain from 150 to 200 g/kg without compromising

	<p>production performance and egg quality. Birds fed cold pressed and expeller CM had better performance than those fed solvent CM using the same price for each CM. Cost per kg egg depends on relative meal prices and other ingredients in each diet. No fishy taint was detected with the small numbers of hens used (99 in the experiment 1 and 96 in experiment 2). While this is favourable, it might not be considered comprehensive evidence given the low incidence of fishy taint (5 to 10% of hens) before elimination of the defective FMO3 gene.</p>
Implications	<p>Cold pressed, expeller and solvent CM can be included up to 150 g/kg in diets for Hy-Line Brown egg layers resulting in significant feed cost savings. Inclusion of cold pressed CM was examined at 200 g/kg giving cost savings of \$25/mt of feed. This is roughly equivalent to industry savings of AUD 18 M per annum at prevailing ingredient costs.</p>
Publications	<p>Bhuiyan M.M., Creswell D.C. and Swick R.A. 2016. Effect of graded levels of cold pressed canola meal on egg production parameters in brown laying hens. In: proceedings of World Poultry Congress, Beijing, China, 5-9 Sept 2016.</p> <p>Three conference papers have been accepted for presentation at the 2017 Australian Poultry Science Symposium, University of Sydney, Australia.</p>



## Appendix 1

### COSCANOLAMEALSPECS

Memo to Andrew:

The nutrient specs of the 3 types of canola meals are shown below. The major differences are in the amounts of oil and energy, so we have 11%, 8% and 2% and 2650, 2400 and 2000 kcal/kg ME for cold pressed, expeller and solvent respectively.

All 3 are quite different due to these differences and should not be mixed or one replaced with another. They need to be separately formulated.

David

	COLD PRESSED	EXPELLER	SOLVENT
ME, Kcal/kg	2650	2400	2000
Protein	35.5	36	37
SID, %			
Lysine	1.62	1.600	1.600
Methionine	0.600	0.588	0.589
MC	1.440	1.344	1.345
Tryptophan	0.344	0.344	0.345
Threonine	1.218	1.310	1.351
Arginine	1.807	1.805	1.863
Isoleucine	1.183	1.226	1.255
Valine	1.496	1.419	1.469
Calcium, %	0.60	0.60	0.600
Avail P, %	0.20	0.20	0.200
Sodium, %	0.004	0.09	0.09
Choline, ppm	2000	2000	2000
Fat, %	11	8	2