Abstract # 145

Government of Alberta
Agriculture and Rural Development

Effect of Extrusion and Enzyme Supplementation on Nutrient Digestibility in Triticale DDGS for Broilers

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Supporters

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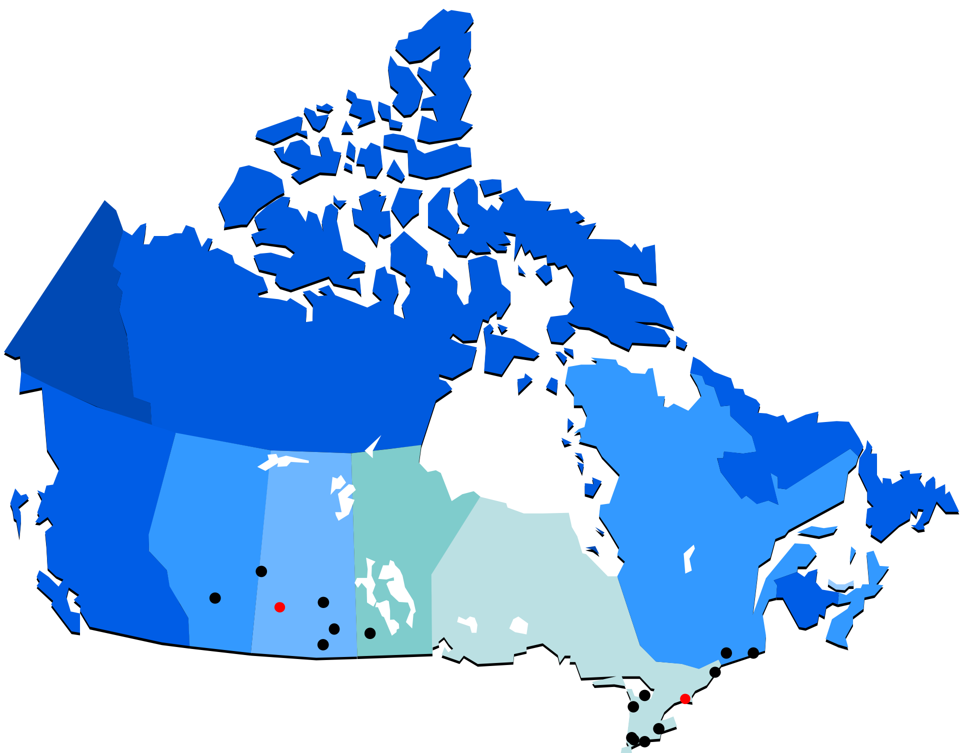
Policy Drivers for Expanded Ethanol Production

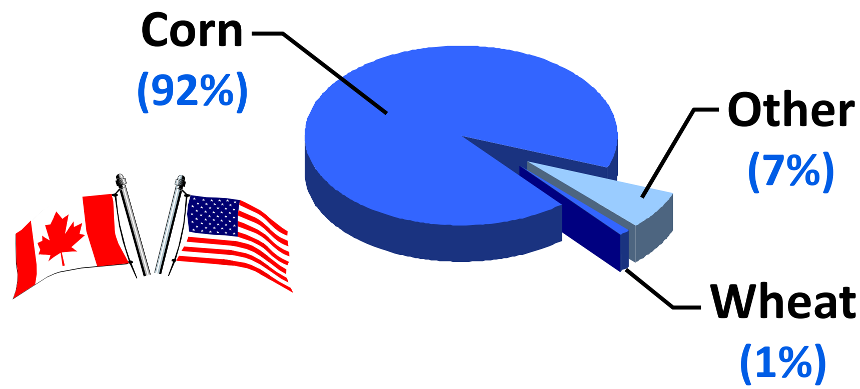
- **Government-mandated ‘green’ content in fuels:**

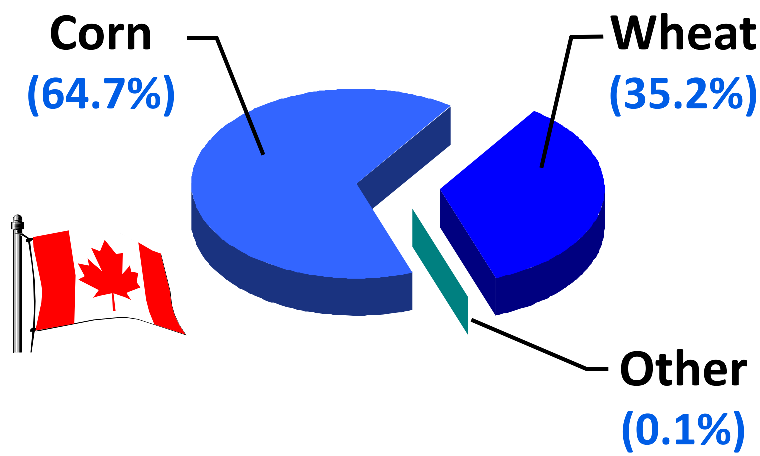
5% in gasoline by 2010
2% in diesel/heating oil by 2012

36 B Gallons by 2022
(~15% of gasoline consumption)

Ethanol Production in Canada







Disposition of Canadian Wheat (in millions of metric tonnes)

	Wheat (except Durum)		
	2007-08	2008-09	2009-10
Total Supply[1]	22.00	26.83	22.42
Exports	12.68	14.50	12.50
Food & Industrial Use	3.02	3.25	3.20
Feed, Waste & Dockage	1.79	3.67	2.08
Total Domestic Use	5.60	7.73	6.12

[1] Annual domestic production + imports + carry-over stocks

Implication: Further expansion of Canadian starch-based ethanol will likely mean less wheat will be exported

Source: Statistics Canada

Background

- **Renewable fuel standards will likely stimulate ethanol production in Canada**
  - ↑ demand/competition for feed grains
  - ↑ supply of ethanol co-products

Background

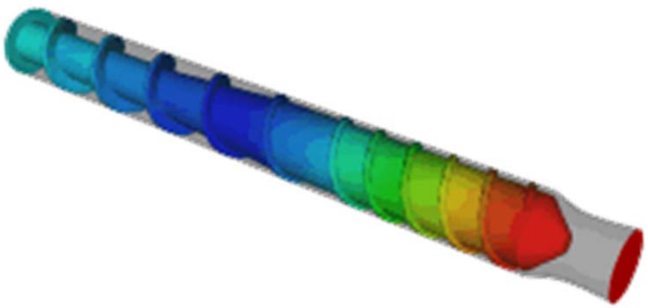
- **Triticale (*x Triticosecale*) has equivalent value compared to wheat for ethanol production**
  - Using triticale as a biofuel feedstock could alleviate local demand for wheat
  - Would create alternate market for triticale producers

Background

- No published reports regarding feed value of triticale DDGS for livestock or poultry
- Like wheat and corn DDGS, fibre content is likely to be a constraint for non-ruminants

Extrusion

- **Extrusion subjects ingredients to heat and shearing forces of a rotating screw auger**
  - Shear forces disrupt fibrous components
  - Heating can improve (or reduce) nutrient digestibility depending on conditions



Enzyme supplementation

- **Superzyme™ DDGS (Canadian BioSystems, Calgary, Canada)**
  - Designed specifically for non-ruminant diets containing DDGS
  - Enzyme combination intended to increase fibre degradation and enhance protein digestibility

Superzyme™ DDGS profile

Enzyme	Guaranteed activity in product	Activity in mixed feed (0.05% inclusion)
Xylanase (XYL)	300 U/g	150 U/kg
Glucanase (GLU)	250 U/g	125 U/kg
Amylase (FAA)	8 000 U/g	4 000 U/kg
Protease (HUT)	3 500 U/g	1750 U/kg
Invertase (INV)	10 000 U/g	10 000 U/kg

Source: **Canadian Bio-Systems Inc.**

Objectives

1. Evaluate extrusion and enzyme supplementation as low-cost processing strategies to improve feed value of DDGS for broilers
2. Generate information regarding the feeding value of triticale DDGS for broilers

Methods and Materials

Test system

- **Male Ross x Ross 308 broilers housed in cage batteries in a single room**
  - Approximately 7-8 birds per cage
  - Continuous access to nipple drinkers and trough feeder fitted with solid partitions
  - Wire mesh floors with conveyor belt system for each tier of battery

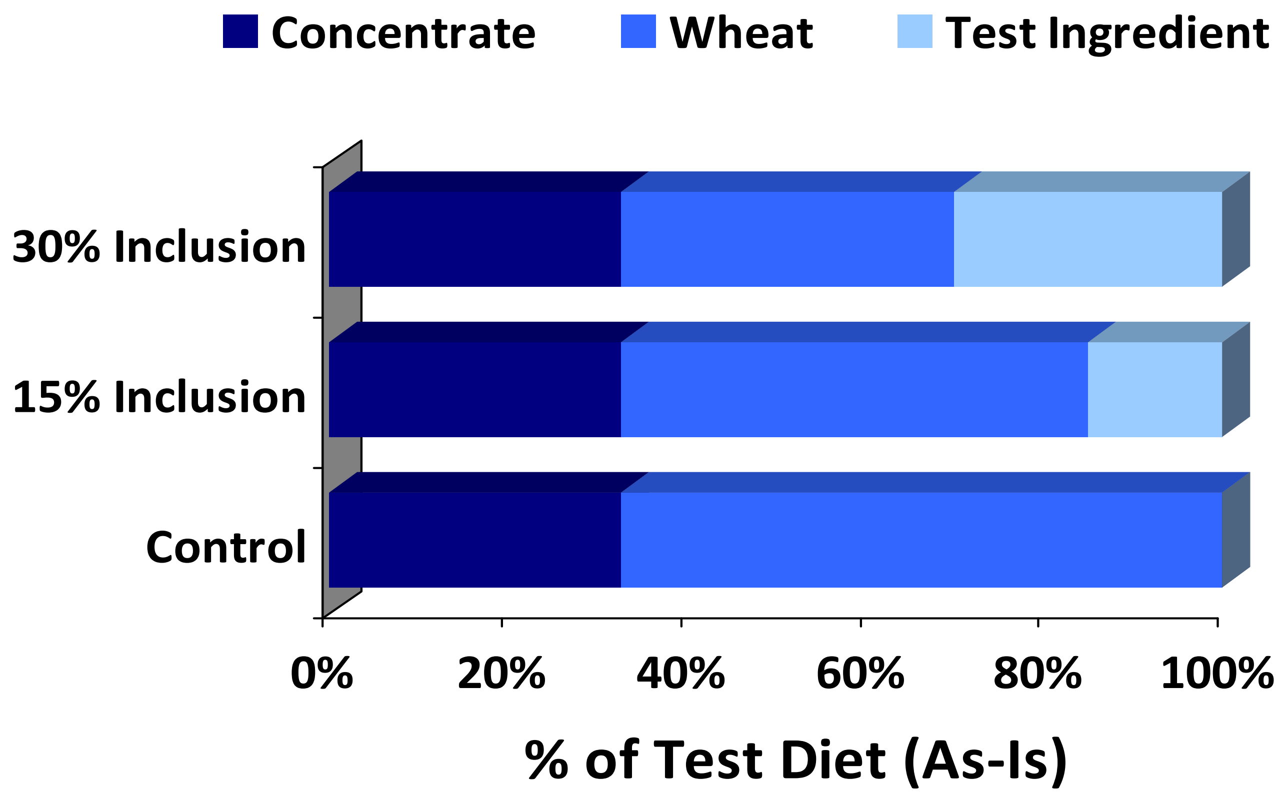
Experimental management

- **Test birds fed basal starter ration from d0-14 and basal grower ration from d14-21**
  - Birds received one of 9 test diets from d21-28
  - Sampled for ileal digesta on d 28 (1 pooled specimen/pen)

Test ingredients

- **Test ingredients:**
  - Triticale DDGS
  - Single-Screw Extruded Triticale DDGS
- **Enzyme:**
  - Superzyme^{TM} DDGS (0.05% inclusion)

Test diets


Concentrate
Wheat
Test Ingredient
30% Inclusion
15% Inclusion
Control
0%
20%
40%
60%
80%
100%
% of Test Diet (As-Is)

Test diets

- **10 test diets:**
  - Basal diet w/ and w/o enzyme (2)
  - 15% or 30% triticale DDGS, single screw extruded or not extruded w/ and w/o enzyme (2 x 2 x 2 = 8)

Table 1. Estimated nutrient content of test diets

Nutrient	Basal (no DDGS)	Triticale DDGS		Ext Triticale DDGS	
		15%	30%	15%	30%
Dry Matter, %	89.44	89.95	90.47	89.95	90.45
ME, kcal/kg	3152	3018	2884	3018	2884
Cr. Protein, %	20.11	22.07	24.04	22.95	25.79
Cr. Fat, %	7.15	8.52	9.89	7.96	8.77
Cr. Fiber, %	2.58	2.98	3.38	3.11	3.64
Av. Phosphorus, %	0.45	0.46	0.48	0.47	0.48
Calcium, %	0.9	0.9	0.89	0.91	0.92
Total Lys, %	1.1	1.18	1.27	1.18	1.27
Total Met + Cys, %	0.79	0.86	0.92	0.87	0.96

Experimental design

- **Randomized Complete Block:**
  – 5 blocks
  – Each treatment fed to 1 pen/block
  – 2 x 2 x 2 factorial (+ basal) arrangement
  – Pen = experimental unit

Statistical analysis

- **Nutrient digestibility in test diets compared using mixed models procedure (PROC MIXED) in SAS (v 9.1)**
  - Model: **y = Extrusion | Enzyme | Level**
  - Random term: block
  - Covariates tested: ADF and cr. fibre intake

Results and Interpretations

Significant terms in models

- ADF, fibre intake not significant (P > 0.10) as covariates
- With few exceptions no significant 2 or 3-way interactions for any nutrients

Table 2. Effect of level of inclusion on apparent ileal nutrient digestibility in diets containing triticale DDGS

Nutrient	15%	30%	SEM	*P-value*
Dry Matter	**64.87[a]**	**60.67[b]**	**0.35**	**<.0001**
Gross Energy	**72.52[a]**	**68.44[b]**	**0.48**	**<.0001**
Crude Protein	**79.70[a]**	**77.41[b]**	**0.26**	**<.0001**
Lysine	**84.11[a]**	**80.56[b]**	**0.49**	**<.0001**
Methionine	**85.67[a]**	**83.17[b]**	**0.47**	**<.0001**
Threonine	**75.15**	**73.71**	**0.54**	**0.0662**
Arginine	**85.06**	**84.45**	**0.58**	**0.4568**
Total AA's	**82.85[a]**	**80.34[b]**	**0.39**	**<.0001**

Interpretation: Generally, AID in 15% diets > AID in 30% diets

Different superscripts within rows denote significant differences ($P < 0.05$)

Table 3. Effect of extrusion of DDGS on apparent ileal nutrient digestibility in diets containing triticale DDGS

Nutrient	Not	Extruded	SEM	*P-value*
Dry Matter	**62.24^{b}**	**63.30^{a}**	**0.35**	**0.0403**
Gross Energy	**70.00^{b}**	**70.97^{a}**	**0.48**	**0.0207**
Crude Protein	**78.21**	**78.91**	**0.26**	**0.0674**
Lysine	**81.91**	**82.76**	**0.49**	**0.0915**
Methionine	**83.22^{b}**	**85.63^{a}**	**0.47**	**<.0001**
Threonine	**74.20**	**74.66**	**0.54**	**0.5545**
Arginine	**84.20**	**85.30**	**0.58**	**0.1862**
Total AA’s	**81.12^{b}**	**82.07^{a}**	**0.39**	**0.0198**

Interpretation: **Extruding DDGS increased AID of DM, GE, Met and Tot AA in diets**

Different superscripts within rows denote significant differences ($P < 0.05$)

Table 4. Effect of enzyme supplementation on apparent ileal nutrient digestibility in diets containing triticale DDGS

Nutrient	(-)	(+)	SEM	*P-value*
Dry Matter	61.39[b]	64.15[a]	0.35	<.0001
Gross Energy	69.20[b]	71.77[a]	0.48	<.0001
Crude Protein	78.14[b]	78.98[a]	0.26	0.0292
Lysine	81.88	82.79	0.49	0.0712
Methionine	84.18	84.67	0.47	0.232
Threonine	73.69	75.16	0.54	0.0618
Arginine	84.03	85.48	0.58	0.0851
Total AA's	81.11[b]	82.08[a]	0.39	0.0178

Interpretation: Enzyme supplementation increased AID of DM, GE, CP and Tot AA in diets

Different superscripts within rows denote significant differences ($P < 0.05$)

Estimating AID in test ingredients

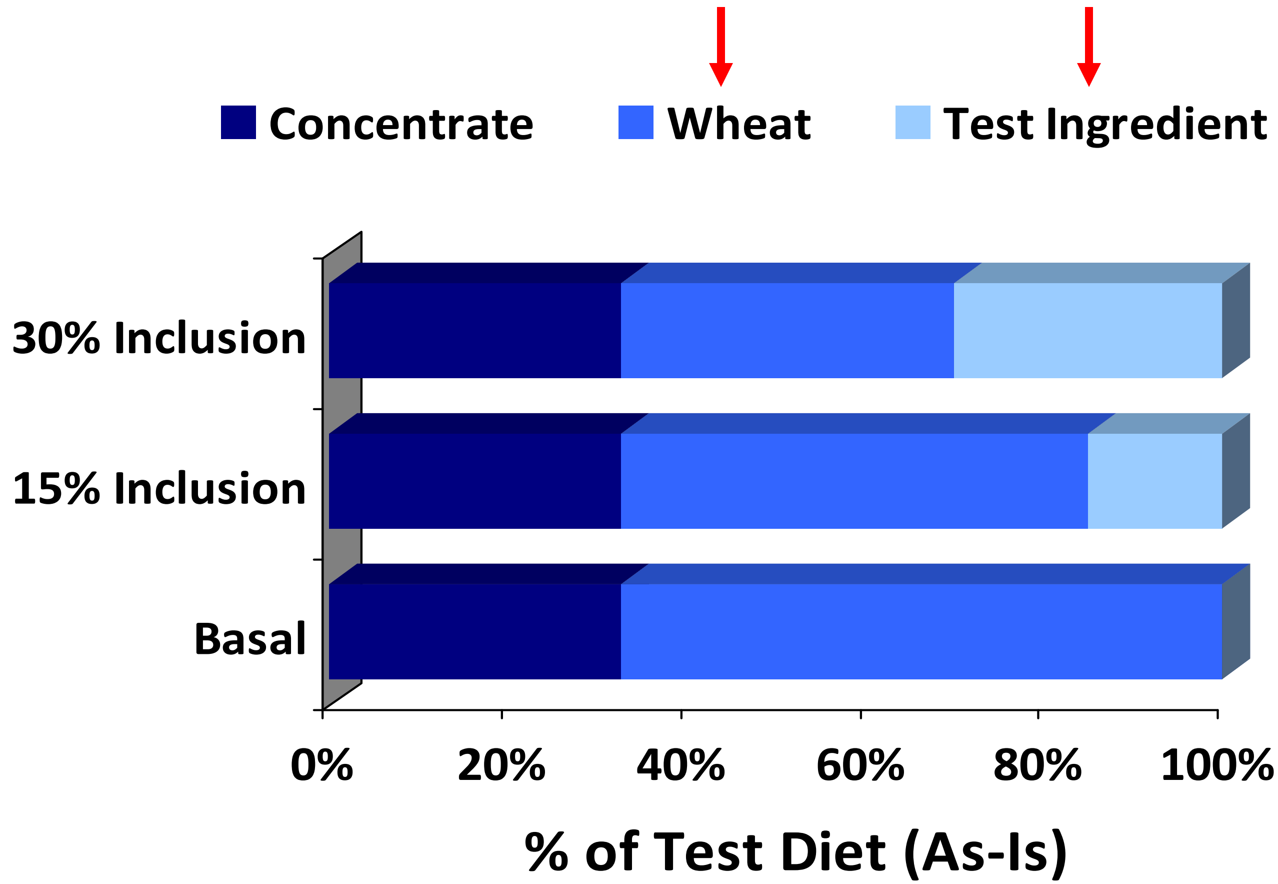
- **Interest in estimating nutrient digestibility coefficients for each DDGS type**
  - How much did extrusion improve AID in DDGS?
  - Needed dig nutrient contents in order to formulate diets for performance study

Procedure used to estimate nutrient digestibility in test ingredients

Assumption underlying the difference method:

$$D_{assay} = D_{basal} \times RC_{basal} + D_{test} \times RC_{test}$$

Test diets


Concentrate
Wheat
Test Ingredient
30% Inclusion
15% Inclusion
Basal
0%
20%
40%
60%
80%
100%
% of Test Diet (As-Is)

Procedure used to estimate nutrient digestibility in test ingredients

As a result, for the diets in our study:

$$\mathbf{D_{assay} = D_{wheat} \times RC_{wheat} + D_{conc} \times RC_{conc} + D_{test} \times RC_{test}}$$

This can be rearranged to solve for $\mathbf{D_{test}}$:

$$\mathbf{D_{test} = \frac{D_{assay} - D_{conc} \times RC_{conc} - D_{wheat} \times RC_{wheat}}{RC_{test}}}$$

Table 5. Literature AID coefficients for wheat used to estimate AID in test ingredients

	w/o NSPase	w/ NSPase
Gross Energy	0.66	0.68
Crude Protein	0.77	0.77
Lysine	0.89	0.92
Methionine	0.94	0.96
Threonine	0.76	0.82
Arginine	0.86	0.90

Derived from:

Afshermanesh et al. 1998 (Can. J. Anim Sci. 86: 255-261)
Huang et al. 2005 (Brit Poult. Sci. 46: 236-245)
Ravindran 1999 (Brit. Poult. Sci. 40: 266-274)
Rutherfurd et al. 2002 (Brit. Poult. Sci. 44: 598-606)
Rafuse et al. 2005 (Can. J. Anim. Sci. 85: 493-499)
Scott et al. 1998 (Poult. Sci. 77: 456-463)
Bedford et al. 1998 (Can. J. Anim. Sci. 78: 335-342)
Huang et al. 2006 (Poult. Sci 86: 625-634)

Significant terms in models

- **Similar outcomes as analysis of diets**
  - ADF, fibre intake not significant (P > 0.10) as covariates
  - With few exceptions no significant 2 or 3-way interactions for any nutrients
- **Effect of level only for GE, CP and Met**

Table 6. Effect of level of DDGS in test diets on estimated apparent ileal nutrient digestibility in triticale DDGS

Nutrient	15%	30%	SEM	*P-value*
Gross Energy	**78.50[a]**	**60.28[b]**	**1.73**	**<.0001**
Crude Protein	**75.93[a]**	**71.02[b]**	**0.86**	**0.0004**
Lysine	**55.00**	**54.38**	**2.30**	**0.8491**
Methionine	**62.47[b]**	**70.14[a]**	**1.07**	**<.0001**
Threonine	**58.84**	**63.99**	**2.18**	**0.1061**
Arginine	**74.50**	**78.61**	**2.66**	**0.2295**

Interpretation: effect of level not solely related to wheat level in test diets (assumptions underlying difference method???)

Different superscripts within rows denote significant differences ($P < 0.05$)

Table 7. Effect of extrusion of DDGS on estimate apparent ileal nutrient digestibility in triticale DDGS

Nutrient	Not	Extruded	SEM	*P-value*
Gross Energy	**71.16^{a}**	**67.62^{b}**	**1.73**	**0.0447**
Crude Protein	**72.10^{b}**	**74.84^{a}**	**0.86**	**0.0327**
Lysine	**54.12**	**55.26**	**2.3**	**0.7302**
Methionine	**63.57^{b}**	**69.04^{a}**	**1.07**	**0.0006**
Threonine	**60.34**	**62.49**	**2.18**	**0.4915**
Arginine	**73.93**	**79.18**	**2.66**	**0.1279**

Interpretation: Extrusion increased AID of CP and several essential AA's in triticale DDGS

Different superscripts within rows denote significant differences ($P < 0.05$)

Table 8. Effect of enzyme supplementation on estimated apparent ileal nutrient digestibility in triticale DDGS

Nutrient	(-)	(+)	SEM	*P-value*
Gross Energy	66.95^{b}	71.83^{a}	1.73	0.0072
Crude Protein	71.33^{b}	75.61^{a}	0.86	0.0015
Lysine	51.35^{b}	58.03^{a}	2.3	0.0497
Methionine	65.86	66.75	1.07	0.5356
Threonine	60.79	62.04	2.18	0.6884
Arginine	75.23	77.88	2.66	0.4351

Interpretation: Enzyme supplementation appears to improve AID of nutrients in triticale DDGS

Different superscripts within rows denote significant differences ($P < 0.05$)

Summary

- **Expanded ethanol production in Canada may involve use of novel feedstock to mitigate pressure on wheat supplies**
  - DDGS from triticale and other feedstocks may become more widespread as ethanol production expands

Summary

- **Feeding value of triticale DDGS appears to be improved by extrusion and enzyme supplementation of diets**
  - Extrusion improved AID of CP, eAA's
  - Enzyme improved AID of GE, CP and Lys
- **Level of inclusion in test diets appears to influence AID estimates**
  - Validity of assumptions in difference method???

What all this means…

Triticale DDGS: not extruded, no enzyme vs. extruded with enzyme

	Increase in dig. nutrient content (units/T)	Value of dig. nutrient content ($/unit)	Estimated increase in value ($/T)
Energy	440 Mcal/T	$0.07/Mcal	$30.00
Lysine	-	$2.40/kg	-
Methionine	0.34 kg/T	$7.50/kg	$2.55
Threonine	-	$3.00/kg	-
		Total	$32.55

Side benefits of extrusion

- **Improved handling characteristics**
  - Flowability improved dramatically
- **Eliminates or reduces toxin/pathogen levels**
  - Some reports suggest extrusion effective against certain mycotoxins (??)

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