

Optimizing canola meal feeding to broiler chickens and egg layers

Matt A. Oryschak
Eduardo Beltranena[©]



Canola Industry in Canada

- Canola contributes ~\$20B/y to Canadian economy.
- Canola crop generates 1/4 of all farm cash receipts.
- Canada's plants process ~10M tonnes of seed/year.
- ~40% of seed, >80% of oil and meal are exported.
- Largest buyer is the United States, ~55% oil, 95% meal.
- Raw seed is exported to China, Japan, Mexico, USA.

<http://www.canolacouncil.org>

¢/unit of AVAILABLE nutrient

Lysine	Canola ¹	SBM ²	DDGS ³
¢/kg	0.310	0.500	0.250
% lysine	2.00	2.80	0.74
AID coeff	0.78	0.90	0.71
% AID lysine	1.56	2.52	0.53
g AID lys/kg	15.60	25.20	5.25
¢/g AID lys	0.020	0.020	0.048

Met+Cys	Canola ¹	Soya ²	DDGS ³
¢/kg	0.310	0.500	0.250
% met+cys	1.60	1.35	1.00
AID coeff	0.77	0.85	0.82
% AID met+cys	1.23	1.15	0.82
g AID met+cys/kg	12.32	11.48	8.20
¢/g AID met+cys	0.025	0.044	0.030

AMEn	Canola ¹	Soya ²	DDGS ³
¢/kg	0.310	0.500	0.250
Mcal/kg	2.000	2.440	2.075
¢/Mcal	0.155	0.205	0.120

¹Canola Council Guide 4th Ed 2009

² NRC 9th Ed. 1994

³ <http://www.ddgs.umn.edu/ppt-poultry/> 11% EE

Phosphorus	Canola ¹	Soya ²	DDGS ³
¢/kg	0.310	0.500	0.250
% P	1.06	0.62	0.74
ATD coeff	0.38	0.35	0.61
% available P	0.40	0.22	0.45
g available P/kg	4.00	2.20	4.51
¢/g available P	0.078	0.227	0.055

Canola Meal for Poultry



- 30% TDF
 - 8 - 11% crude fibre
 - 15 - 19% ADF, 25 - 28% NDF
- No starch, 7-8% sugars
- 2.5% fat, mostly gums
- **Cake 10-20% remaining oil**
- Glucosinolates $\sim 5 \mu\text{mol/g}$
- Phytic acid 3%
- Tannins 1.5%
- Sinapine 1%

Canola meal in broiler diets

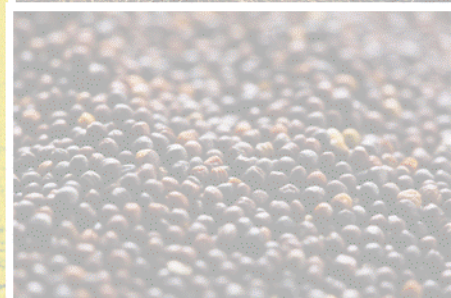
Effects of graded inclusions of
B. napus, *B. juncea*, vs. SBM

Matt Oryschak and
Eduardo Beltranena

Government of Alberta ■

Agriculture and Rural Development

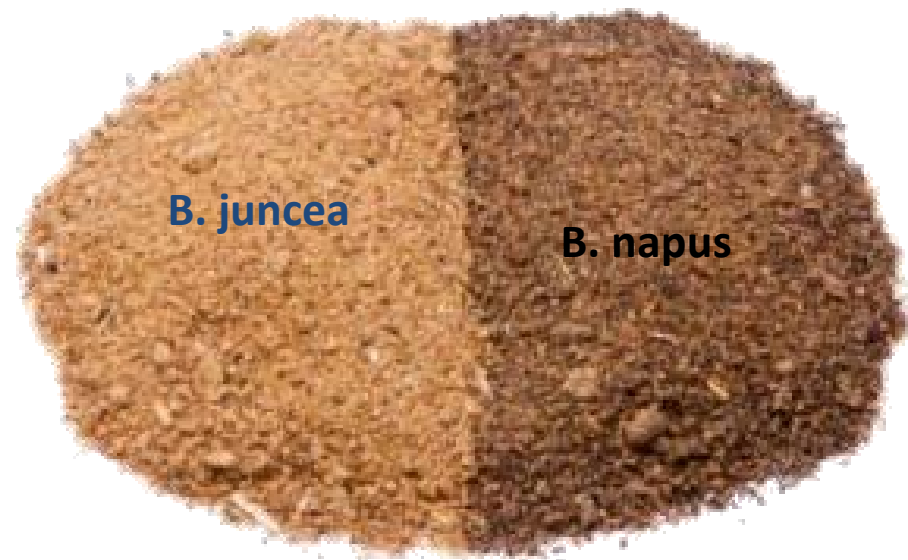
Alberta Agriculture and Rural Development ©



B. juncea (yellow), *B. napus* (dark)

- *B. Juncea* canola meal potentially has a higher energy value
 - Yellow, more attractive meal
 - Lower meal fibre content due to thinner seed coat
 - Greater glucosinolate content (~11 vs. 3.5 $\mu\text{mol/g}$)
 - Lower antinutritional factors (phytate, tannins, sinapine)

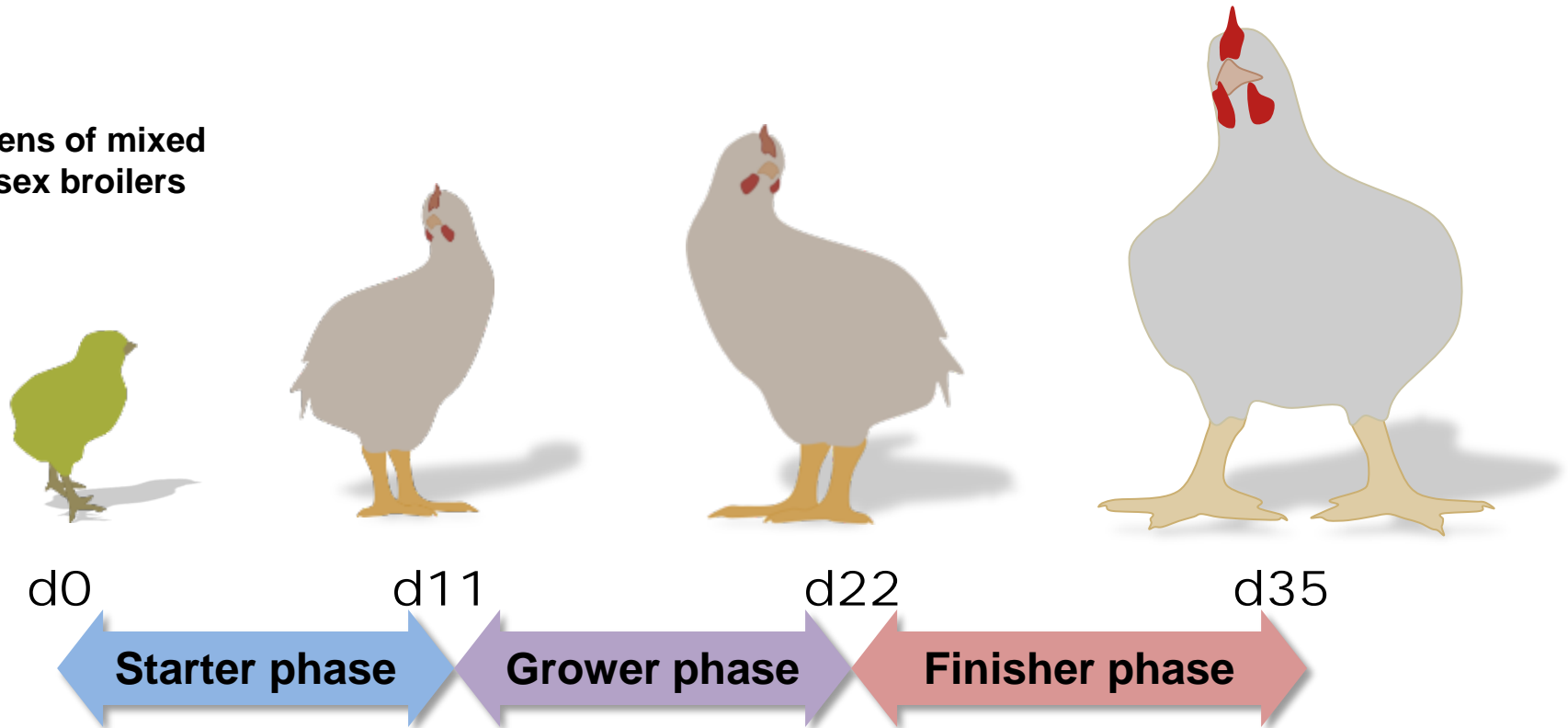
	<i>B.</i> <i>Juncea</i> <u>'yellow</u> <u>CM'</u>	<i>B.</i> <i>Napus</i> <u>'dark</u> <u>CM'</u>
Protein, %	39.1	38.9
ADF, %	13.4	18.2
NDF, %	19.8	27.2
Avail. lysine	1.85	1.82



Our approach

- Phase-specific diets including 0%, 10%, 20% or 30% *B. napus* or *B. juncea* canola meal

Pens of mixed sex broilers



Growth Performance

	Dietary inclusion level of CM, %							<i>P</i> -value Diet
	SBM	<i>B. napus</i>			<i>B. juncea</i>			
		10%	20%	30%	10%	20%	30%	
Wt d35, g	2284	2236	2282	2269	2300	2312	2261	0.487
ADG, g	61.9	60.7	62.0	61.7	62.5	62.9	61.4	0.768
ADFI, g	106.8	107.1	106.7	107.3	107.5	107.9	108.4	0.903
Gain:feed	0.614	0.607	0.625	0.616	0.621	0.614	0.606	0.736

Yield of Carcass Components

%	Dietary inclusion level of CM, %							P-value Diet
	SBM	<i>B. napus</i>			<i>B. juncea</i>			
		10%	20%	30%	10%	20%	30%	
<i>P. major</i>	24.0 ^b	25.3 ^a	25.3 ^a	25.1 ^a	24.7 ^{ab}	25.4 ^a	25.4 ^a	0.012
<i>P. minor</i>	5.0 ^c	5.3 ^{ab}	5.3 ^{ab}	5.4 ^{ab}	5.3 ^{ab}	5.2 ^{bc}	5.5 ^a	0.007
Thighs	17.7	17.4	17.5	17.7	18.0	17.5	17.8	0.859
Drumsticks	14.0	13.7	13.9	13.9	13.9	13.9	13.6	0.593
Wings	11.0	11.0	11.0	11.5	11.0	11.2	11.3	0.840
Total saleable	71.6 ^b	72.6 ^{ab}	72.9 ^a	73.6 ^a	73.0 ^a	73.3 ^a	73.7 ^a	0.045

Revenue Over Feed Cost

	Dietary inclusion level of CM, %							P-value Diet
	SBM	<i>B. napus</i>			<i>B. juncea</i>			
		10%	20%	30%	10%	20%	30%	
\$/broiler placed	2.64 ^{abc}	2.58 ^c	2.63 ^{bc}	2.59 ^c	2.72 ^{ab}	2.74 ^a	2.59 ^c	0.004
\$/broiler placed (quota-adjusted)	1.92 ^{bc}	1.86 ^c	1.90 ^c	1.87 ^c	1.98 ^{ab}	2.01 ^a	1.89 ^c	<0.001
\$/ broiler marketed	2.73 ^{bc}	2.66 ^d	2.74 ^{bc}	2.70 ^{cd}	2.80 ^{ab}	2.86 ^a	2.74 ^{bcd}	<0.001
\$/ broiler marketed (quota-adjusted)	1.98 ^c	1.92 ^d	1.98 ^c	1.96 ^{cd}	2.04 ^{ab}	2.09 ^a	2.00 ^{bc}	<0.001

Conclusions

1. *B. napus* and *B. juncea* canola meal can be included at up to 30% of broiler diets without adverse effects on growth performance.
2. There was likely an AA response on breast yield and total saleable meat due to canola meal inclusions.

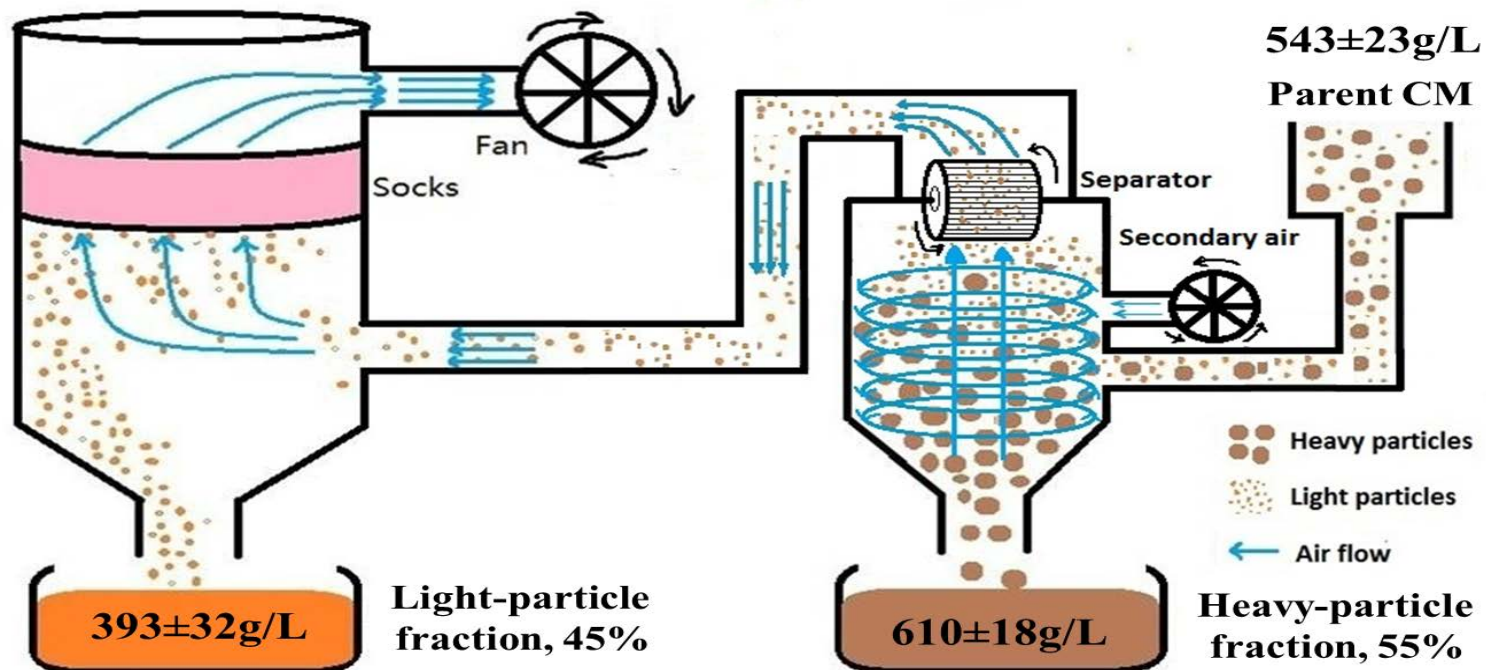
A photograph showing several white broiler chickens crowded together in a metal wire cage. The chickens are packed closely, with some visible through the bars. The cage floor is covered with a layer of brown, granular material, likely bedding or litter. The lighting is somewhat dim, and the overall scene suggests a high-density poultry farming environment.

**Broiler AME comparison of
B. napus, *B. juncea*, and
air-classified fractions**

**Matt Oryschak and
Eduardo Beltranena[©]**

AME value of canola meal

- Canola meal is relatively high in fibre, SE no oil.
- Low AME value limits inclusion in broiler feed.
- Increased AME is key to greater feed inclusions.
- Air classification shifts fibre creating fractions.



Air-Classified CM Fractions (90% DM)

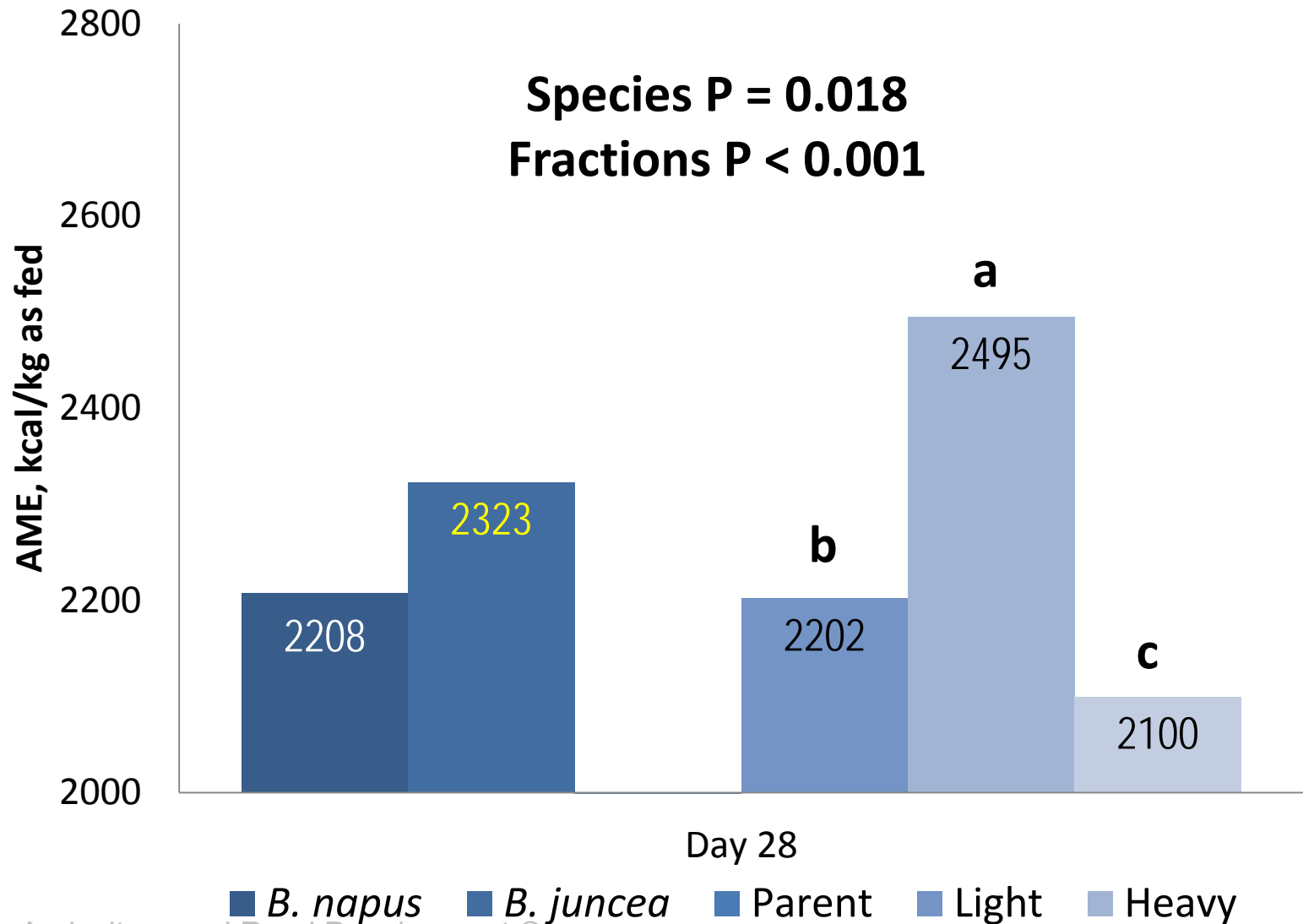
	<i>B. napus</i>				<i>B. juncea</i>		
%	Parent	Light	Heavy		Parent	Light	Heavy
CP	39.5	40.9	36.6		38.9	40.0	36.6
EE	2.2	4.0	2.0		1.8	3.1	1.7
CF	9.8	0.3	8.6		6.9	0.4	8.2
ADF	20.2	12.8	25.1		13.0	8.4	16.3
NDF	27.4	20.1	30.9		20.6	13.3	23.1
Av. Lys	1.8	2.2	1.9		1.9	1.9	1.6
Met	0.7	0.8	0.7		0.7	0.8	0.6
Thr	1.4	1.7	1.5		1.6	1.6	1.4
Try	0.5	0.5	0.5		0.4	0.5	0.4
Glucosinolates, μmol/g	6.4	4.6	3.8		11.8	9.6	8.8

Grower diets fed d14 - 35

		<i>B. napus</i>	<i>B. napus</i>	<i>B. napus</i>	<i>B. juncea</i>	<i>B. juncea</i>	<i>B. juncea</i>
	Control	Parent	Light fraction	Heavy fraction	Parent	Light fraction	Heavy fraction
CONTROL DIET		70.00	70.00	70.00	70.00	70.00	70.00
B. napus meal		30.00					
B. napus AC light fraction			30.00				
B. napus AC heavy fraction				30.00			
B. juncea meal					30.00		
B. juncea AC light fraction						30.00	
B. juncea AC heavy fraction							30.00
Corn grain	73.66						
Egg white, dry	12.66						
Cornstarch	7.14						
Mono-di-calcium phosphate	2.01						
Limestone	1.54						
Sunflower oil (high oleic)	1.43						
Vitamin/mineral premix	0.71						
Salt	0.33						
Lysine-HCl	0.33						
L-Arginine	0.14						
D,L-Methionine	0.04						

- Diets limiting in energy, but not in other nutrients
- Amino acids 110% on g dAA/Mcal
- Assumed AME for test ingredients was 2000 kcal/kg

B. napus, *B. juncea* and Fractions



Growth Performance

	<i>B. napus</i>	<i>B. juncea</i>	SEM	Parent stock	Heavy fraction	Light fraction	SEM	Spec	Frac
ADFI, g	98.9	95.6	1.2	97.1	98.2	96.4	1.5	0.070	0.698
ADG, g	75.1	76.0	0.8	73.4 ^b	75.9 ^a	77.3 ^a	0.9	0.256	0.002
Gain:Feed	0.760 ^b	0.798 ^a	0.010	0.757 ^b	0.774 ^{ab}	0.807 ^a	0.013	0.015	0.029

Carcass and Yield

	<i>B. napus</i>	<i>B. juncea</i>	SEM	Parent stock	Heavy fraction	Light fraction	SEM	Spec	Frac
Antemortem wt, g	2091.9	2114.7	18.7	2047.2 ^b	2114.7 ^a	2148.1 ^a	22.2	0.343	0.003
Carcass, g	1446	1449	3.7	1447 ^{ab}	1455 ^a	1441 ^b	4.6	0.572	0.095
Dress, %	68.71	68.88	0.20	68.72	69.16	68.51	0.20	0.508	0.111
Breast, %	31.19	30.84	0.18	31.36 ^a	31.16 ^a	30.53 ^b	0.22	0.168	0.023
Legs, %	31.60	31.71	0.04	31.62	31.69	31.65	0.05	0.624	0.968
Wings, %	11.10	11.09	0.09	11.16	11.03	11.09	0.11	0.939	0.463
Edible, %	73.87	73.66	0.09	74.09 ^a	73.90 ^a	73.31 ^b	0.10	0.250	0.002

Conclusions

- 200kcal AME diff Light vs. Parent; 100kcal diff Parent vs. Heavy.
- Feeding fractions 100g heavier birds at d35, 4% improvement.
- Overall ADFI, no diff *juncea* vs. *napus*; fractions vs. parent.
- Overall ADG 1g/d *juncea* vs. *napus*; 4g/d fractions vs. parent.
- Overall G:F, 5%↑ *juncea* vs. *napus*; 7%↑ light vs. parent.
- More breast (*P. minor*) and more edible meat for parent and heavy vs. light fractions, and more trim for light fractions suggest that **there was not enough dig AA for the extra AME in light fractions.**



Production of Brown Egg Layers
Fed Solvent-Extracted or Extruded-
Expelled *B. juncea* or *B. napus*

Matt Oryschak
Eduardo Beltranena[©]

Test ingredients

Nutrient, %	SE napus	EP napus	SE juncea	EP juncea
Moisture	10.57	6.58	8.99	5.02
Gross energy, Mcal/kg	4.38	4.92	4.34	4.91
Crude protein	37.69	34.60	38.40	35.87
Lysine, reactive	2.02	1.48	1.70	1.43
Methionine + Cysteine	1.77	1.44	1.44	1.33
Threonine	1.72	1.40	1.57	1.43
Tryptophan	0.46	0.44	0.45	0.48
Crude fat	2.52	11.94	2.56	9.93
Crude fiber	7.75	6.82	7.24	6.57
Acid detergent fiber	19.68	14.80	12.79	13.13
Neutral detergent fiber	27.60	22.30	22.26	22.03
Ash	7.60	6.19	7.35	6.74
Calcium	0.55	0.47	0.62	0.66
Phosphorus	0.98	0.90	1.09	0.99

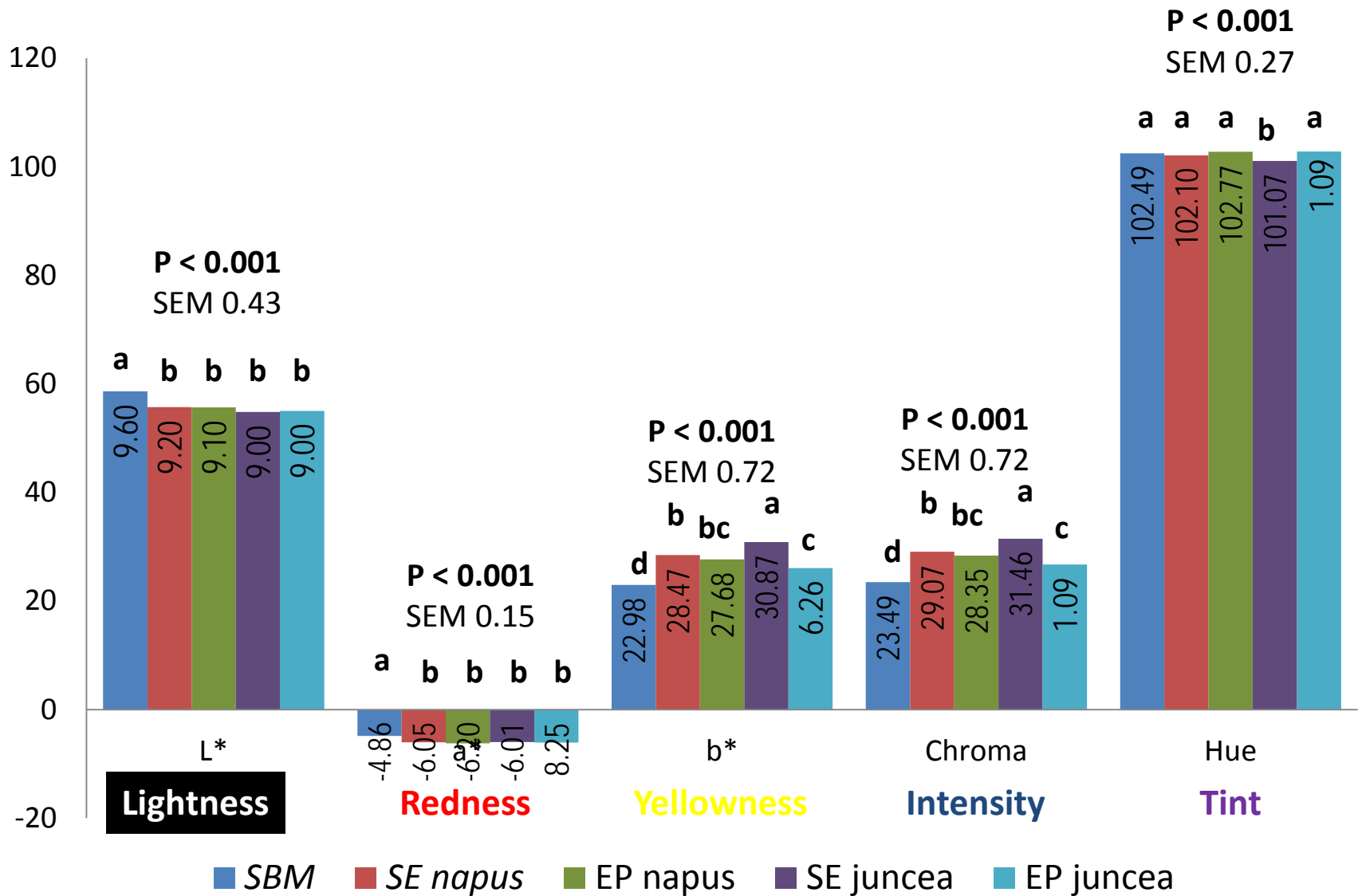
Phase 1 diets fed Wks 1 -24

Ingredient, %	SBM	SE	EP	SE	EP		Nutrient, %	SBM	SE	EP	SE	EP
		napus	napus	juncea	juncea				napus	napus	juncea	juncea
Barley grain	58.64	43.47	28.54	43.47	28.54		AME, Mcal/kg	2.8	2.8	2.8	2.8	2.8
Wheat grain		12.71	27.34	12.71	27.34		Crude protein	17.25	17.5	17.5	17.5	17.5
SE napus meal		20.00					Ether extract	8.4	7.8	8.0	7.8	8.0
EP napus meal			20.00				Linoleic acid	1.9	1.9	1.95	1.9	1.95
SE juncea meal				20.00			Calcium	3.7	3.7	3.7	3.7	3.7
EP juncea meal					20.00		Avail. phosp	0.43	0.43	0.43	0.43	0.43
Soybean meal	12.99	5.10	4.68	5.10	4.68		Sodium	0.17	0.17	0.17	0.17	0.17
Wheat DDGS	10.00	1.05	4.07	1.05	4.07		Chloride	0.17	0.17	0.17	0.17	0.17
Limestone	9.28	9.07	9.15	9.07	9.15		Magnesium	0.20	0.197	0.214	0.197	0.214
Canola oil	6.70	6.50	4.20	6.50	4.20		AID Lys	0.731	0.678	0.678	0.678	0.678
Vitamin premix	0.50	0.50	0.50	0.50	0.50		AID Met	0.397	0.352	0.373	0.352	0.373
Choline premix	0.50	0.50	0.50	0.50	0.50		AID Met+Cys	0.667	0.618	0.618	0.618	0.618
Mono-dical phos	0.49	0.45	0.40	0.45	0.40		AIDThr	0.526	0.478	0.478	0.478	0.478
Sodium bicarb	0.37	0.29	0.25	0.29	0.25		AIDTry	0.259	0.22	0.197	0.22	0.197
Salt	0.05	0.11	0.13	0.11	0.13		AID Arg	0.787	0.819	0.794	0.819	0.794
D,L - methionine	0.18	0.13	0.10	0.13	0.10		AID Ile	0.648	0.548	0.548	0.548	0.548
Lysine - HCl	0.15	0.06	0.07	0.06	0.07		AID Val	0.700	0.677	0.654	0.677	0.654
Threonine	0.10	0.01	0.02	0.01	0.02							
Enzyme	0.05	0.05	0.05	0.05	0.05							

36wks Layer Performance

		<i>B. napus</i>		<i>B. juncea</i>			
	SBM	Meal	Cake	Meal	Cake	SEM	P value
ADFD, g	109.4 ^{ab}	111.4 ^a	107.8 ^{bc}	105.9 ^c	110.8 ^{ab}	1.8	0.006
Egg wt, g	63.75 ^b	64.46 ^a	62.55 ^c	62.05 ^c	62.41 ^c	0.41	<0.001
Laying, %	95.59	94.92	95.32	96.52	96.42	0.67	0.368
Egg mass, g	60.99 ^a	61.40 ^a	59.44 ^b	60.05 ^b	60.15 ^b	0.66	<0.001
Egg:feed, g:g	0.558 ^{ab}	0.548 ^{bc}	0.549 ^{bc}	0.567 ^a	0.544 ^c	0.006	0.006
D252 wt, g	2193	2169	2093	2103	2174	41	0.325

Yolk Colour



Egg Fatty Acids

	SBM	SE napus	EP napus	SE juncea	EP juncea	SEM	P value
Fat, % of egg dry matter	35.77 ^a	35.30 ^{ab}	34.59 ^b	34.63 ^b	35.72 ^a	0.33	0.037
Fatty acids, % of total fat							
Total saturated	27.82 ^a	27.37 ^{ab}	27.00 ^b	27.09 ^b	27.44 ^{ab}	0.19	0.040
C16:0	20.31	19.79	19.79	19.71	20.33	0.21	0.069
C18:0	6.89 ^{ab}	7.00 ^a	6.64 ^{bc}	6.79 ^{abc}	6.53 ^c	0.14	0.044
Total monounsaturated	52.19 ^b	54.00 ^a	53.94 ^a	53.33 ^a	53.91 ^a	0.25	<.0001
C16:1	1.89	1.78	1.82	1.85	1.99	0.06	0.131
C9c-18:1	49.49 ^b	51.33 ^a	51.21 ^a	50.72 ^{ab}	51.04 ^a	0.26	<.0001
Total polyunsaturated	17.82 ^a	16.44 ^b	16.87 ^b	17.07 ^{ab}	16.70 ^b	0.28	0.021
C18:2(n6)	12.67 ^a	11.42 ^c	11.85 ^{bc}	12.29 ^{ab}	11.74 ^{bc}	0.23	0.008
C18:3(n3)	1.40 ^{ab}	1.22 ^c	1.28 ^{bc}	1.43 ^a	1.44 ^a	0.05	0.005
C20:4(n6)	1.67 ^{ab}	1.74 ^a	1.69 ^a	1.68 ^{ab}	1.59 ^b	0.03	0.043
C22:6(n3)	1.77	1.81	1.80	1.73	1.74	0.04	0.509
Total n3	3.48	3.28	3.33	3.38	3.37	0.06	0.281
Total long-chain n3	2.08	2.07	2.05	1.95	1.93	0.04	0.052
Total n6	14.34 ^a	13.16 ^b	13.54 ^b	13.69 ^{ab}	13.33 ^b	0.23	0.014
n3:n6	0.24	0.25	0.25	0.25	0.25	0.01	0.322

AME and AID%

	SE napus	EP napus	SE juncea	EP juncea	SEM	P value
AME, kcal/kg as fed	1973^b	2730^a	2184^b	2763^a	87	<0.001
AID, %						
Crude protein	74.16	70.15	73.01	72.83	1.37	0.268
Lysine	79.76^a	75.35 ^b	76.18 ^b	78.39 ^{ab}	1.13	0.046
Methionine	89.04^a	83.71 ^b	86.46 ^{ab}	84.92 ^b	1.08	0.014
Methionine + Cysteine	81.79^a	75.74 ^b	78.22 ^{ab}	76.99 ^b	1.43	0.040
Threonine	72.50	68.01	72.99	70.93	1.56	0.136
Tryptophan	91.87	88.81	91.37	92.02	1.28	0.281

Conclusions

- Excellent egg production (96% over 36 wks).
- Egg mass slightly greater for SE *napus* and SBM.
- No differences in egg physical characteristics.
- Darker yolk in eggs from layers fed CM vs. SBM.
- 0.25 n3:n6 fatty acids for all treatments.
- AME 10%↑ *juncea* vs. *napus*; 32%↑ cakes vs. meals.



Feeding canola meal or soybean meal-based diets at 2 energy densities to egg layers

Matt Oryschak,
Zahra Dehghani, and
Eduardo Beltranena[©]

Our Approach

- Evaluate replacing SBM with CM at two dietary energy densities on production and egg quality.
- H&N layers were housed 4/cage in a 3-tiered battery from 37 to 53 weeks of age (16 wks).
- 2 x 2 factorial:
 - CM or SBM-based diets
 - 2.6 or 2.9 Mcal AME/kg
 - 8 white, 8 brown layer cages per treatment

	Canola meal		Soybean meal	
Ingredient, %	2.6 Mcal/kg	2.9 Mcal/kg	2.6 Mcal/kg	2.9 Mcal/kg
Corn	8.64	32.18	-	4.81
Barley	29.15	17.80	51.89	8.08
Wheat	22.56	-	15.57	46.14
Soybean meal	-	-	12.64	16.86
Canola meal	20.40	24.13	-	-
Wheat DDGS	7.50	7.50	7.50	7.50
Canola oil		7.00		4.03
Sunflower oil	1.71		1.70	0.77
Salt	0.21	0.26	0.12	0.26
Sodium bicarbonate	0.06	0.12	0.25	0.13
Limestone	8.54	9.20	8.64	9.59
Mono/di-calcium phosp.	0.20	0.57	0.32	0.58
L - lysine - HCl	-	0.10	0.07	-
D,L - methionine	0.07	0.09	0.12	0.15
L - threonine	-	-	0.14	0.05
Superzyme™ Plus ¹	0.05	0.05	0.05	0.05
Vitamin – mineral premix ²	0.50	0.50	0.50	0.50
Choline premix ³	0.50	0.50	0.50	0.50

16wks Layer Performance

	Canola meal		Soybean meal		SEM	P -values		
	2.6 Mcal/kg	2.9 Mcal/kg	2.6 Mcal/kg	2.9 Mcal/kg		Meal	Energy	M x E
ADFD, g	121.1 ^a	114.7 ^b	120.7 ^a	119.4 ^a	0.8	0.002	<0.001	<0.001
Egg wt, g	63.53 ^b	62.82 ^c	63.60 ^b	65.38 ^a	0.30	<0.001	<0.001	<0.001
Laying, %	93.11	92.64	93.86	95.31	0.56	0.002	0.391	0.086
Egg mass, g	59.46 ^{bc}	58.59 ^{bc}	60.08 ^b	62.74 ^a	0.78	<0.001	0.023	<0.001
Egg:feed, g:g	0.489	0.503	0.490	0.520	0.010	0.080	<0.001	0.115
D112 wt, g	1959	2011	1997	2092	30	0.056	0.019	0.505

Egg Quality

	Canola meal		Soybean meal		SEM	P -values		
	2.6 Mcal/kg	2.9 Mcal/kg	2.6 Mcal/kg	2.9 Mcal/kg		Meal	Energy	M x E
Egg wt, g	63.26 ^b	62.06 ^c	62.80 ^{bc}	64.86 ^a	0.34	<0.001	0.213	<0.001
Albumen height, mm	4.83	4.91	5.01	4.89	0.09	0.367	0.861	0.292
Haugh units	65.06	65.88	66.98	65.00	0.98	0.657	0.644	0.190
Eggshell thickness, mm	0.333	0.329	0.325	0.333	0.004	0.531	0.649	0.086

Conclusions

- High feed intakes (~120g) despite M x E interaction.
- Extra-large egg wt (63g) and egg mass (60g) M x E.
- 2%↑ laying % feeding SBM vs. CM.
- 1.8% better feed efficiency feeding 2.9 vs. 2.6 Mcal.
- Extra energy went to body condition, not eggs
- 2.5%↑yolk, 4%↓shell feeding SBM vs. CM, but no difference in egg quality.

Income over feed cost for avg. AB flock per d	2.9 Mcal/kg, Canola meal	2.9 Mcal/kg, Soybean meal	2.6 Mcal/kg, Canola meal	2.6 Mcal/kg, Soybean meal
Overall (16 wks), \$	1457.36	1508.24	1555.36	1539.04

Broiler and Layer Conclusions

- Broilers and layers can be fed high CM inclusions.
- Focus on ¢/g digestible AA, Phos., \$/Mcal AME.
- Canola meal is not perfect, but give it a chance.
- ANFs less of a concern with poultry.
- Broilers and layers can readily utilize coproducts and fractions.
- Lower energy diets can result in greater profitability.

www.agric.gov.ab.ca, click...

- Information
 - Livestock Research
 - Monogastric Feed Research Group



Acknowledgements



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