CAMELINA,
an egg out of the canola basket?

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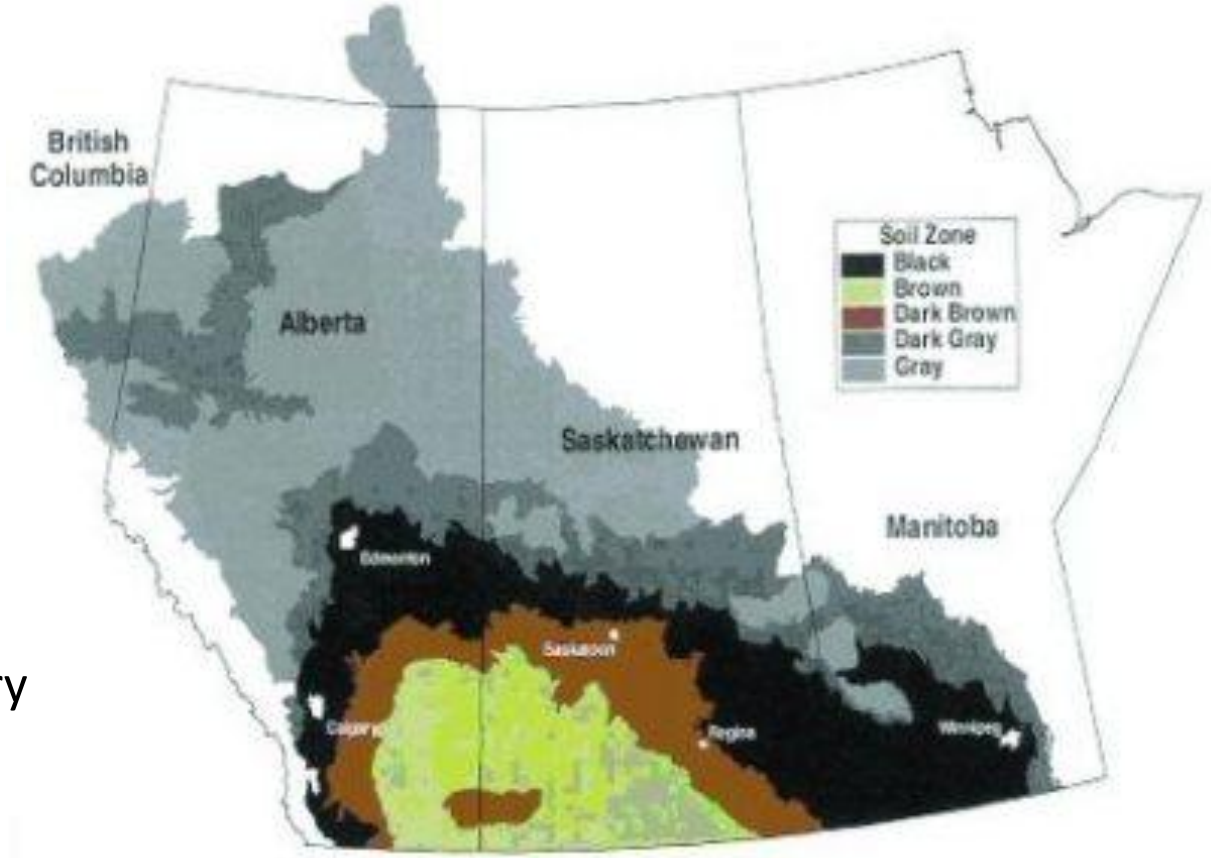
Alberta
Agriculture and
Rural Development

Why Camelina?

- **Oil value**, >40% of seed
  - Bio-industrial
  - Feed
  - Food
  - Agronomy
  - Exports
  - Rural development
- **Meal coproduct**, <60% of seed
  - Canadian feed listing
  - Chicken and egg paradigm

Camelina –Agronomic advantage

- Better adapted to grow in the southern Prairies
  - Brown, Dark Brown soils *"One crop could add 1M acres of production"*
  - Marginal lands
  - Drought tolerant
  - Thermotolerant
  - Disease resistance
  - US Great Plains
  - **Diversify canola**
  - Displacement of flax, sunflower, canary
  - Current weed status!



Camelina -Bioindustrial advantage

- Biodiesel
- **Biokerosene**
  - SK advantage
- Bioplastic
- Biofilm
- Foam
- Aliphatic polyesters
- Cosmetics
- Not a ‘food’ meal
- Algae, jatropha, carinata

Camelina –Feed advantage

- 10 - 20% residual oil
  - Dietary energy at lower cost
  - PUFAs
  - 'Natural' vit E
- Protein source
- ANFs limitations
  - Glucosinolates
  - Tannins
  - Sinapine

Camelina –Food advantage

- Gourmet oil
  - **30% Linolenic (18:3n3)**
  - 20% Linoleic (18:2n6)
  - 15% Gonodic (20:1n9)
  - 15% Oleic (9c-18:1)
  - 5% Palmitic (16:0)
  - 2.5% Stearic (18:0)
  - **2.5% Erucic acid (22:1n9)**
- 2x tocopherols vs. canola
- Unpalatable meal

Camelina –Export advantage

- Current #1 SK market
- 2x oil content vs. Soy!
- Current supply limits canola exports
- Opportunity to displace market share from other vegetable oils

Camelina meal, our focus is CFIA listing

- Schedule IV, Feed Act
  - Safety
  - Performance
  - Efficacy
- US FDA 10% inclusion
- Species
  - Broilers, layers
  - Cattle
  - Pigs
  - Fish

CONSOLIDATION | CODIFICATION

Feeds Act | Loi relative aux aliments du bétail

R.S.C., 1985, c. F-9 | L.R.C., 1985, ch. F-9

Oilseed processing

Cold-Pressed

Expeller-Pressed

Extruded+Expeller Pressed

Solvent Extraction

Camelina vs. canola expeller meal

%, as is	Camelina	Napus
EE	12	12
AMEn, kcal/kg	2350	2500
CP	35 - 36	34
• Lys, %	1.75	1.65
• Av. lys	1.7	1.45
• Met	0.6	0.65
• Thr	1.3	1.38
• Try	0.4	0.43
CFibre	10	6.7
ADF	15	15
NDF	30 - 45	22-28
Starch	< 1	<5
Ash	5.5	6.1

ANFs, as is	Camelina	Napus
Phytic acid, %	4.2	3.0
Tannins, %	2	1.4
Sinapine, %	0.6	1.0
Trypsin inhibit activity	18	vs Soy 110
Glucosinolates, µmol/g		
9-methyl-sulfinyl-nonyl	8.5	
10-methyl-sulfinyl-decyl	22.5	
11-methyl-sulfinyl-undecyl	4.3	
Total methyl-sulfinyl	35	
3-butenyl		2.1
2-OH-3-butenyl		3.3
4-OH-3-CH3-indolyl		2.3
Total aliphatic		5.7

Camelina meal fed to broilers 42d

Gwr ingredient, %	0%	8%	16%	24%
Cornstarch	24.0	16.0	8.0	0.00
Camelina meal	---	8.0	16.0	24.0
Wheat, ground	39.9	39.9	39.9	39.9
Soybean meal	12.2	12.2	12.2	12.2
Corn, ground	13.5	13.5	13.5	13.5
Canola oil	2.5	2.5	2.5	2.5
Fish meal	3.8	3.8	3.8	3.8
Mono-dical phosp.	1.0	1.0	1.0	1.0
Limestone	1.1	1.1	1.1	1.1
Vit, trace min.	0.5	0.5	0.5	0.5
Choline chloride px	0.5	0.5	0.5	0.5
Salt	0.35	0.35	0.35	0.35
Vitamin E px	0.30	0.30	0.30	0.30
D,L – Methionine	0.08	0.08	0.08	0.08
L – Lysine HCl	0.11	0.11	0.11	0.11
L-Threonine	0.08	0.08	0.08	0.08
Enzyme	0.05	0.05	0.05	0.05

Screw-pressed meal	92% DM
Crude protein, %	34.25
Crude fat, %	21

Skinless breast lipids of AB broilers

	Camelina meal inclusion level, %				*P* - value
% of total fatty acids	0	8	16	24	Linear
Total saturated	34.75^{a}	33.72^{ab}	32.64^{bc}	32.02^{c}	< 0.001
Total monounsaturated	44.82^{a}	41.99^{b}	39.09^{c}	36.27^{d}	< 0.001
α-Linolenic acid (C18:3 n-3)	1.93^{c}	3.99^{b}	5.31^{ab}	6.65^{a}	< 0.001
DPA (C22:5 n-3)	0.89^{b}	1.15^{b}	1.47^{a}	1.53^{a}	< 0.001
Total omega-3	4.46^{c}	6.83^{b}	8.80^{a}	10.24^{a}	< 0.001
Total long-chain omega-3	2.53^{b}	2.84^{b}	3.48^{a}	3.59^{a}	< 0.001
Linoleic acid (C18:2 n-6)	11.26^{d}	12.86^{c}	14.67^{b}	16.39^{a}	< 0.001
Total omega-6	14.92^{c}	16.28^{c}	18.33^{b}	20.25^{a}	< 0.001
Total omega-6:total omega-3	3.66^{a}	2.47^{b}	2.18^{b}	2.13^{b}	< 0.001
Total polyunsaturated	19.38^{c}	23.13^{b}	27.31^{a}	30.10^{a}	< 0.001

Thigh lipids of AB broilers

	Camelina meal inclusion level, %					P - values
% of total fatty acids	0%	8%	16%	24%	SEM	Linear
Total saturated	26.66	24.89	25.17	23.39	1.14	0.085
Total monounsaturated	41.19^{a}	39.56^{a}	36.99^{ab}	34.32^{b}	1.91	0.003
α-Linolenic acid (C18:3 n-3)	1.88^{d}	3.62^{c}	6.09^{b}	8.34^{a}	0.44	< 0.001
DPA (C22:5 n-3)	0.27^{b}	0.45^{a}	0.48^{a}	0.54^{a}	0.07	0.003
Total omega-3	2.63^{d}	4.70^{c}	7.31^{b}	9.72^{a}	0.44	< 0.001
Total long-chain omega-3	0.75^{b}	1.08^{ab}	1.22^{a}	1.38^{a}	0.17	< 0.001
Linoleic acid (C18:2 n-6)	11.23^{bc}	10.31^{c}	13.66^{ab}	15.06^{a}	1.42	0.004
Total omega-6	13.17	11.78	15.82	16.84	1.83	0.020
Total omega-6:total omega-3	5.53^{a}	2.54^{b}	2.59^{b}	1.90^{b}	0.63	< 0.001
Total polyunsaturated	15.80^{b}	16.48^{b}	23.13^{a}	26.56^{a}	2.02	< 0.001

Conclusions –AB broilers

1. Increasing dietary camelina meal level increased ALA in breast, thigh and liver, but not brain.
2. Increasing camelina meal inclusion increased long-chain n-3 PUFA including docosapentaenoic (DPA) and docosahexaenoic acid (DHA) in liver and brain.
3. The predominant n-3 PUFA in liver and brain was DHA (50% and 89% of n-3 PUFA) unlike breast and thigh where ALA was the major n-3 PUFA (58% and 81% of n-3 PUFA).
4. **BREAST:** We achieved 349 mg/100g with 119 mg/100g being LC n-3 PUFA feeding the 24% camelina meal diet for 28 d.
5. **THIGH:** We achieved the 300 mg/100 g meat labeling req. feeding 16% CM for 42d or 24% CM for 28d.

Camelina meal fed to layers –M&M

- **White, Brown** Nick layers **fed 0, 5, 10, 15, 20, 25%**
- Brown egg layers **only** fed 0, 5, 10, 15, 20, 25% + Cu 125 ppm
- 12 or 6 replicate cages of 4 layers each / treatment
- 3-tiered battery, blocked by tier
- Layers weighed and feed disappearance @ 4wks intervals

Measurements:

- Egg/cage counted daily
- Egg weighed weekly
- Egg physical attributes
- Egg lipids, TMA, TBARS
- Egg sensory attributes
- Necropsy, organ wts

Phase 1 diets fed for first 24 wks

	EP camelina meal, %					
Ingredient, %	0	5	10	15	20	25
Barley, ground	58.6	51.4	44.1	36.8	29.6	22.3
Corn, ground	-	5.0	10.0	15.0	20.0	25.0
EP camelina	-	5.0	10.0	15.0	20.0	25.0
Soybean meal	13.0	11.1	9.2	7.2	5.3	3.4
Wheat DDGS	10.0	8.9	7.7	6.6	5.5	4.4
Wheat, ground	-	0.8	1.7	2.5	3.4	4.2
Canola oil	6.7	6.2	5.8	5.3	4.9	4.4
Limestone coarse	6.2	6.2	6.1	6.1	6.1	6.1
Limestone fine	3.1	3.1	3.1	3.1	3.1	3.0
Vitamin premix	0.5	0.5	0.5	0.5	0.5	0.5
Choline premix	0.5	0.5	0.5	0.5	0.5	0.5
Mono-dical phos	0.49	0.47	0.45	0.43	0.41	0.39
Sodium bicarb	0.37	0.36	0.35	0.35	0.34	0.33
Lysine HCl	0.15	0.15	0.16	0.16	0.17	0.17
D,L methionine	0.18	0.16	0.15	0.13	0.12	0.10
L-threonine	0.10	0.08	0.06	0.04	0.02	-
Salt	0.05	0.07	0.09	0.10	0.12	0.14
Enzyme	0.05	0.05	0.05	0.05	0.05	0.05

	EP camelina meal, %					
Nutrient, %	0	5	10	15	20	25
AME, Mcal/kg	2.8	2.8	2.8	2.8	2.8	2.8
Crude protein	17.3	17.3	17.3	17.3	17.3	17.3
Crude fat	8.4	8.5	8.6	8.7	8.7	8.8
Linoleic	2.1	2.2	2.3	2.3	2.4	2.4
Calcium	3.7	3.7	3.7	3.7	3.7	3.7
Av. Phosp	0.43	0.43	0.43	0.43	0.43	0.43
Sodium	0.17	0.17	0.17	0.17	0.17	0.17
Chloride	0.17	0.17	0.17	0.17	0.17	0.17
Magnesium	0.11	0.10	0.09	0.09	0.08	0.07
Dig Arg	0.79	0.82	0.84	0.87	0.90	0.93
Dig His	0.35	0.34	0.33	0.31	0.30	0.29
Dig Ile	0.65	0.63	0.61	0.59	0.57	0.55
Dig Leu	1.05	1.05	1.05	1.05	1.05	1.06
Dig Lys	0.73	0.72	0.71	0.70	0.69	0.68
Dig Meth	0.40	0.39	0.38	0.37	0.36	0.35
Dig Met+Cys	0.67	0.66	0.65	0.64	0.63	0.62
Dig Thr	0.53	0.52	0.51	0.50	0.50	0.49
Dig Try	0.26	0.25	0.24	0.23	0.22	0.21

Phase 2 diets fed for last 12 wks

	EP camelina meal, %					
Ingredient, %	0	5	10	15	20	25
Barley, ground	57.8	50.2	42.7	35.2	27.7	20.2
Corn, ground		5.0	10.0	15.0	20.0	25.0
EP camelina		5.0	10.0	15.0	20.0	25.0
Soybean meal	13.1	11.7	10.2	8.7	7.3	5.8
Wheat DDGS	10.0	8.2	6.4	4.5	2.7	0.9
Wheat, ground		1.4	2.7	4.1	5.5	6.8
Canola oil	6.9	6.4	5.9	5.4	4.9	4.3
Limestone coarse	6.6	6.5	6.5	6.5	6.5	6.5
Limestone fine	3.2	3.2	3.2	3.2	3.2	3.2
Vitamin premix	0.5	0.5	0.5	0.5	0.5	0.5
Choline premix	0.5	0.5	0.5	0.5	0.5	0.5
Mono-dical phos	0.45	0.43	0.42	0.40	0.39	0.37
Sodium bicarb	0.37	0.36	0.35	0.34	0.33	0.32
D,L methionine	0.19	0.20	0.21	0.21	0.22	0.23
Lysine HCl	0.17	0.17	0.17	0.16	0.16	0.16
L-threonine	0.11	0.10	0.09	0.08	0.07	0.06
Salt	0.04	0.06	0.08	0.10	0.12	0.14
Enzyme	0.05	0.05	0.05	0.05	0.05	0.05

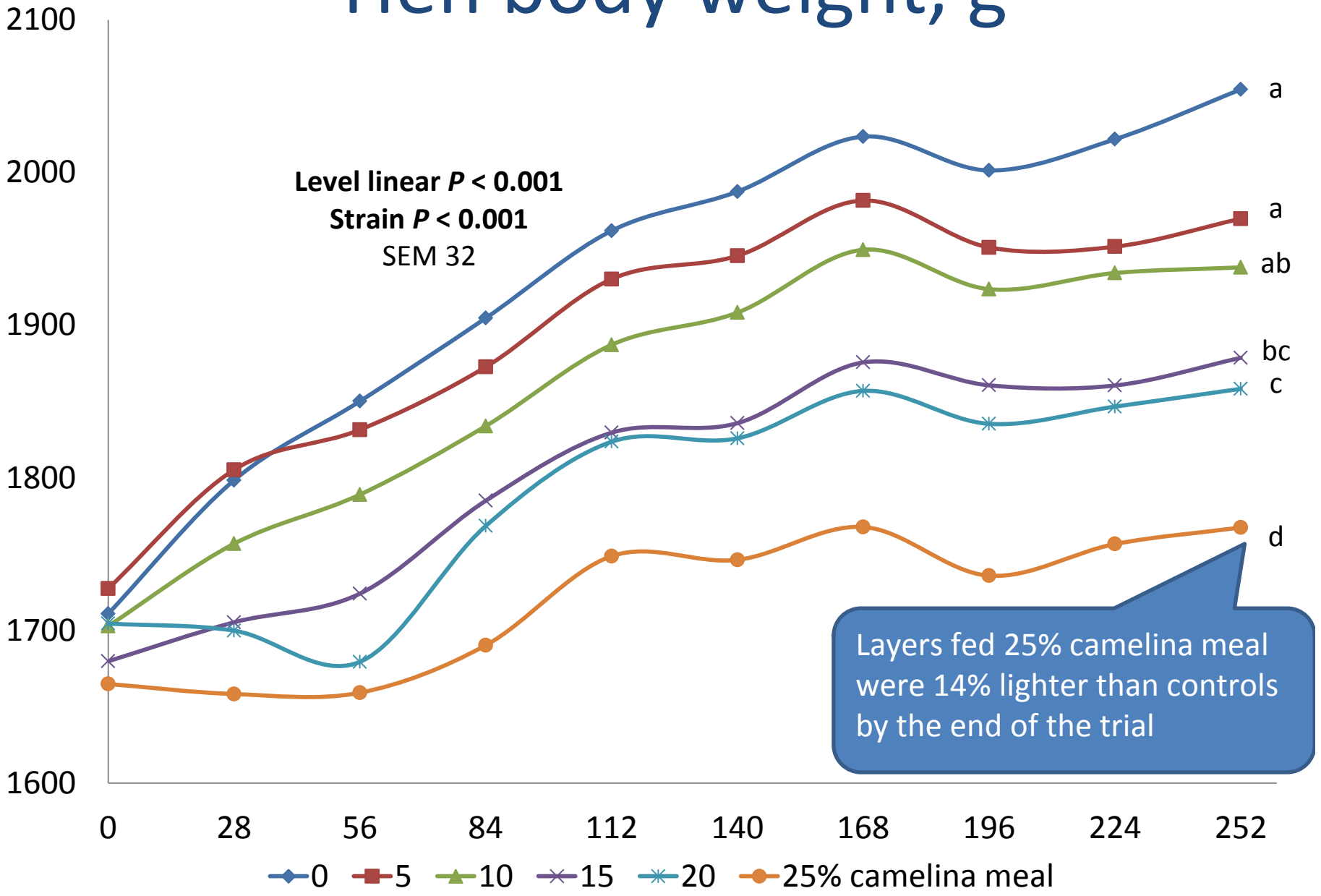
	EP camelina meal, %					
Nutrient, %	0	5	10	15	20	25
AME, Mcal/kg	2.8	2.8	2.8	2.8	2.8	2.8
Crude protein	17.3	17.3	17.3	17.3	17.3	17.3
Crude fat	8.6	8.6	8.6	8.6	8.6	8.6
Linoleic acid	2.2	2.2	2.3	2.3	2.3	2.4
Calcium	3.9	3.9	3.9	3.9	3.9	3.9
Av. phosp	0.42	0.42	0.42	0.42	0.42	0.42
Sodium	0.17	0.17	0.17	0.17	0.17	0.17
Chloride	0.17	0.17	0.17	0.17	0.17	0.17
Magnesium	0.1	0.1	0.1	0.09	0.09	0.08
Dig Arg	0.79	0.82	0.86	0.89	0.93	0.97
Dig His	0.35	0.34	0.33	0.31	0.3	0.29
Dig Ile	0.65	0.63	0.61	0.6	0.58	0.56
Dig Leu	1.05	1.03	1.02	1.01	0.99	0.98
Dig Lys	0.75	0.74	0.73	0.72	0.71	0.7
Dig Met	0.41	0.42	0.43	0.43	0.44	0.45
Dig Met+Cys	0.68	0.67	0.66	0.65	0.65	0.64
Dig Thr	0.54	0.53	0.52	0.51	0.5	0.49
Dig Try	0.26	0.24	0.22	0.2	0.18	0.16

Organ weights, % of BW

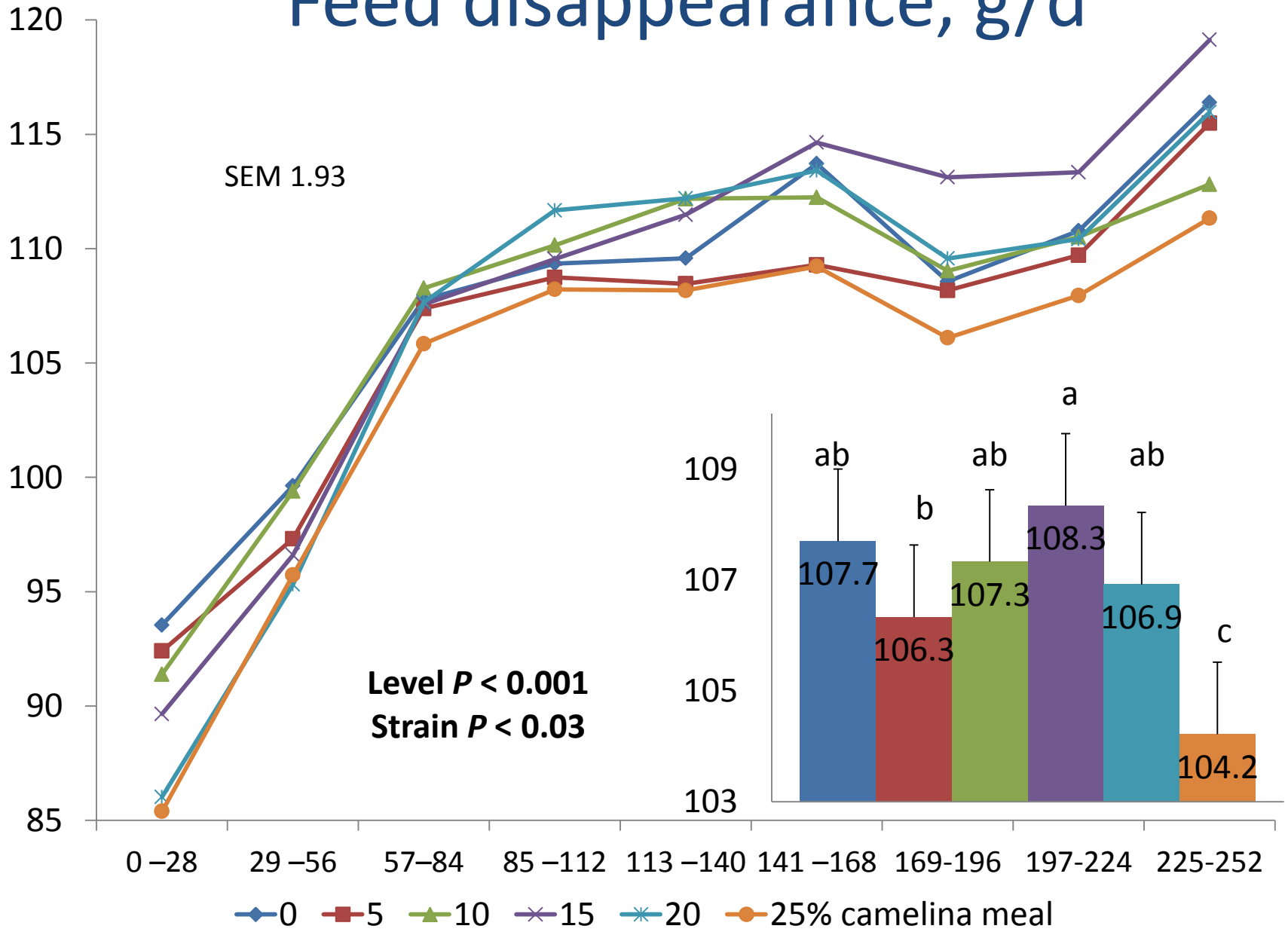
Serology

PDS, Saskatoon, SK	Camelina meal inclusion, %							*P* value	
	0	5	10	15	20	25	SEM	Level	Strain
Calcium	6.29^{ab}	6.36^{ab}	5.98^{abc}	5.90^{bc}	6.42^{a}	5.78^{c}	0.18	0.044	0.094
Phosphorus	1.62	1.43	1.64	1.87	1.71	1.53	0.13	0.276	0.135
Glucose	11.7	11.7	13.1	12.3	11.9	12.2	0.5	0.393	0.183
CCK	1300	1828	1493	2565	1531	1175	475	0.346	0.913
AST	183	174	186	203	177	183	14	0.727	0.152
Uric Acid	165	149	147	119	130	131	12	0.107	0.018
T4	7.37	6.76	3.69	3.02	4.39	7.26	1.59	0.199	0.777
T3	1.71	1.56	1.36	1.36	1.43	1.37	0.14	0.437	0.001

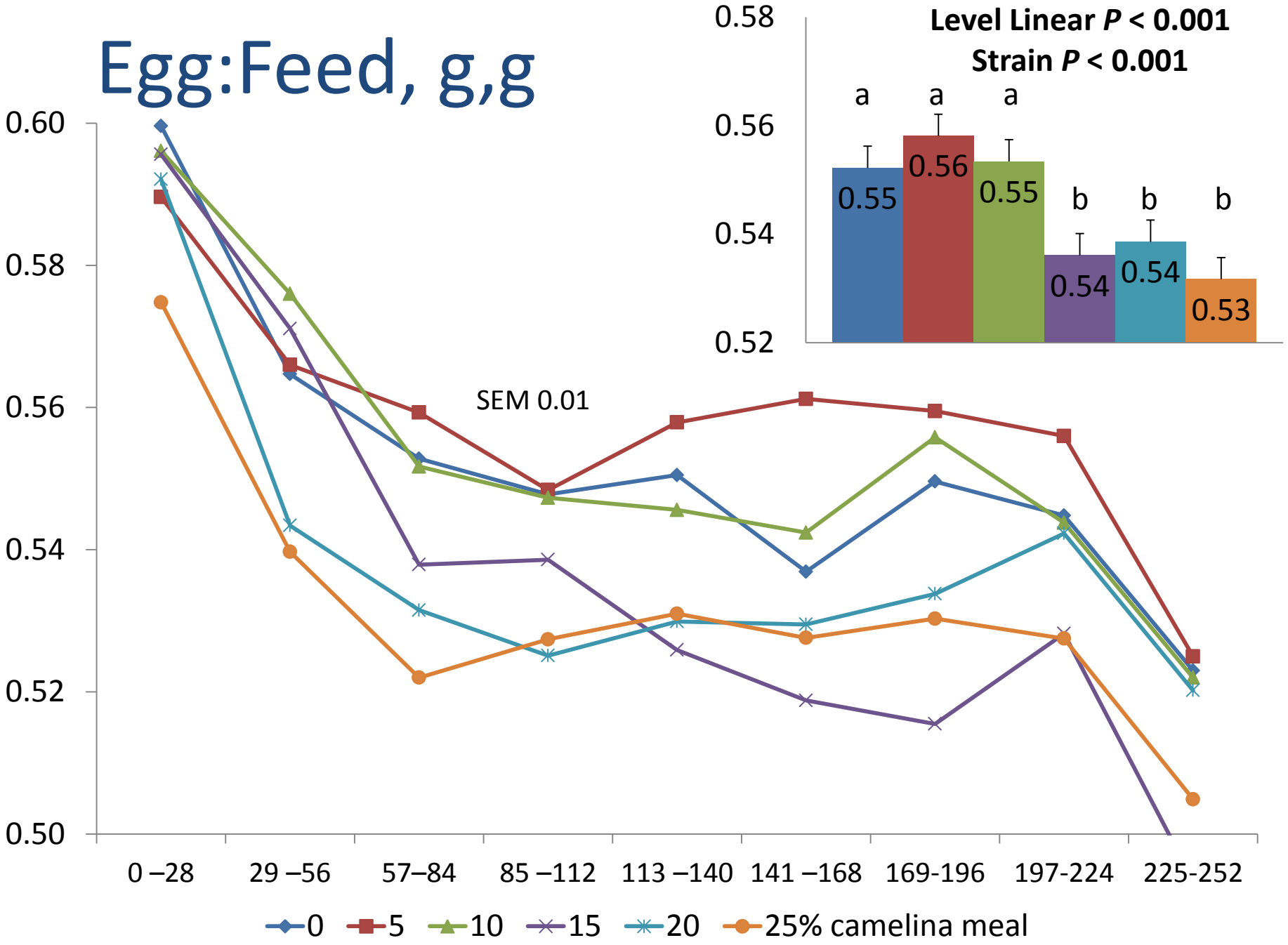
Hen body weight, g

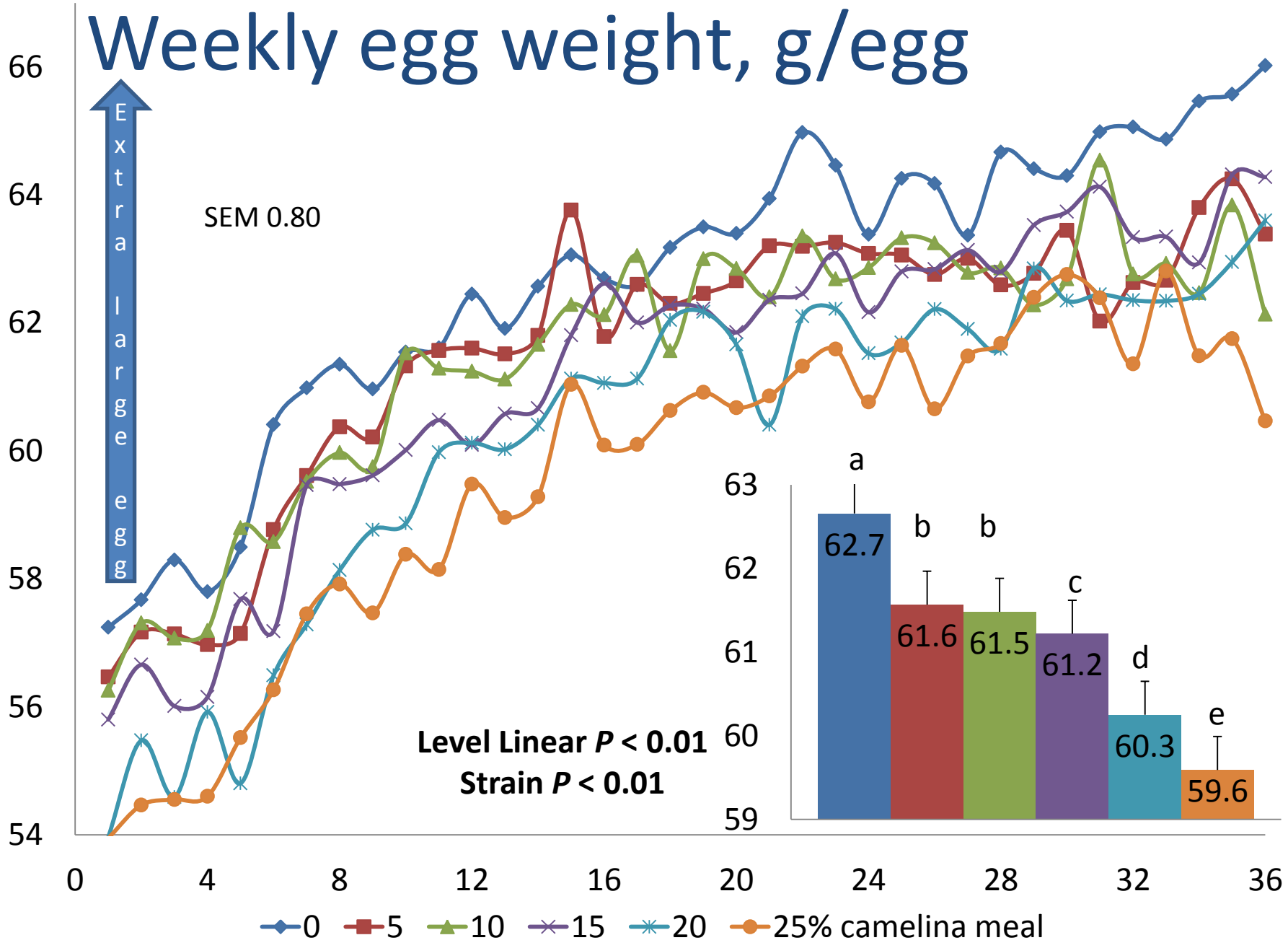


Feed disappearance, g/d

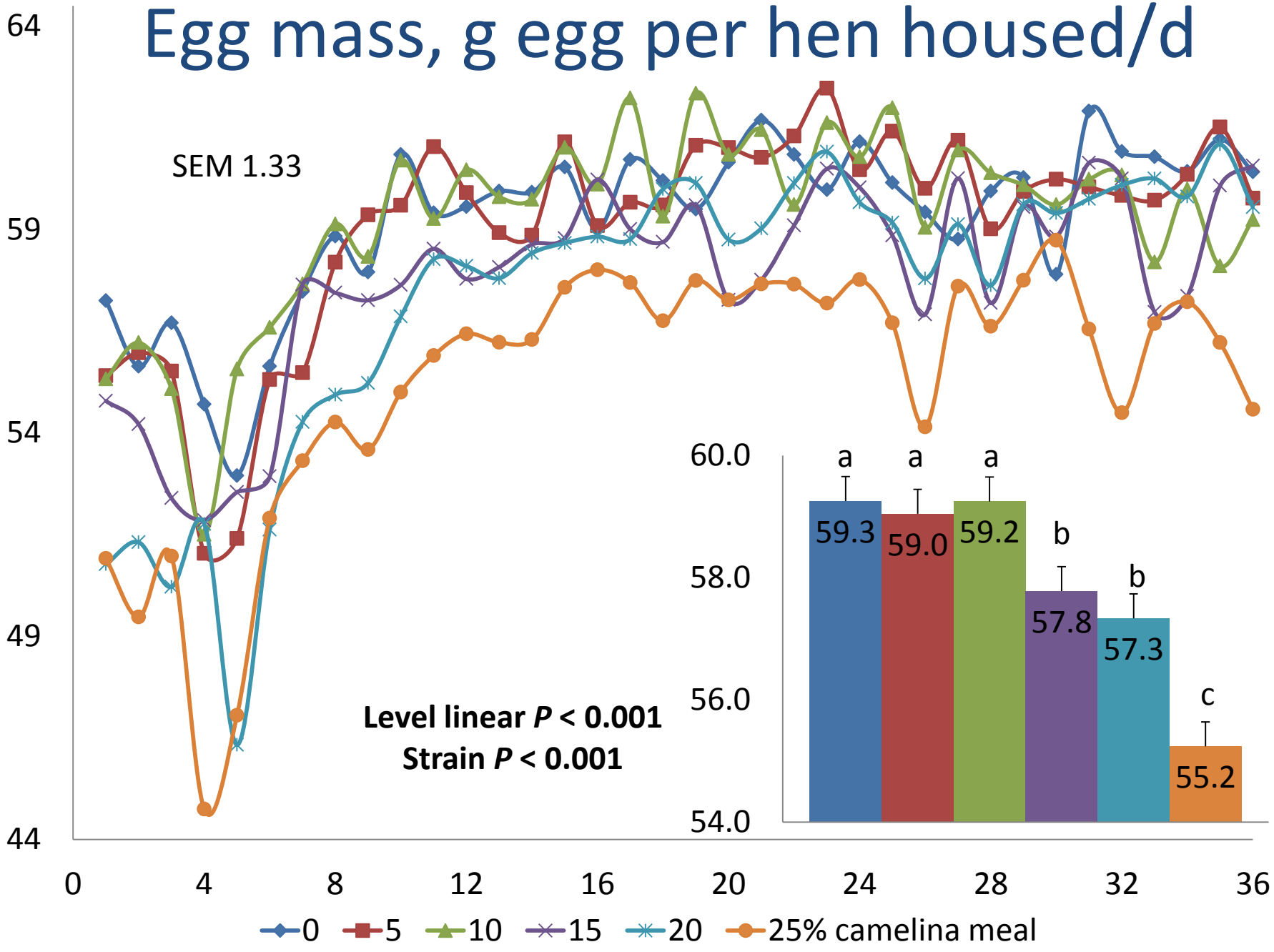


Egg:Feed, g,g

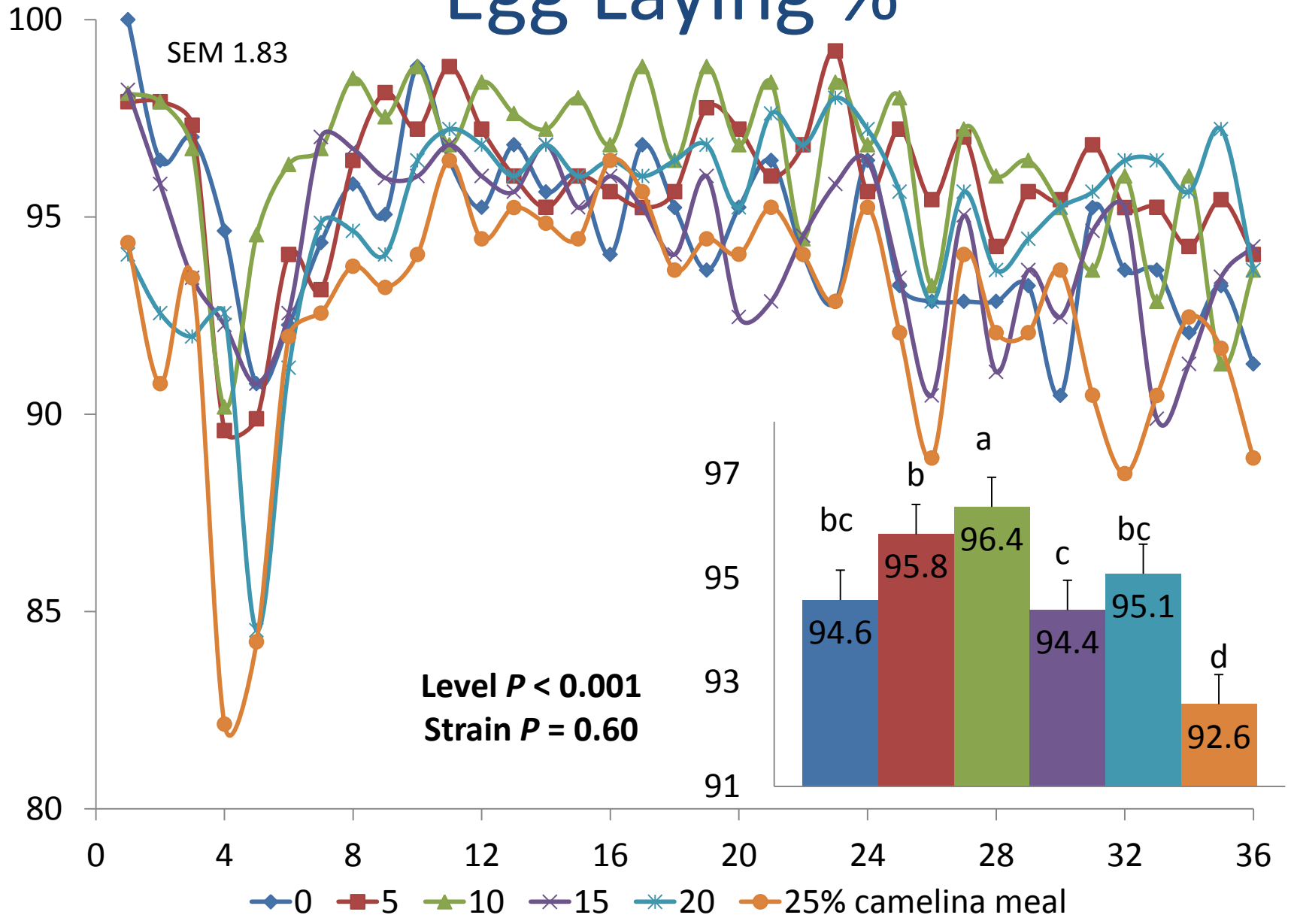




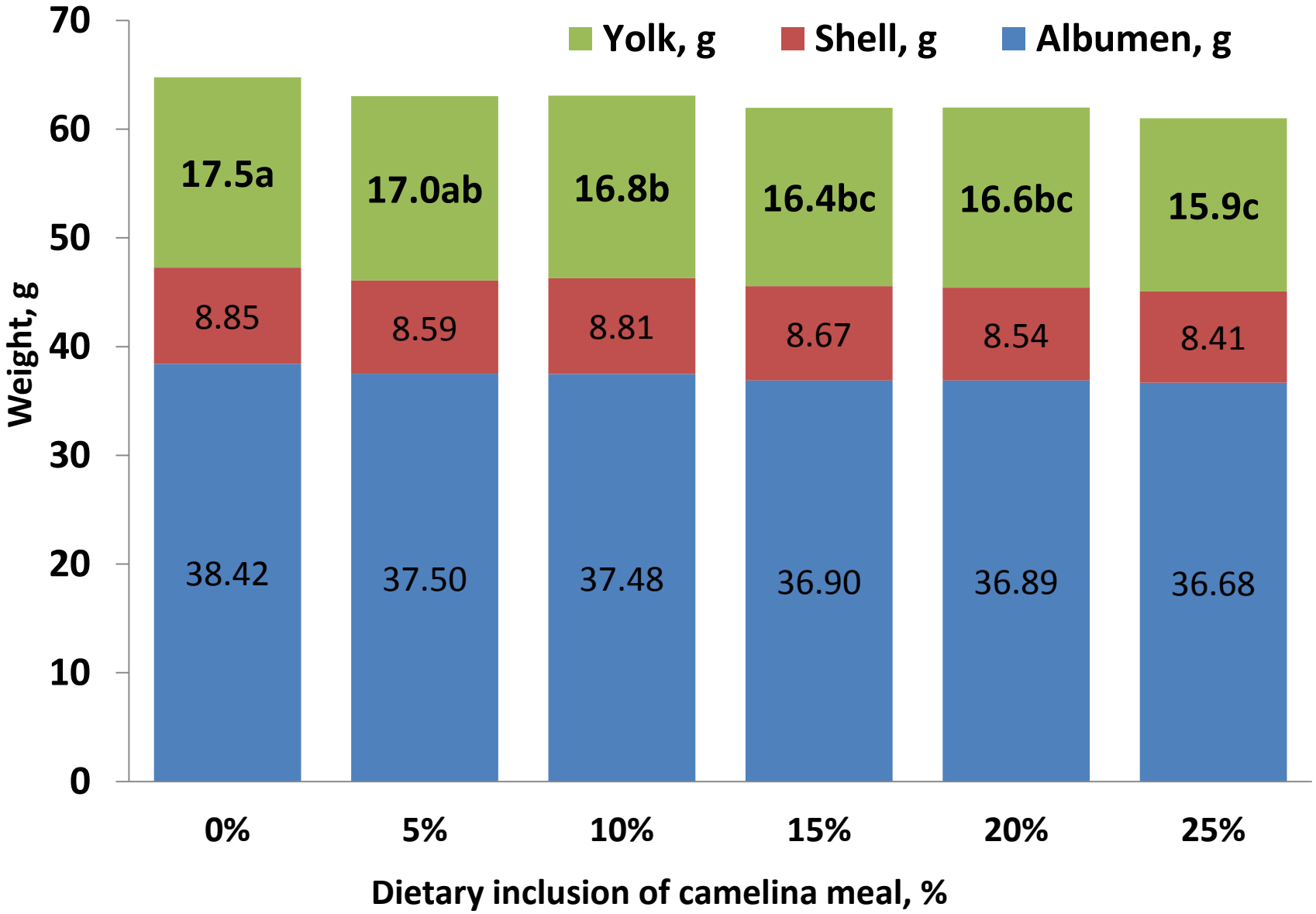
Egg mass, g egg per hen housed/d



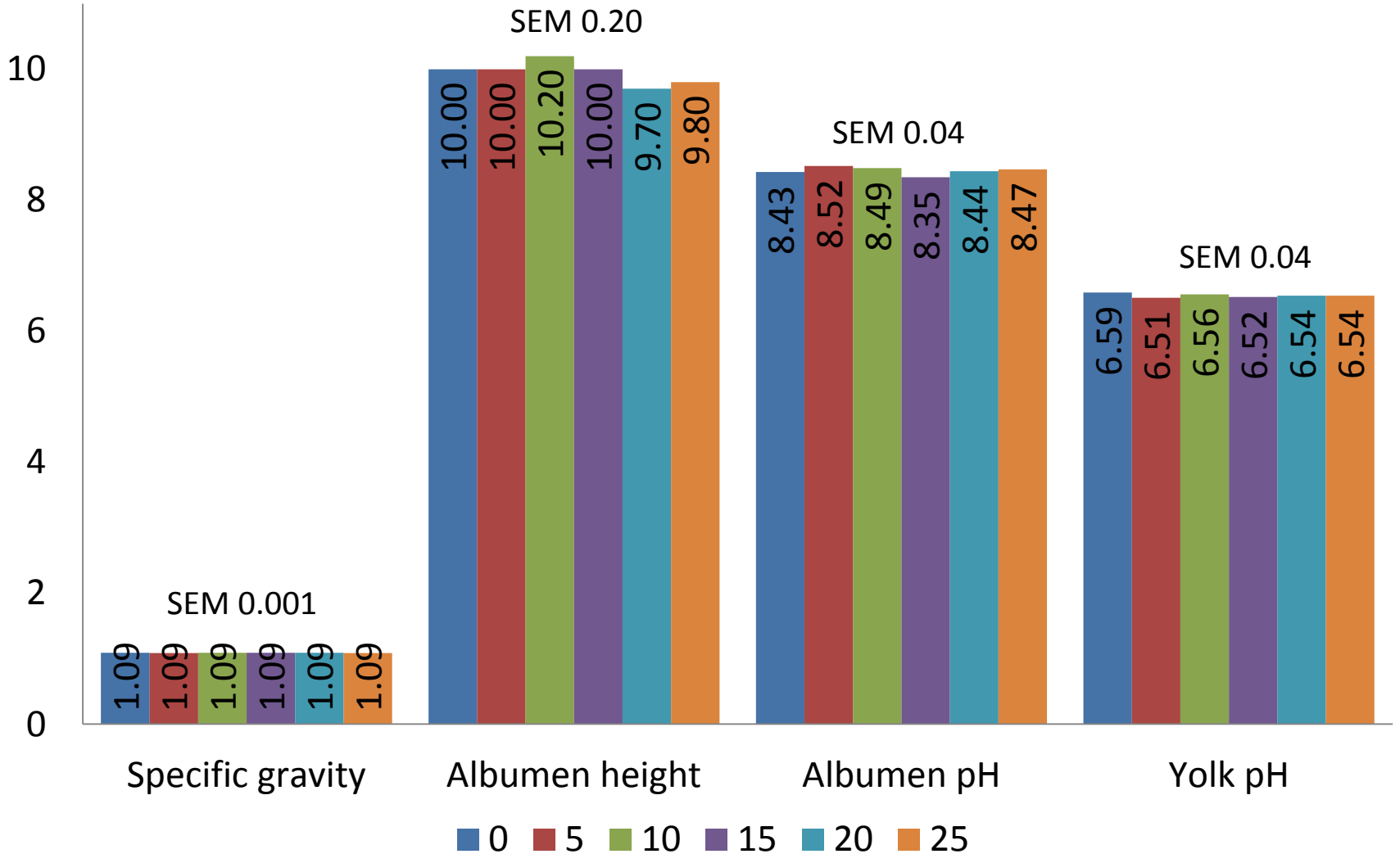
Egg Laying %



Egg components



Egg physical characteristics



Egg Fatty Acids

Linear *P* <0.0001

	Camelina meal inclusion level, %						
mg/g fresh egg	0	5	10	15	20	25	SEM
Total saturated	25.72a	25.49a	25.00ab	23.99c	24.11bc	24.55bc	0.33
Total monounsaturated	44.75a	43.47ab	42.93bc	41.66c	41.66c	42.13bc	0.54
α-Linolenic acid (C18:3 n-3)	1.17f	1.40c	1.60d	1.75c	2.10b	2.43a	0.04
DPA (C22:5 n-3)	0.14c	0.16bc	0.18a	0.18a	0.17ab	0.18a	0.01
Total omega-3	2.82e	**3.10d**	**3.38c**	**3.54c**	**3.93b**	**4.33a**	0.06
Total long-chain omega-3	1.65c	1.70bc	1.78ab	1.79ab	1.80ab	1.84a	0.04
Linoleic acid (C18:2 n-6)	11.07c	11.09c	11.18bc	11.04c	11.55b	12.12a	0.16
Total omega-6	12.51b	12.37b	12.36b	12.16b	12.61b	13.14a	0.17
Total omega-6:total omega-3	3.91a	3.45b	3.12c	2.86d	2.70e	2.61e	0.04
Total polyunsaturated	15.33c	15.47c	15.75c	15.70c	16.54b	17.47a	0.22

Summary

SAFETY:

1. Layers fed 25% camelina meal were 14% lighter than controls by the end of the trial
2. NO effect on serum parameters, T3, T4, organ wts.
3. Linear increase in pancreas wt, but NO hypertrophy

PERFORMANCE:

1. Layers fed 25% camelina avg. 92.6% egg prod. over 36 wks
2. Daily feed intake was reduced 3% only at 25% inclusion
3. Egg:feed was reduced 1% for each 10% camelina meal
4. Egg weight was reduced 1% for each 10% camelina meal
5. Egg mass was reduced 1.5% for each 10% camelina

Summary

EGG QUALITY:

1. No effect on egg components as % of egg wt.
2. No effect on specific gravity, albumen height, yolk pH

EGG SENSORY:

1. 30 panelists did NOT perceived cooked eggs from layers fed camelina to be different from controls.

EFFICACY:

1. Feeding only 5% camelina meal exceeded the 3 mg/g label requirement to claim ω-3 fatty acid enrichment.

CAMELINA

- Another egg out diversifying the canola basket
- Crop suitable to southern Prairies soils
- A bioindustrial crop, NO food controversy
- More stable oil and meal than flax for feeding
- ω-3 enrichment of eggs, broiler thigh, breast
- Lower cost of dietary energy feeding expellers
- PUFAs health benefit to animals and humans

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