Camelina sativa co-products as feedstuffs for poultry

Eduardo Beltranena & Matt Oryschak

Livestock Research Branch

Alberta Agriculture and Forestry

WESTERN POULTRY CONFERENCE
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RED DEER, ALBERTA, CANADA

Alberta Agriculture and Forestry

Presentation overview

- Camelina – an introduction
- Camelina cake as feedstuff
- Recent research with poultry
- Future research needs

K. Topinka,
University of Alberta

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Why Camelina ?

An introduction

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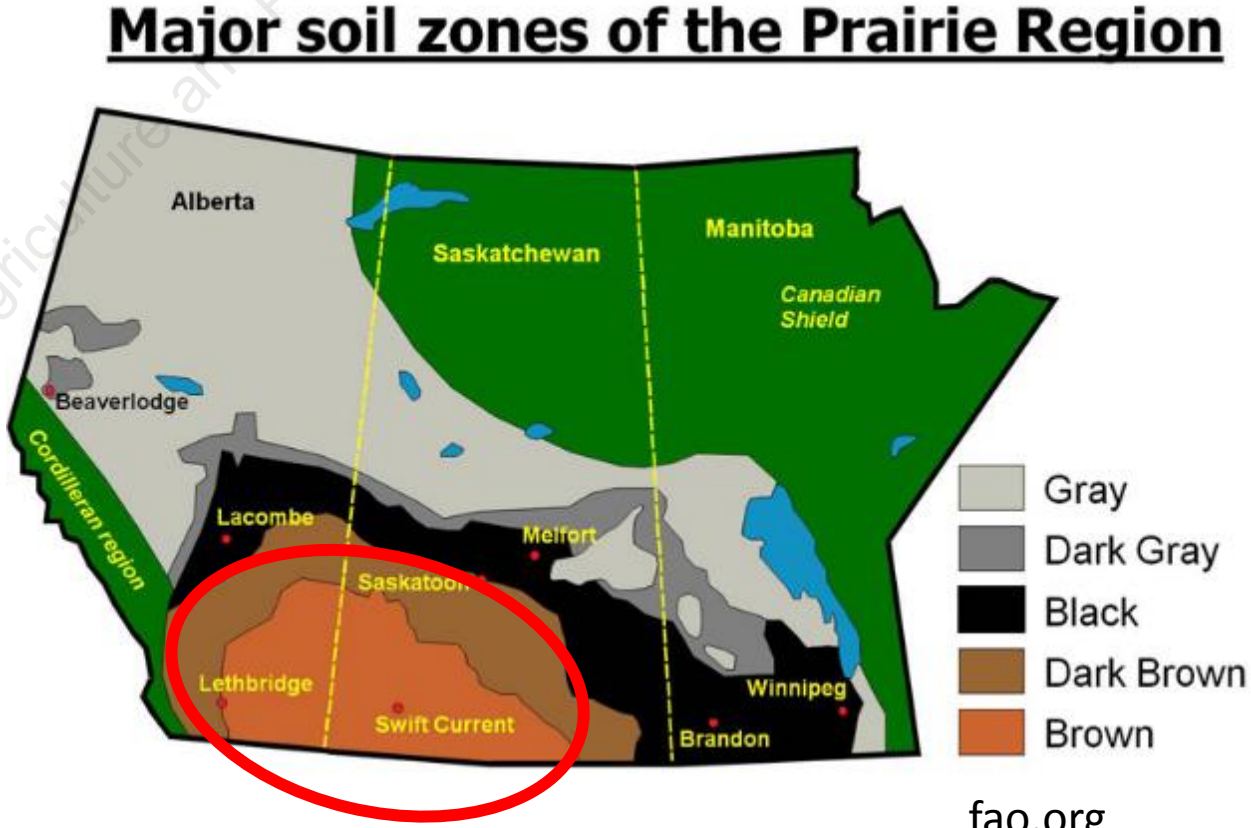
Trade Risk

- The all-eggs-in-one-basket known as ‘canola’
- COOL –What did we learn? What did it cost?
- We have had canola meal trade issues in the past
- Naïve thinking that trade issues won’t be back
- Diversifying oilseed production mitigates risk

Agronomy

- **Camelina would be best suited to Brown, Light Brown soils**
  - complement ***not*** compete with canola
  - Opportunity for 1-2 million new acres into oilseeds



fao.org

Agronomic comparison between camelina and canola

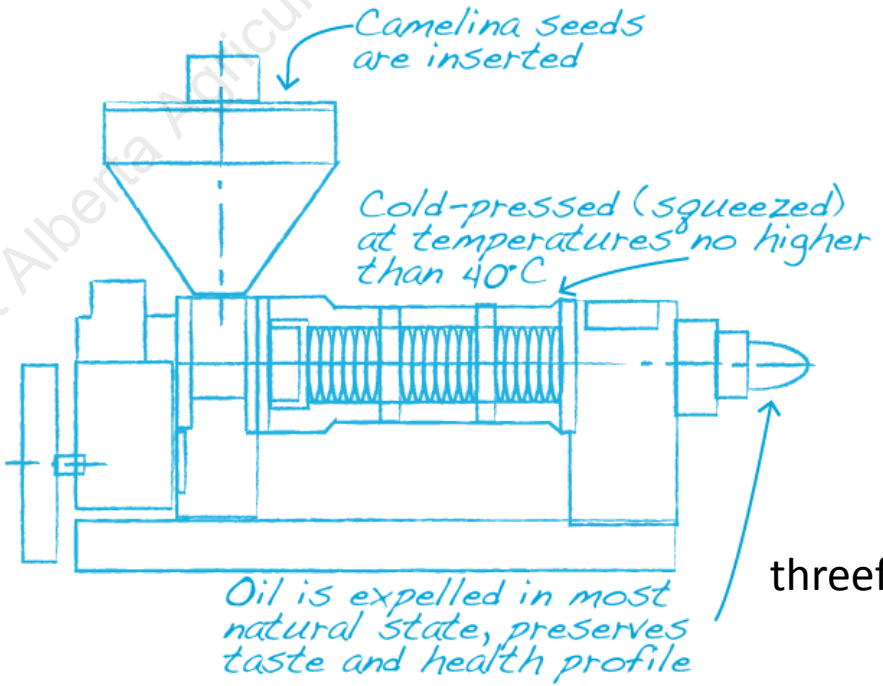
Characteristic	Canola	Camelina
Maturity	90-130 days	85-100 days
Drought resistance	+	+++
Pest resistance	+	+++
Yield	1170-1320 kg/ha	1100-1200 kg/ha
Seed size		¼ to ½ of canola
Oil content	~45%	38 – 43%
Protein content	26 – 30%	27 – 32%
Carbon footprint	570 kg CO_2 eq/T	564 kg CO_2 eq/T

smartearthseeds.com

Camelina oil -Food

- **Cake –unpalatable to humans**
- **Traceable culinary oil**
- **High Vitamin E**

Fatty acid	%
α-linolenic acid (C18:3)	25 – 42
linoleic acid (C18:2)	13 – 21
oleic acid (C18:1)	15 – 20
gondoic (eicosenoic) acid (C20:1)	12 – 18
erucic acid (C22:1)	1 - 2



threefarmers.ca

Camelina oil -Biofuels

The aviation industry is committed to achieving carbon-neutral growth by 2020

- **Biofuels may reduce life-cycle GHG emissions by up to 85% vs. conventional petroleum-based aviation fuels**
- **Sustainable Aviation Fuels Users Group "Accelerating development and commercialization of sustainable fuel"**
    1. Exhibit minimal impact on biodiversity
    2. Meet a sustainability standard with respect to land, water, and energy use
    3. Do not displace or compete with food crops
    4. Provide a positive socioeconomic impact
    5. Do not require any special fuel handling equipment, distribution systems, or changes to engine design
- **Algae, camelina, salicornia, jatropha, animal/ veggie waste fats, cellulosics, municipal waste**

Lufthansa became the first airline to use biofuels on regular commercial flights in a six month trial that reduced CO2 emissions by up to 1,500 tonnes during this period. airnewstimes.co.uk 2011Jul15

Camelina oil: Bioindustrial

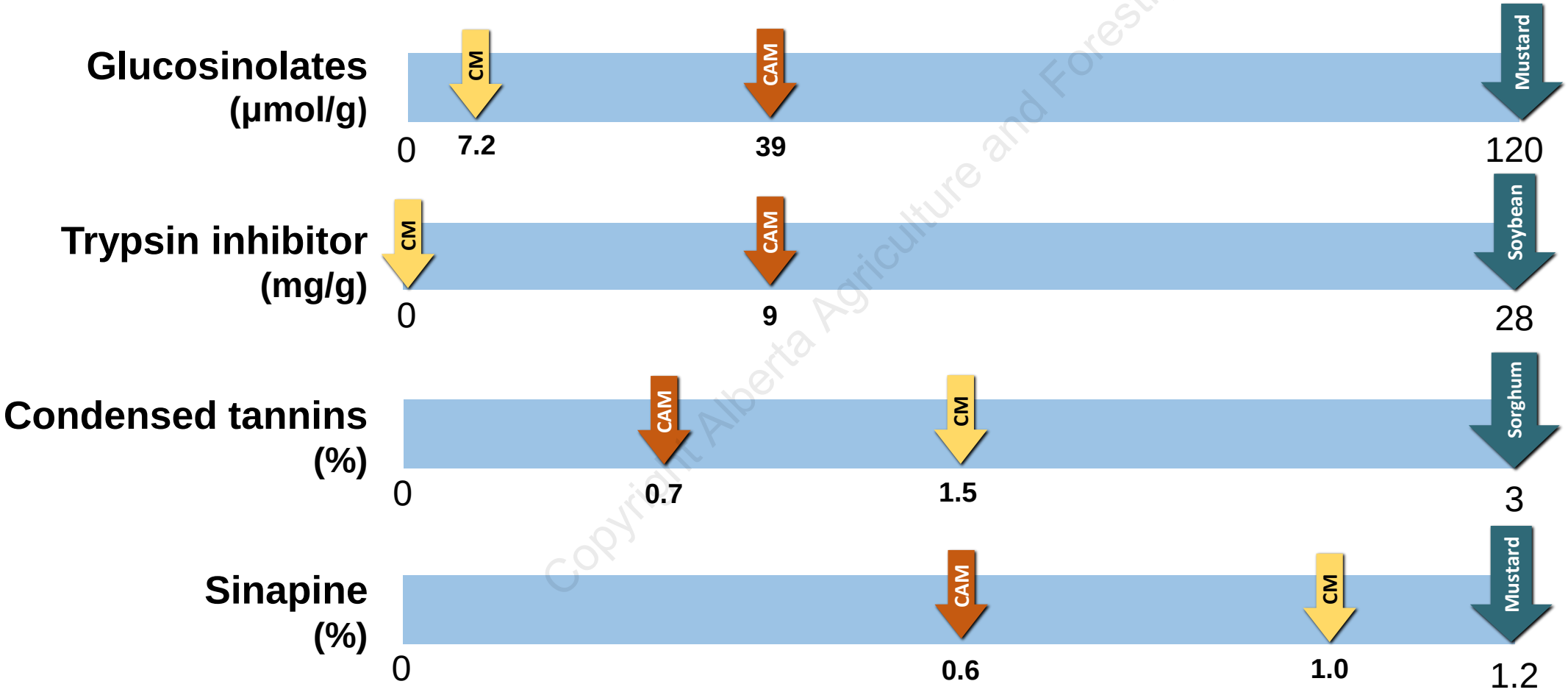
- Biofoam
- Epoxy resin
- Biofilms
- Bioplastics
- Paints, inks
- Soaps, varnishes
- Lubricants, cosmetics

advancedinsulationla.com

Camelina for feed

- **Cake (2/3 of seed) is a valuable co-product**
  - Remaining oil in cake –energy, protein, omega-3s, vit E
  - Omnivores convert co-products into human food
- **Before cake can be fed to livestock in Canada, it must be listed in Schedule IV of the Feeds Act**
  - Prove ‘safety’ and ‘efficacy’ to CFIA
  - Antinutritionals factors

Antinutritional factors in camelina cake



Camelina cake for feed

- **Current status in US**
  - 10% inclusion in cattle feed
  - 10% inclusion in broilers, layers
  - 2% inclusion in pig feed
- **Current status in Canada**
  - ✓12% **APPROVED** inclusion in broilers
  - Waiting for layer approval (20%??)
  - Pigs –we have solid data for 12% inclusion

Camelina cake for feed

- **Maximum inclusion ≠ optimum inclusion**
  - Complement, not displace other feedstuffs
  - Optimal inclusion based on feeding program objectives
- **Potential feedstuff for nutritional programming**
  - Modify fat deposition energy metabolism
  - Chick quality implications???
- **Carbon footprint vs. imported soybean meal**
  - Lower crop inputs and freight

Table 1. Nutrient content (%) of camelina seed, cake and solvent extracted meal compared with canola meal

%	Camelina			Canola meal
	Seed	Cake	SE meal	
Moisture	4.64	8.06	7.75	9.52
Crude fat	41.44	11.39	0.56	3.23
Crude fibre	13.06	13.11	13.11	12.31
Acid detergent fibre	14.24	22.28	20.64	19.91
Neutral detergent fibre	43.65	34.67	41.64	27.92
Calcium	0.18	0.36	0.46	0.62
Phosphorus	0.53	0.90	1.07	1.09
Crude protein	24.57	33.61	32.17	37.84
Lysine, total	1.10	1.65	1.78	2.09
Met+Cys, total	0.95	1.29	1.56	1.63

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Feeding camelina co-products to poultry

What the research says

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Broiler chickens

- **Study we did in 2011 looked at increasing levels of high-oil camelina cake (17% EE) fed to broilers, 0 – 42 d of age**
  - 0, 8, 16 and 24% dietary inclusion
  - Diets were designed to look at potential toxicity, fatty acid enrichment of tissues as opposed to growth performance

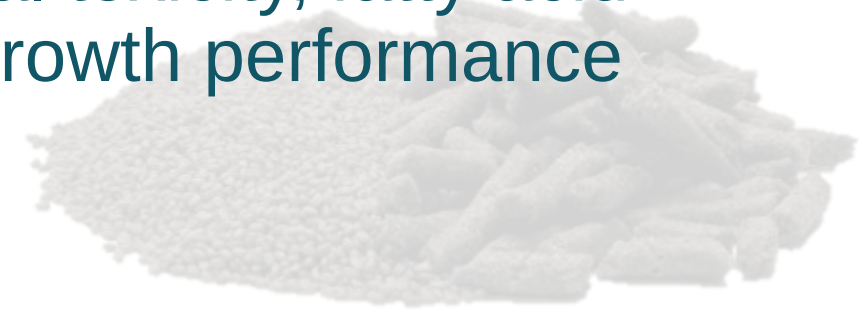
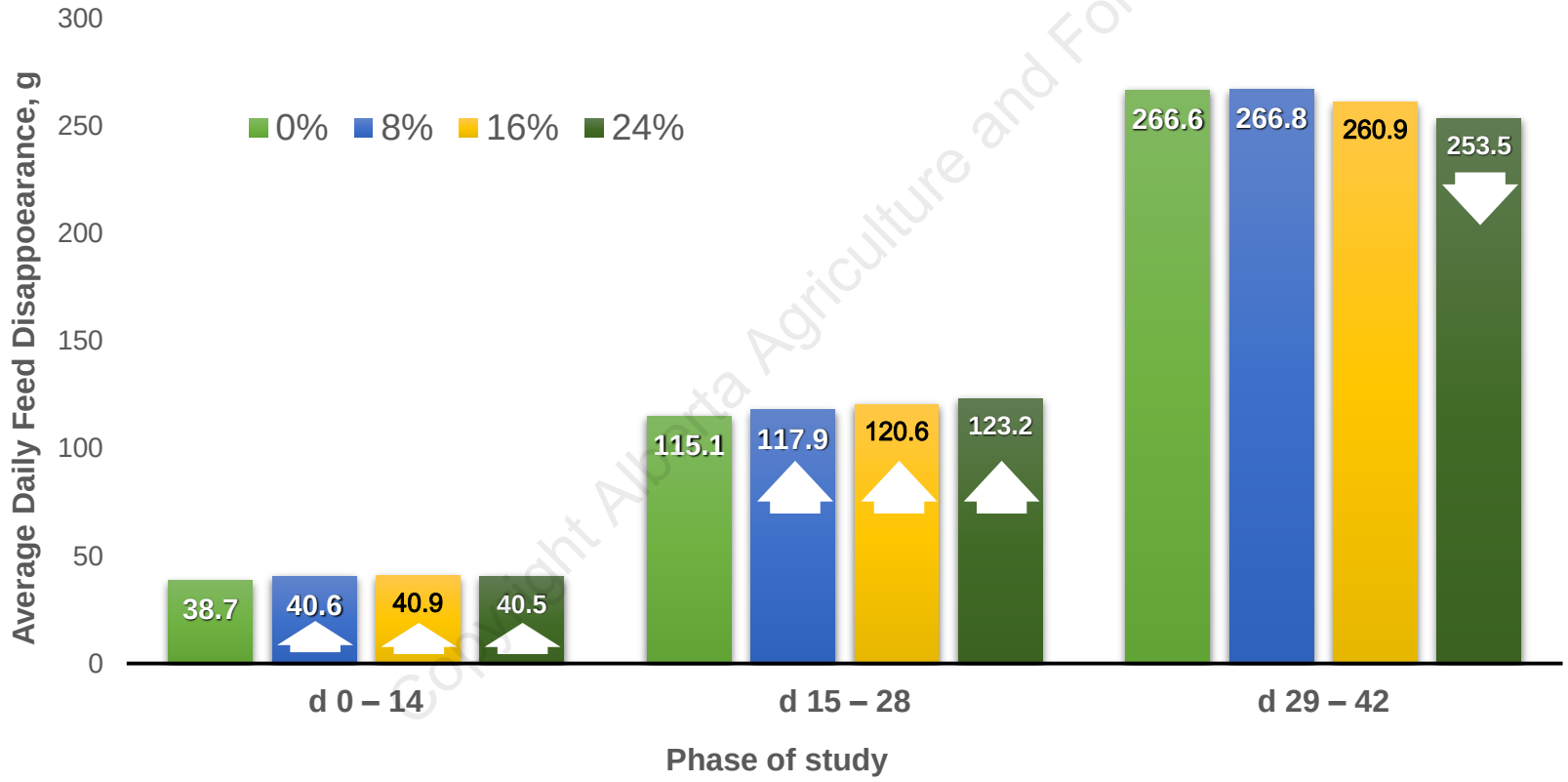
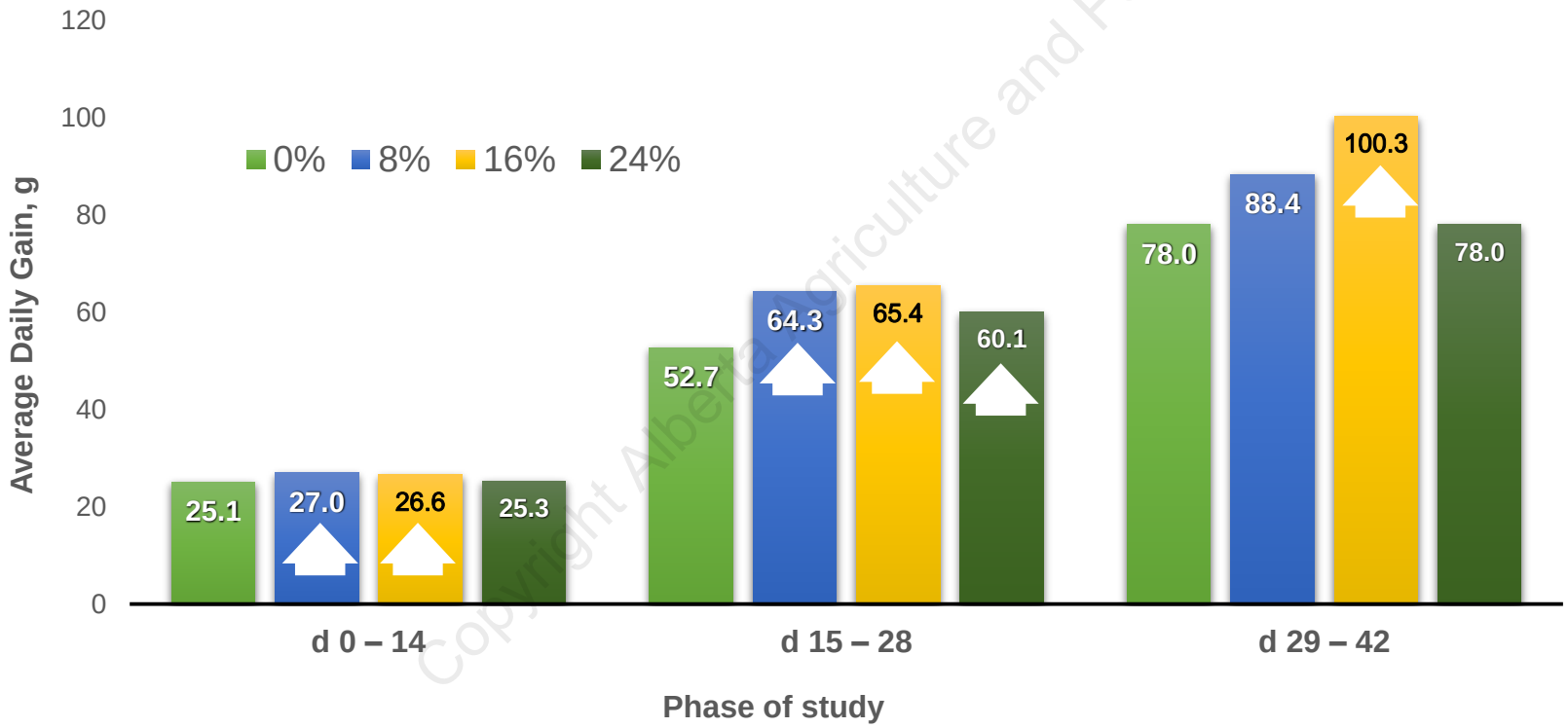


Figure 1. Effect of dietary inclusion of camelina cake on feed intake of broiler chickens, 0 – 42 d of age



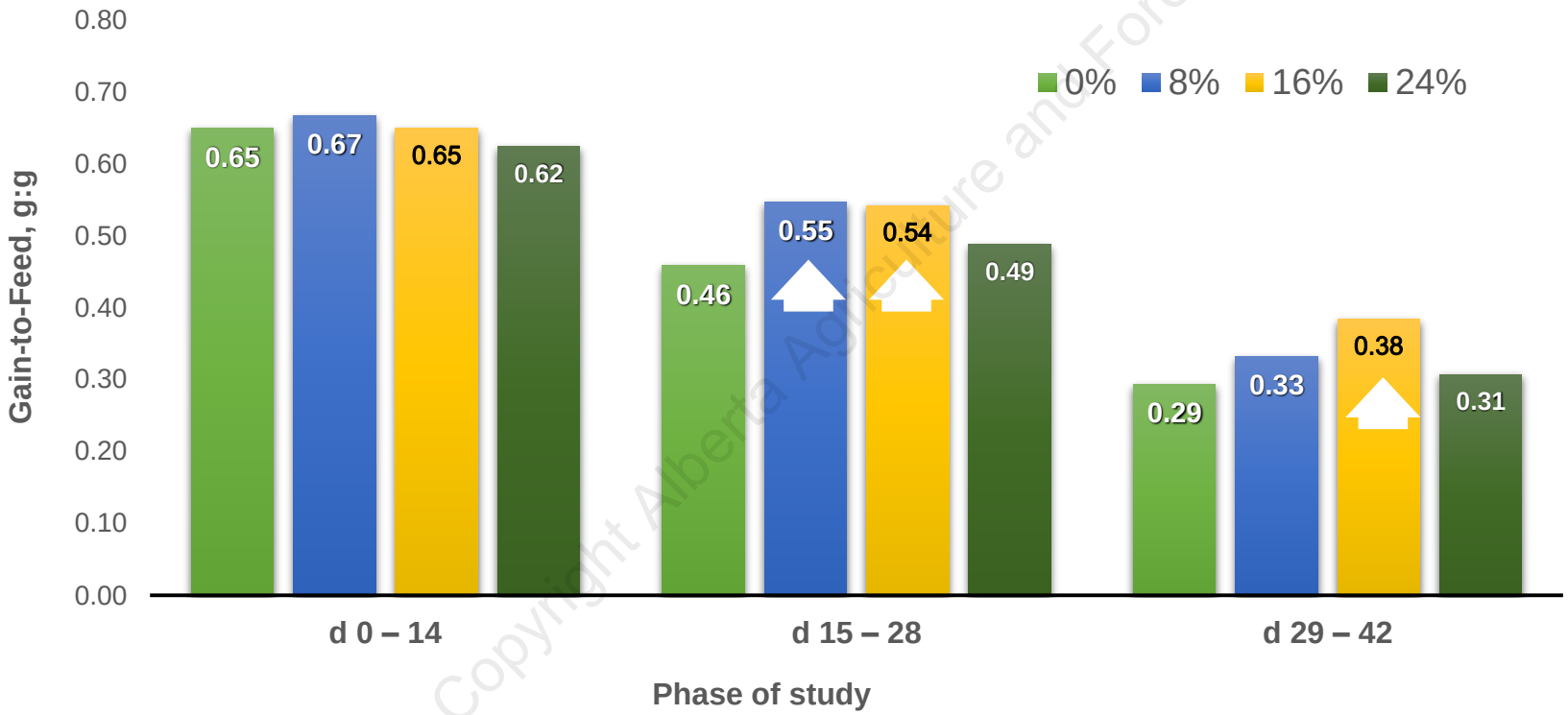
Source: Eduardo Beltranena, unpublished

Figure 2. Effect of dietary inclusion of camelina cake on average daily gain of broiler chickens, 0 – 42 d of age



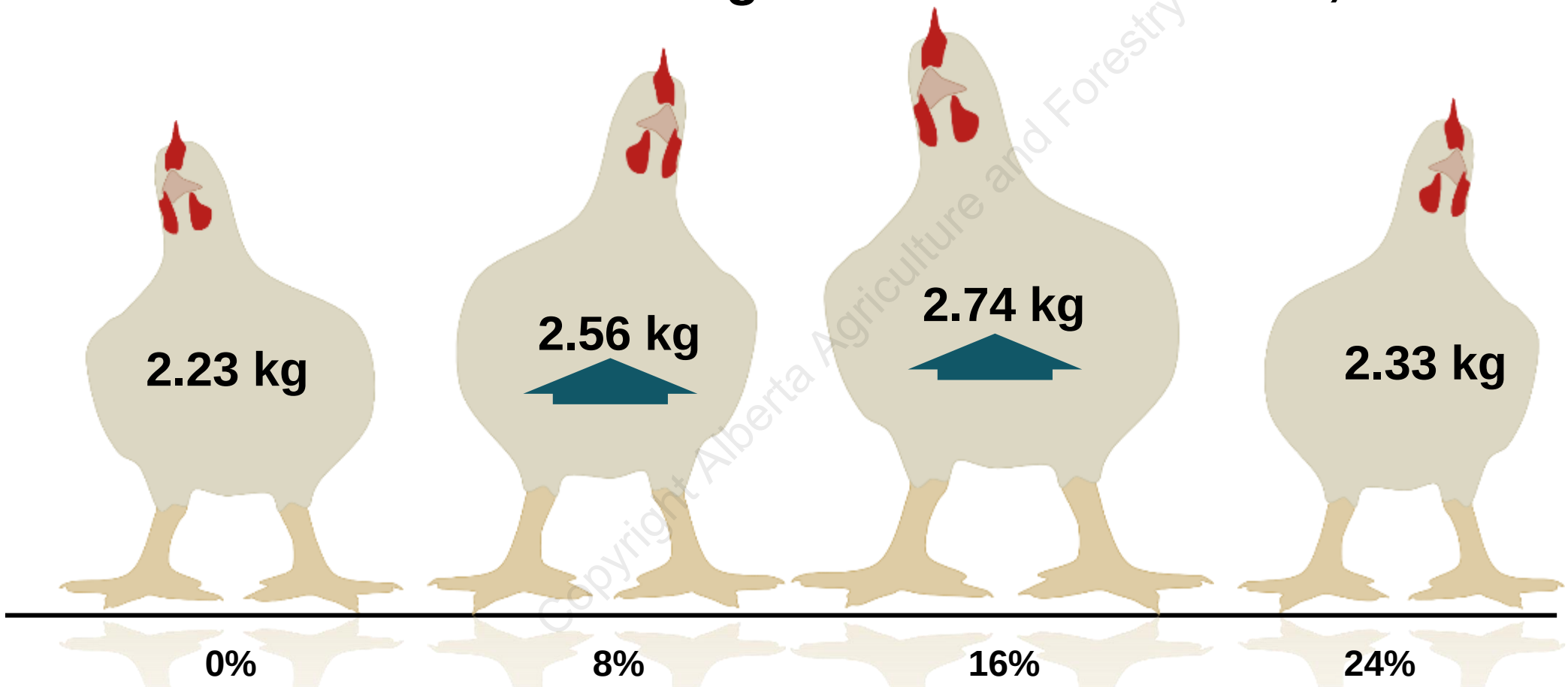
Source: Eduardo Beltranena, unpublished

Figure 3. Effect of increasing dietary inclusion of camelina cake on feed efficiency of broiler chickens, 0 – 42 d of age



Source: Eduardo Beltranena, unpublished

Figure 4. Effect of increasing dietary inclusion of high oil camelina cake on live weight of broiler chickens, 42 d of age



Source: Eduardo Beltranena, unpublished

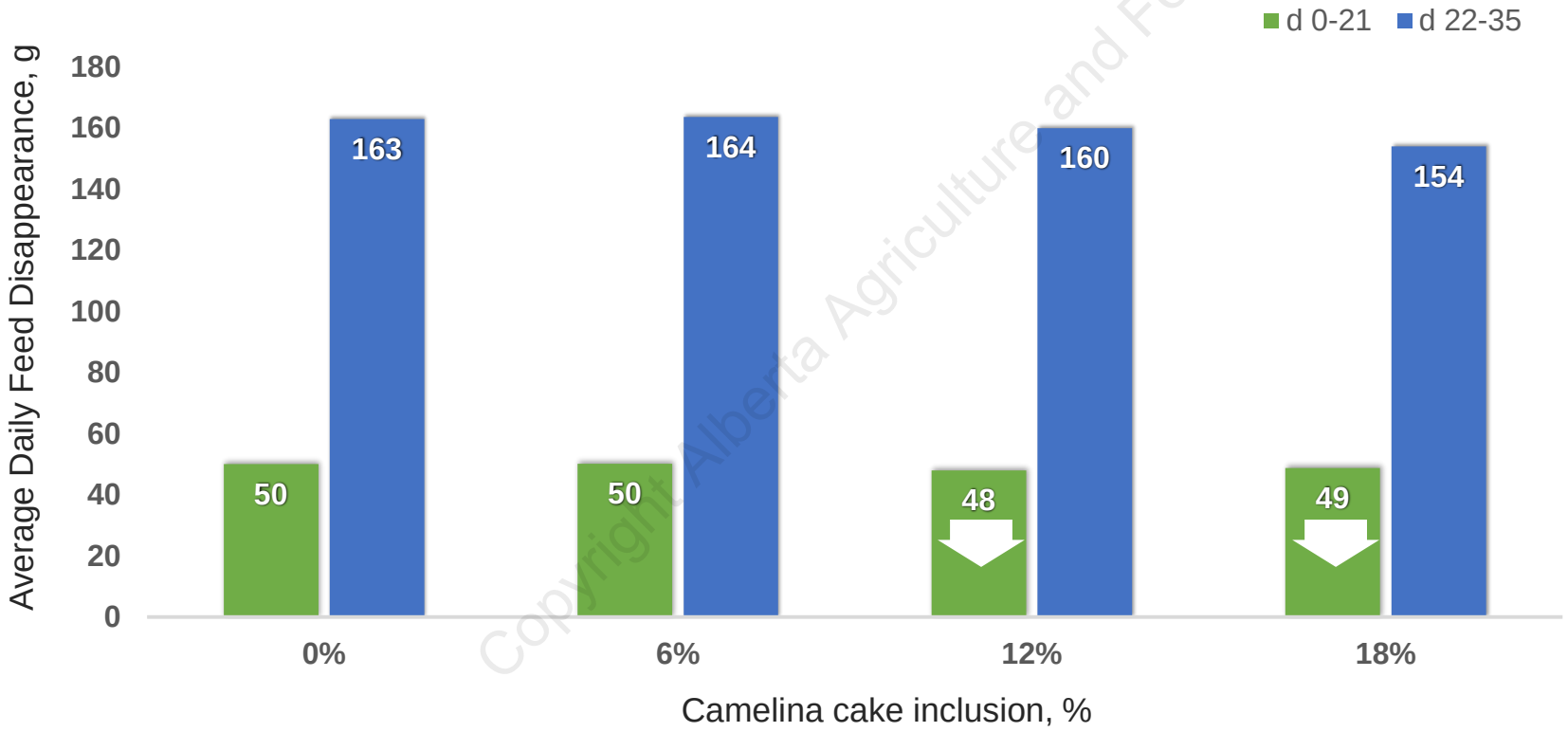
Broiler chickens (cont'd)

- **University of Saskatchewan led effort to obtain listing of camelina cake as a feedstuff for poultry**
  - Projects spanned 2012-2014
  - Tested inclusion levels up to 24% in broilers

Broiler chickens (cont'd)

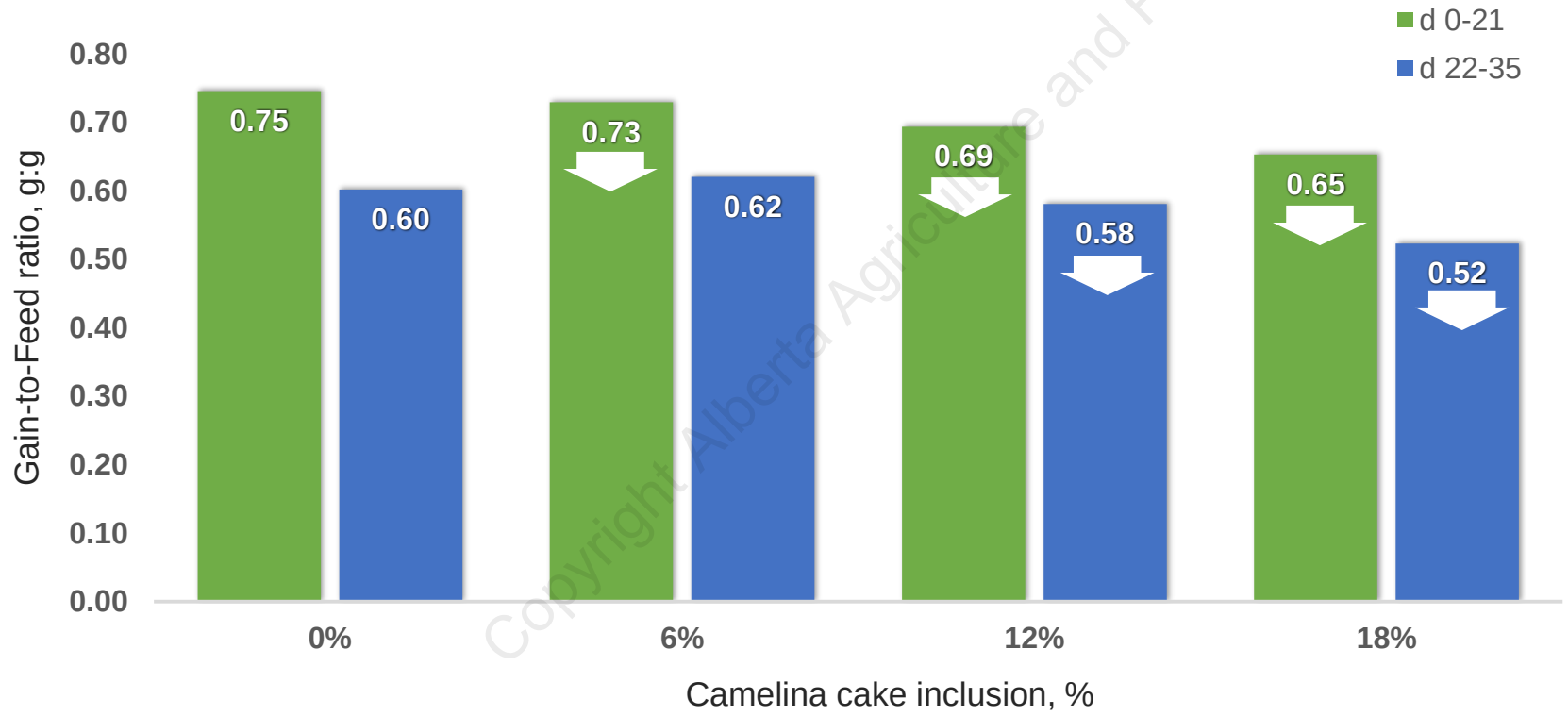
- **Projects:**
  1. Effect of dietary inclusion (0, 6, 12, 18 or 24%) of camelina cake for broilers (0 – 35 d of age)
  2. Effect of dietary inclusion (0, 6, 12, or 18%) of one of two sources of camelina cake for broilers (0 – 35 d of age)

Figure 5. Effect of increasing dietary inclusion of camelina cake on feed intake of broiler chickens, 0 – 35 d of age



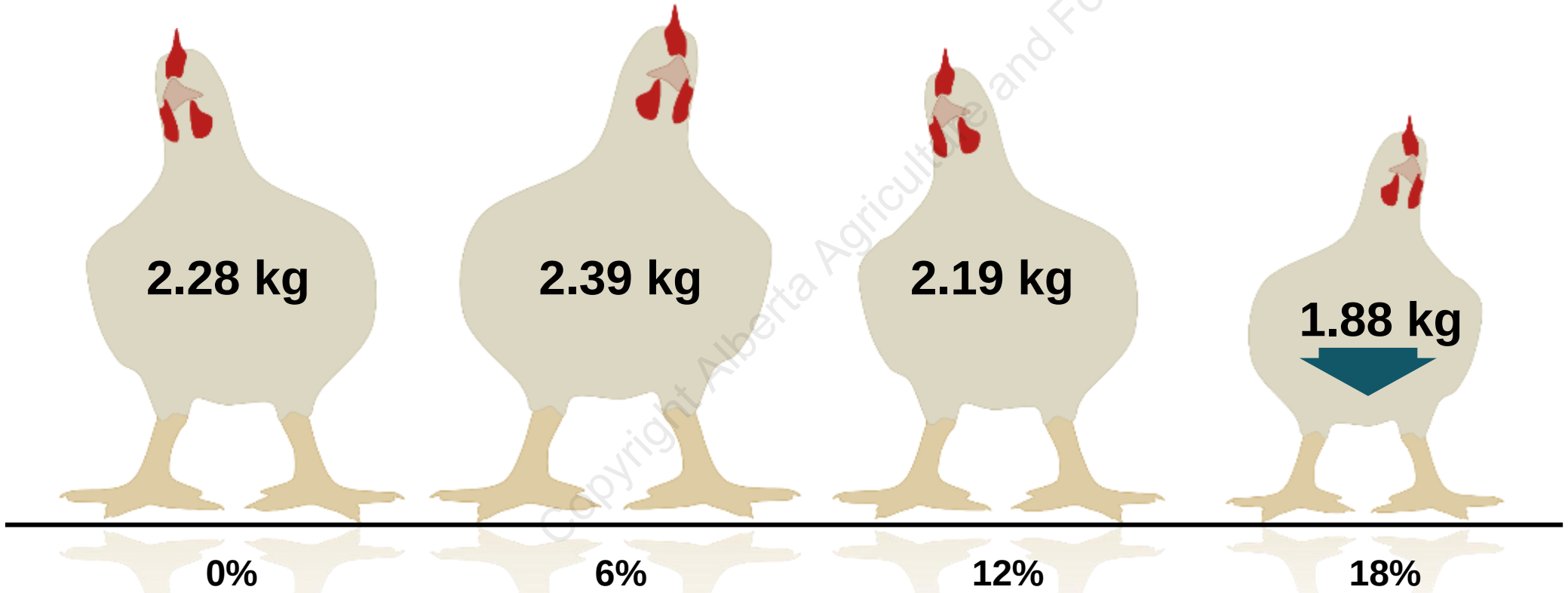
Source: Dr. Tom Scott, unpublished

Figure 6. Effect of increasing dietary inclusion of camelina cake on feed efficiency of broiler chickens, 0 – 35 d of age



Source: Dr. Tom Scott, unpublished

Figure 7. Effect of increasing dietary inclusion of camelina cake on final live weight of broiler chickens, 35 d of age



Source: Dr. Tom Scott, unpublished

So why such a difference in results?

- **Neither of these studies were designed to look explicitly at performance**
  - Focus of both was to establish the safety of the product for poultry
  - Data on digestible nutrient content in broilers was lacking

Table 2. Nutrient digestibility and digestible nutrient content of camelina cake for broiler chickens, 21-d of age

	Nutrient digestibility		Digestible nutrient content	
	No enzyme	+ Enzyme	No enzyme	+ Enzyme
Energy, % or kcalkg	36.6	41.6 < *56.7*	1729	1965 < *2799*
Amino acids, %				
Arginine	90.1	90.1 > *85.3*	2.59	2.59 > *1.87*
Lysine	76.5	74.5 = *72.4*	1.31	1.28 < *1.53*
Methionine	85.5	85.9 > *81.1*	0.54	0.55 = *0.56*
Threonine	72.8	72.8 > *67.3*	1.03	1.03 = *1.02*
Tryptophan	84.1	87.2 = *84.6*	0.34	0.36 = *0.44*
Valine	80.9	81.9 > *70.7*	1.46	1.47 > *1.23*

Figures in red are based on a canola cake with similar fat content measured in our lab

Source: Woyengo et al., submitted

Figure 8. Effect of increasing dietary inclusion of camelina cake on fatty acid composition (% of total) of thigh and breast tissue from broiler chickens

	0%	8%	16%	24%
Saturated	38.1	39.1	34.9	34.2
Monounsaturated	46.1	44.4	42.0	39.2
Polyunsaturated n-3	2.6	4.7	7.3	9.7
Long chain n-3	0.75	1.08	1.22	1.38
Polyunsaturated n-6	13.2	11.8	15.8	16.8
n-6:n-3 ratio	5.5	2.5	2.6	1.9

	0%	8%	16%	24%
Saturated	34.8	33.7	32.6	32.0
Monounsaturated	44.8	42.0	39.1	36.3
Polyunsaturated n-3	4.5	6.8	8.8	10.2
Long chain n-3	2.5	2.8	3.5	3.6
Polyunsaturated n-6	14.9	16.3	18.3	20.3
n-6:n-3 ratio	3.7	2.5	2.2	2.1

Source: Nain et al., 2015

Broilers and camelina cake: What we have learned

- **At 12% inclusion, should not run into serious feed refusal issues**
- **Camelina cake is a very good dietary source of amino acids for broilers**
  - Energy content is problematic, even with the extra oil
- **Measureable shifts in tissue lipids**

Laying hens

- **Camelina cake for layers has been a major area of focus for us over the past 3-4 years**
  - Our data has gone to CFIA for review
  - We anticipate approval to feed up to 25%

Laying hens (con't)

- **Several projects:**
  1. Increasing dietary inclusion (0, 5, 10, 15, 20 or 25%)
  2. Increasing dietary inclusion and copper fortification
  3. Increasing dietary inclusion of camelina cake or solvent extracted camelina meal
  4. Full fat camelina seed vs. flax (10%)
  5. Very high (30%) dietary inclusion of camelina cake and solvent extracted meal

Laying hens (con't)

- **Questions we sought to answer:**
  1. Will laying hens eat diets containing camelina cake?
  2. Can hens maintain high productivity when fed diets containing high dietary inclusion of camelina cake?
  3. What is the quality of the eggs produced from hens fed camelina cake?

Figure 9. Effect of increasing dietary inclusion of camelina cake on feed intake of laying hens, 23 – 56 weeks of age

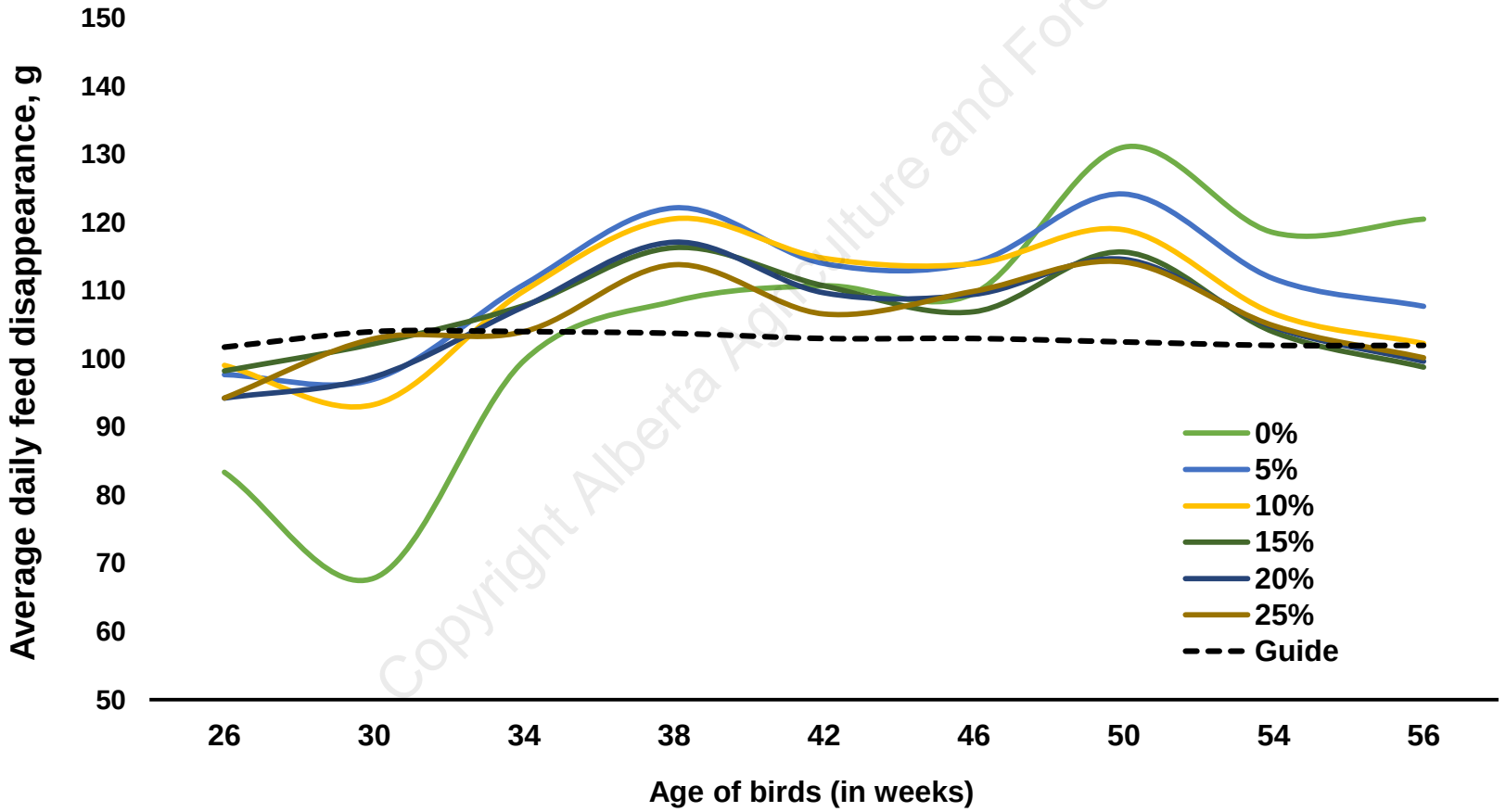
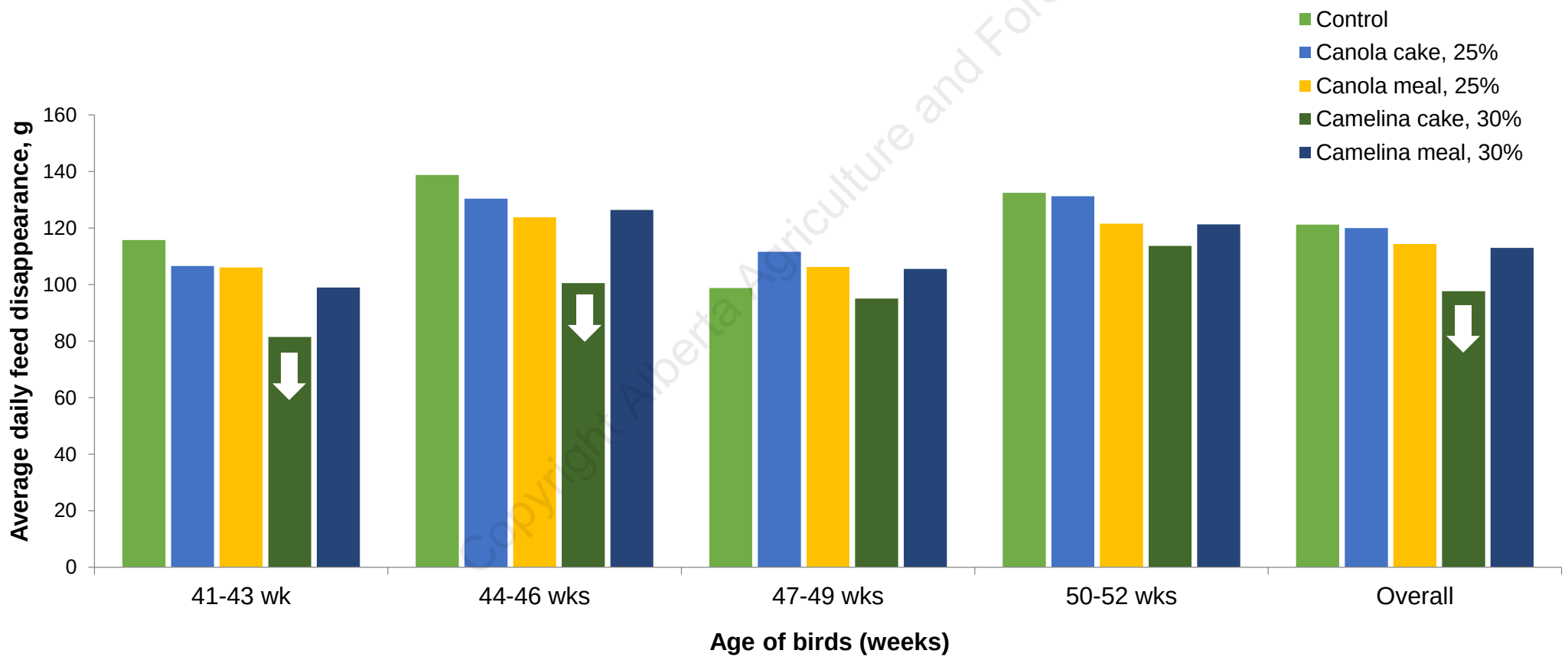


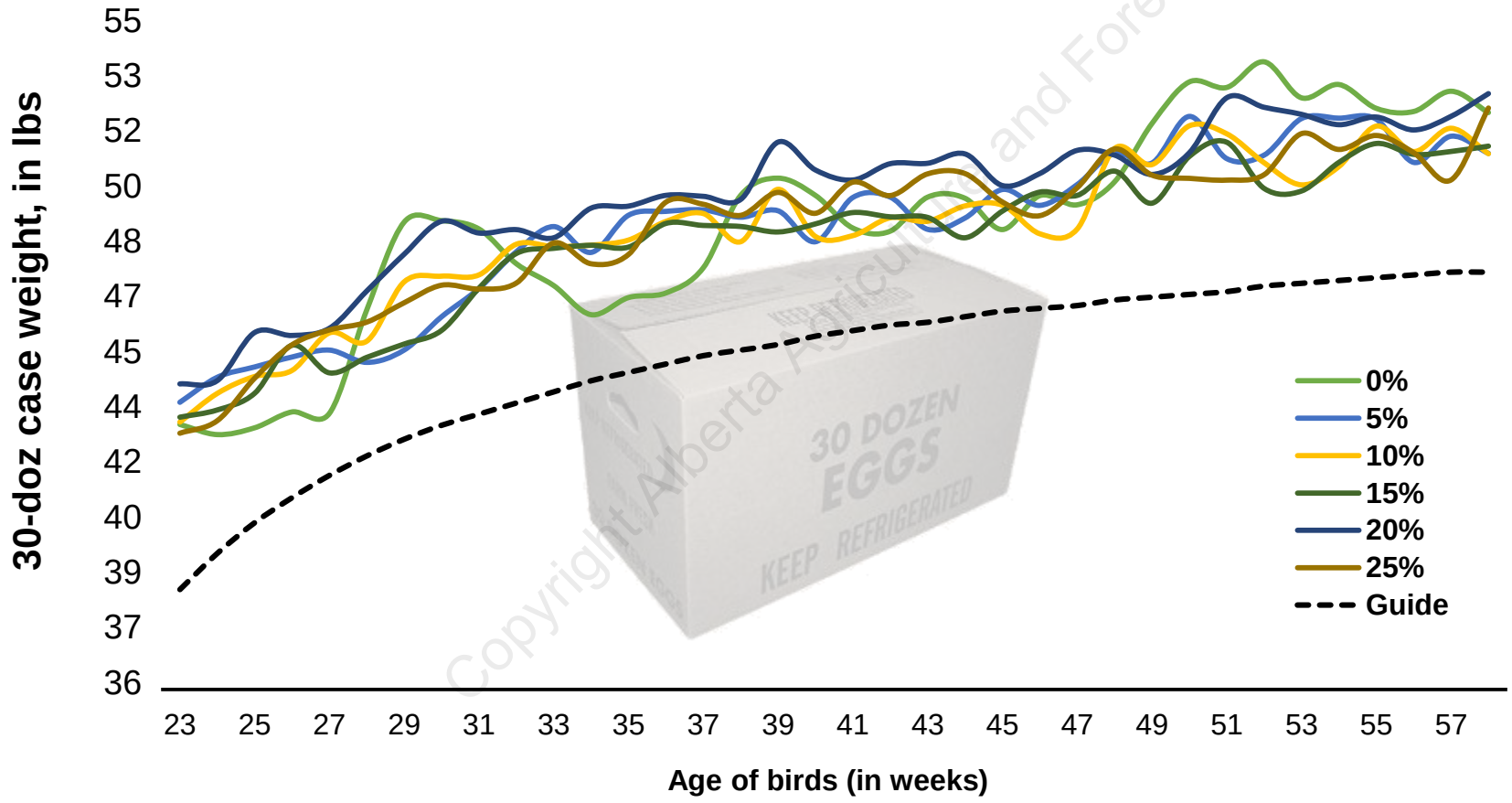
Figure 10. Effect of very high dietary inclusion of canola (25%) or camelina (30%) co-products on feed intake of hens, 41-52 wks of age



Laying hens (con't)

- **Questions we sought to answer:**
  1. Will laying hens eat diets containing camelina cake? **YES!**
  2. Can hens maintain high productivity when fed diets containing high dietary inclusion of camelina cake?
  3. What is the quality of the eggs produced from hens fed camelina cake?

Figure 11. Effect of increasing dietary inclusion of camelina cake on case weight (average egg weight)



Laying hens (con't)

- **Questions we sought to answer:**
  1. Will laying hens eat diets containing camelina cake? **YES!**
  2. Can hens maintain high productivity when fed diets containing high dietary inclusion of camelina cake? **YES!**
  3. What is the quality of the eggs produced from hens fed camelina cake?

Table 3. Effect of very high dietary inclusion of camelina or canola cake or meal fed to laying hens on initial egg quality

	Control	Canola		Camelina	
		Cake (25%)	Meal (25%)	Cake (30%)	Meal (30%)
Haugh units, HU	62.3	66.7 ↑	62.3	60.1	63.4
Eggshell thickness, mm	0.328	0.327	0.333	0.323	0.330
Shell, % of egg	14.0	14.3	14.2	13.9	13.7
Albumen, % of egg	57.5	57.7	58.3	59.1 ↑	59.4 ↑
Yolk, % of egg	28.7	28.2	27.8 ↓	27.1 ↓	26.8 ↓

Table 4. Effect of increasing dietary inclusion of camelina cake fed to laying hens on fatty acid composition of eggs

	Camelina cake inclusion, %					
Fatty acid, mg/g edible egg	0%	5%	10%	15%	20%	25%
Total saturated	29.8	30.1	28.3	28.5	26.7	26.1
Total monounsaturated	39.9	40.2	38.6	40.7	38.4	38.6
Total polyunsaturated	14.8	16.5	16.6	17.8	17.3	18.3
Omega-3 fatty acids						
Alpha-linolenic (ALA)	0.31	0.71	1.05	1.54	1.79	2.23
Eicosapentaenoic (EPA)	0.01	0.01	0.02	0.03	0.03	0.04
Docosahexaenoic (DHA)	0.69	1.15	1.28	1.44	1.43	1.50
Total omega-3	1.14	2.08	2.52	3.18	3.41	3.97
omega-6:omega-3 ratio	10.71	6.37	4.61	4.06	3.51	3.08

3.0

Health Canada

Laying hens (con't)

- **Questions we sought to answer:**
  1. Will laying hens eat diets containing camelina cake? **YES!**
  2. Can hens maintain high productivity when fed diets containing high dietary inclusion of camelina cake? **YES!**
  3. What is the quality of the eggs produced from hens fed camelina cake? **NOT TOO SHABBY!**

Laying hens (con't)

- **Questions we sought to answer:**
  1. Will laying hens eat diets containing camelina cake? **YES!**
  2. Can hens maintain high productivity when fed diets containing high dietary inclusion of camelina cake? **YES!**
  3. What is the quality of the eggs produced from hens fed camelina cake? **NOT TOO SHABBY!**
  4. What is the digestible nutrient content of camelina cake for laying hens?

Table 5. Nutrient digestibility and digestible nutrient content in camelina cake vs canola cake* for laying hens

	Nutrient digestibility (%)		Digestible nutrient content (% or kcal/kg)	
	Camelina cake	Canola cake	Camelina cake	Canola cake
Energy	44.7	55.6	2315	2730
Amino acids				
Arginine	78.6	84.4	2.08	1.71
Lysine	59.4	75.4	0.98	1.27
Methionine	73.3	83.7	0.45	0.55
Methionine + Cysteine	56.9	75.7	0.73	1.09
Threonine	48.5	68.0	0.67	0.95
Tryptophan	78.3	88.8	0.33	0.39
Valine	61.0	74.6	1.00	1.44

Table 6. Nutrient digestibility and digestible nutrient content in rolled camelina seed vs flax for laying hens

	Nutrient digestibility (%)		Digestible nutrient content (% or kcal/kg)	
	Camelina seed	Flax seed	Camelina seed	Flax seed
Energy	46.22	42.90	3134	2717
Amino acids				
Arginine	77.77	73.69	1.63	1.14
Lysine	62.76	61.14	0.72	0.40
Methionine	73.41	64.92	0.35	0.24
Methionine + Cysteine	63.66	48.88	0.64	0.31
Threonine	53.92	32.77	0.53	0.22
Tryptophan	100.35	99.83	0.33	0.22
Valine	55.10	57.58	0.72	0.54

Layers and camelina cake: What we have learned

- **Hens seem to accept it, though palatability is probably an issue**
  - Glucosinolates??
- **Just as with broilers, appears to be a good source of digestible amino acids**
  - Energy seems to be easier for older birds to handle
  - Enzyme supplementation seems to help

Layers and camelina cake: What we have learned

- **We can generate 'omega-3' eggs with about 15% dietary inclusion**
  - Could potentially do it with 5% rolled seed
- **Careful processing of the cake is <u>CRITICAL!!</u>**

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Future research needs

Where do we go next?

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Next steps (we think)

- **Agronomy/plant breeding**
  - Deal with antinutritional factors (e.g., glucosinolate, erucic acid, trypsin inhibitor)
  - Increase oil content of seed
  - Change carbohydrate profile

Next steps (we think)

- **Animal nutrition**
  - Optimization of cake usage in broiler diets
  - Full-fat camelina seed for layers and broilers
  - Pre/post-press processing to improve dig. nutrient content
  - Development of specialized enzyme cocktails
  - Control of fat deposition
  - Chick development

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Canada

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University of Saskatchewan

Alberta Agriculture and Forestry

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