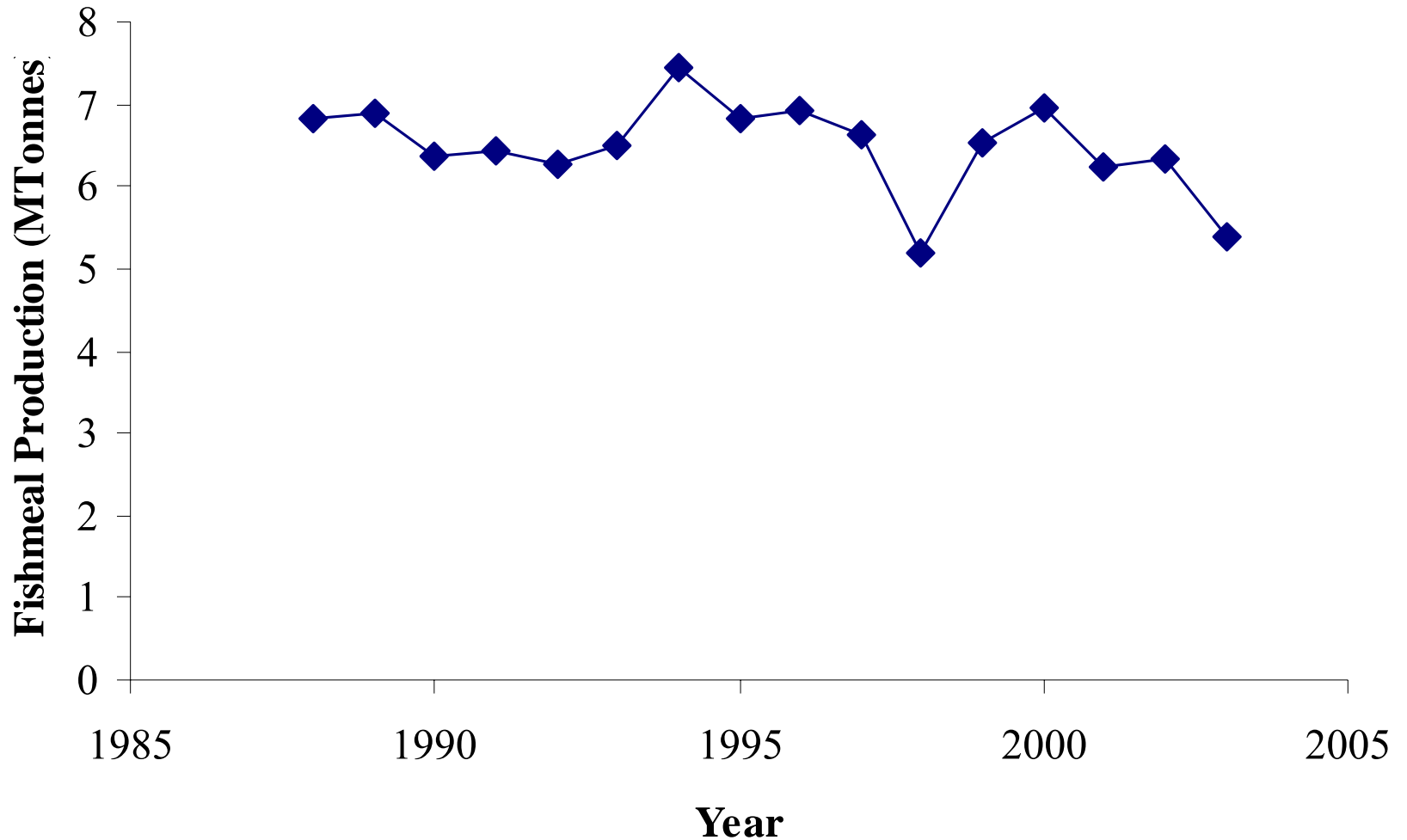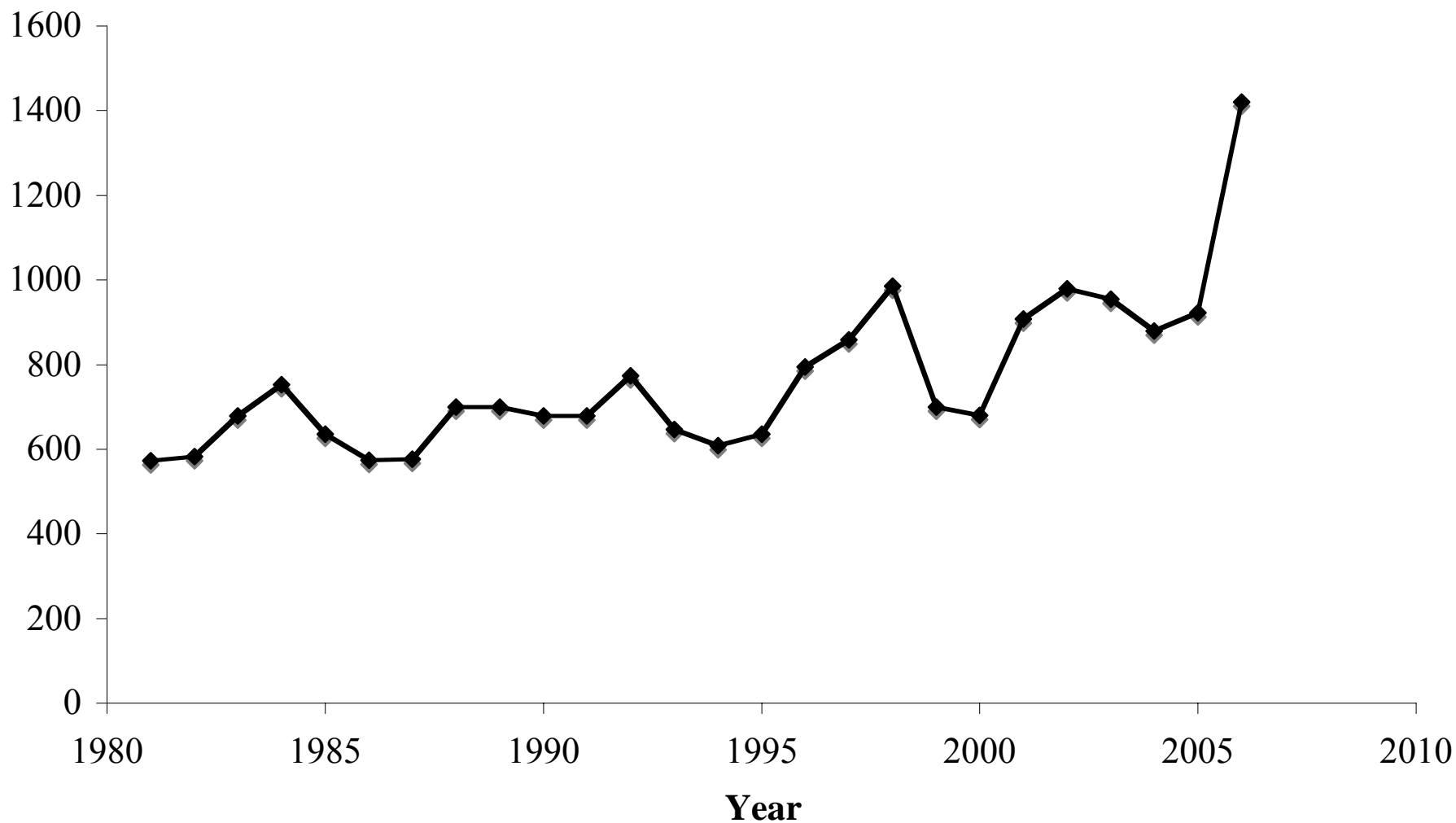# *Use of canola in aquafeeds*

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World Fishmeal Production 1985-2005

Price of fishmeal 1980-2003

How will we replace fish meal?

Soybean meal

- The #1 plant protein source in the world
- Accounts for 75% of all protein used in animal agriculture
- Soyabean meal can replace 20-30% of fishmeal with no negative effects
- At higher levels fish growth and efficiency is affected

Nutritional Properties of fish meal and some plant proteins use in aquaculture diets

|	Crude Protein	PER	Heat Labile ANF	Heat Stable ANF
Fish Meal	50-72	3.1-3.7		
Soyabean Meal	48	1.60	trypsin inhibitor, lectins	saponins, NSP, phytate, phytoestrogens, protein antigens
Canola/ Rapeseed	38	3.29	glucosinolates	phytate, tannins, sinapine, fibre, phenolic compounds
Peas	23	1.56	protease inhibitors, lectins, cyanogens	saponins, starch, phytic acid, protein antigens
Flax	25	2.88	cyanogenic glycosides,	mucilage and NSP

Strategy for Replacing Fish Meal with Plant Proteins

- Protein concentrates
  - Increase protein concentration
  - remove antinutritional factors
- Complex diets
  - Formulate diets with a low inclusion (< 20%) of many different plant proteins
 - avoid negative reactions to plant antinutritional factors

Effect of Processing on Nutrient Density of Canola

Crop	Protein (%)	DE Trout (Mcal/Kg)
Corn Gluten Meal	63.1	4.26
Soybean Meal	47.5	2.90
Canola Meal	36-38	2.60
Sieved Canola Meal	43	2.43
Canola Protein Concentrate	60-70	4.31

Effect of processing canola on energy and protein digestibility in Rainbow Trout
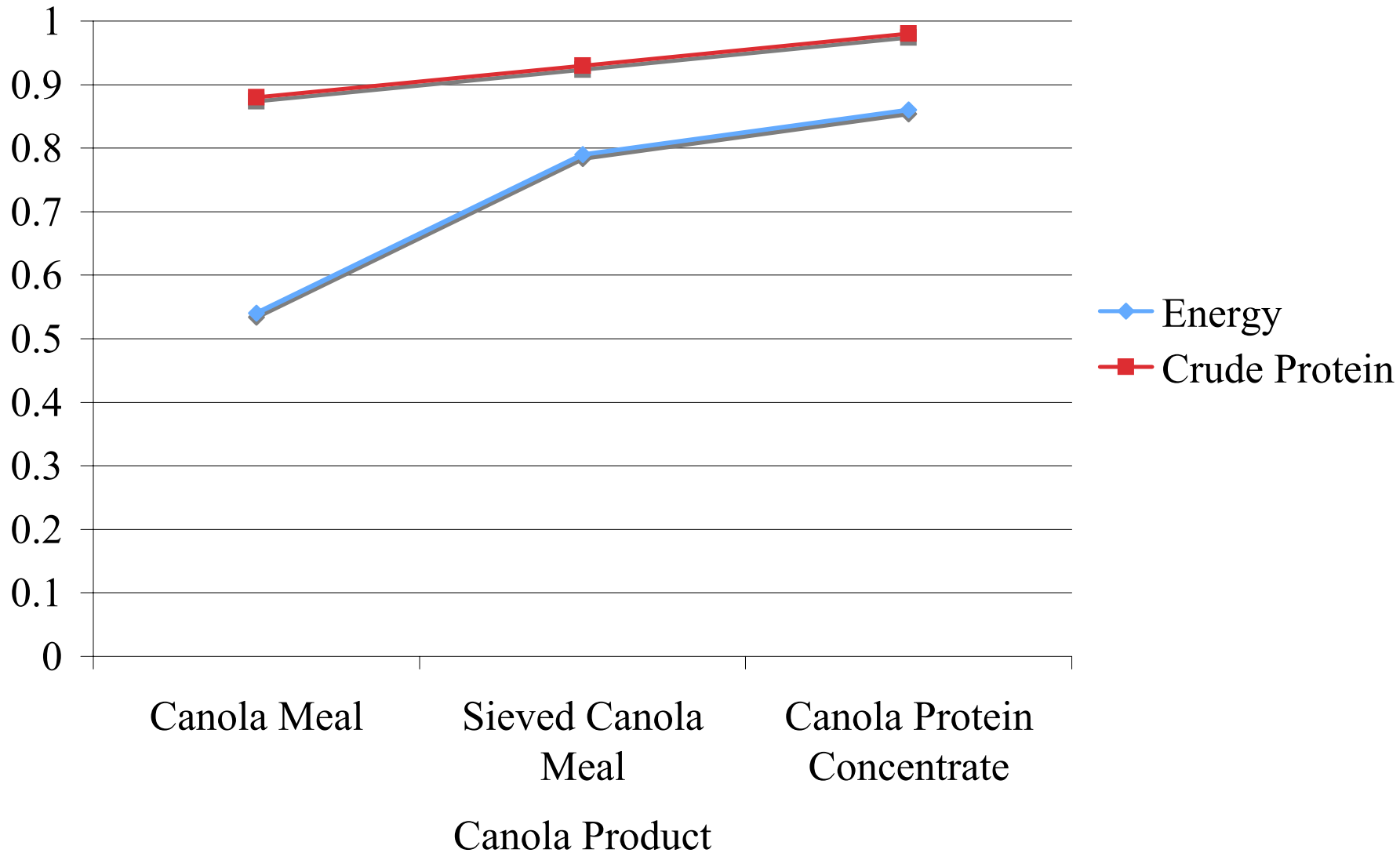
Effect of processing canola on energy and protein digestibility in Nile Tilapia
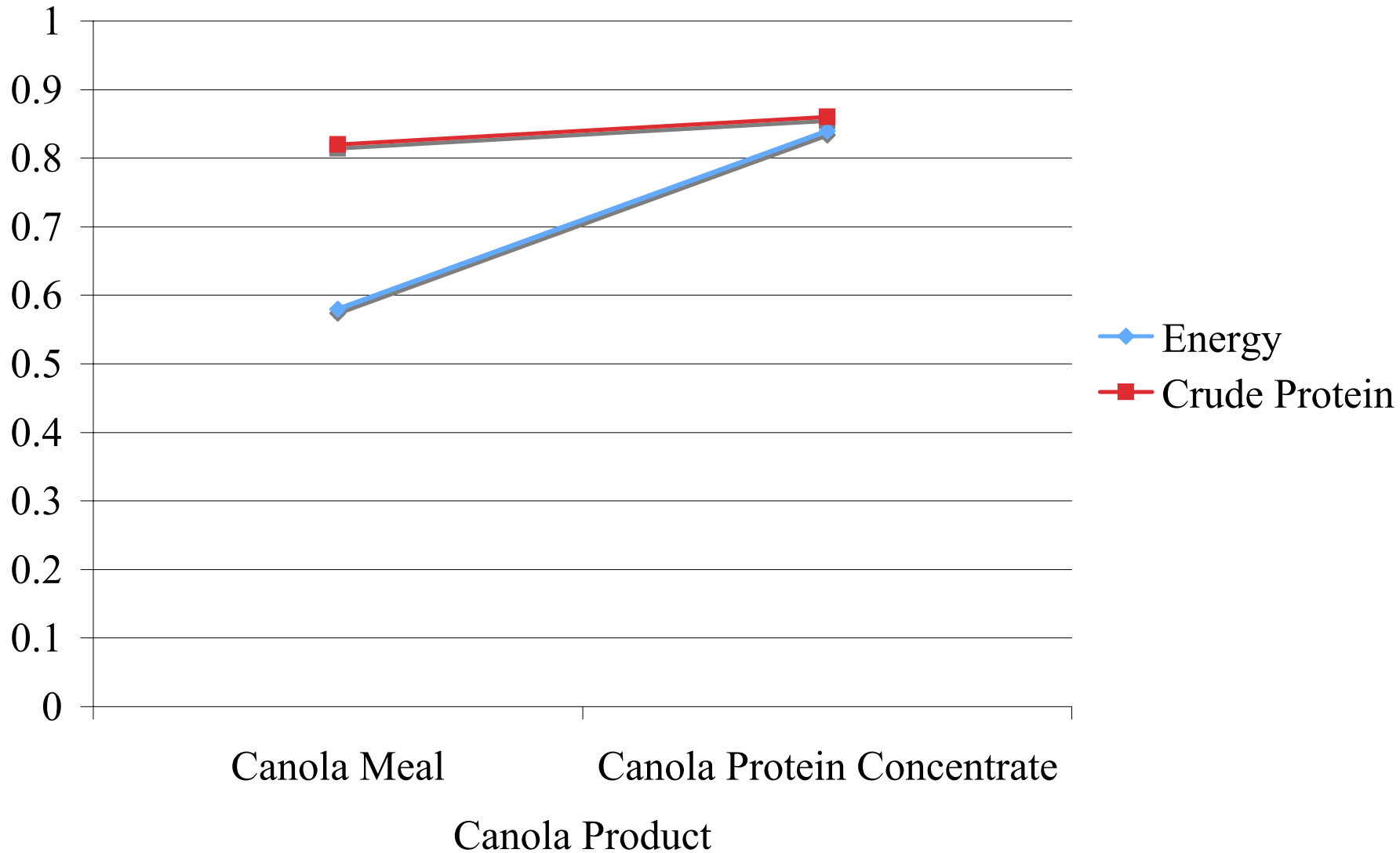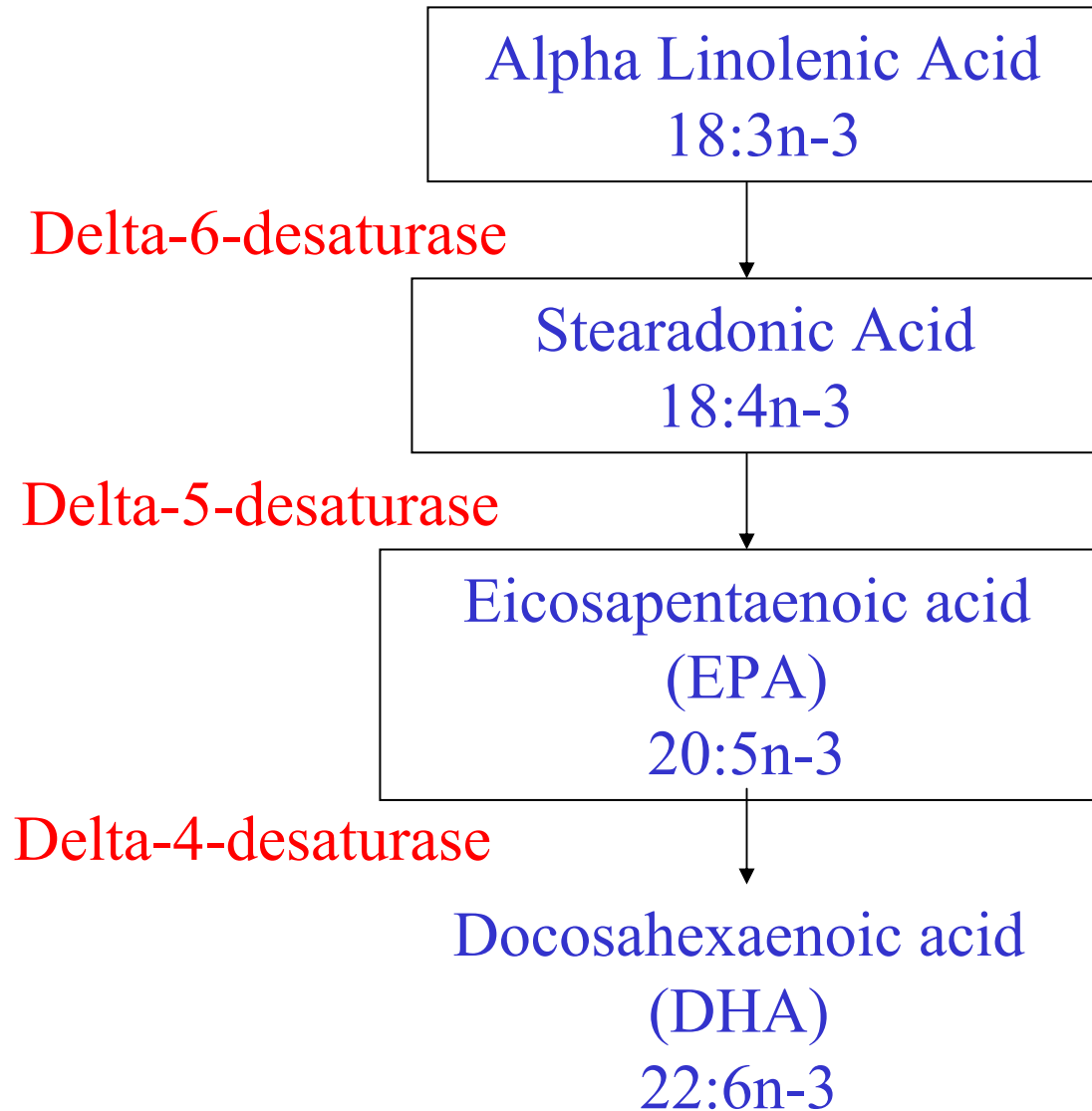
How will we replace fishoil?

Fatty acid composition of oils

Fat Source	% n-6	% n-3	N-6:n-3
Herring Oil	1.4	17.8	0.1
Tallow	3.1	0.6	5.2
Sunflower Oil	65.7	0	∞
Corn Oil	58.0	0.7	82.9
Canola Oil	20.2	12.0	1.7
Linseed Oil	12.7	53.3	0.2

Fatty acid composition of fish and vegetable oils (% of oil)

Fat Source	18:2-n6	18:3-n3	20:5-n3	22:6-n3
Herring Oil	1.1	0.6	8.1	4.8
Tallow	3.1	0.6	0	0
Sunflower Oil	65.7	0	0	0
Corn Oil	58.0	0.7	0	0
Canola Oil	20.2	12.0	0	0
Linseed Oil	12.7	53.3	0	0

Fresh water fish and most salmonids

Alpha Linolenic Acid
18:3n-3

Delta-6-desaturase

Stearadonic Acid
18:4n-3

Delta-5-desaturase

Eicosapentaenoic acid
(EPA)
20:5n-3

Delta-4-desaturase

Docosahexaenoic acid
(DHA)
22:6n-3

Diet formulations

Ingredient	Fish oil	Linseed/Canola Oil
Fish meal	40.00	40.00
Fish oil	20.00	0.00
Canola oil	0.00	13.00
Linseed oil	0.00	7.00
Corn gluten meal	7.04	7.04
Soybean meal	10.00	10.00
Wheat flour	11.42	11.42
Poultry meal	8.00	8.00
Blood meal,	2.00	2.00
Vitamin premix	0.50	0.50
Mineral premix	0.50	0.50
Choline chloride	0.40	0.40
Vitamin C monoP	0.12	0.12
Antioxidant	0.30	0.30
Calculated Analysis (%)		
Digestible Protein	40.0	40.0
Digestible Energy (MJ/kg)	20.5	20.5
n-3 fatty acids	6.8	6.5

Fish Growth Performance

Diet	Initial Body Weight g/fish	Total Wt Gain g/fish	Total Feed Intake g/fish	Feed Efficiency Feed:Gain
Fish oil	47.9	257.3	282.9	1.10b
Linseed/ Canola oil	46.3	271.4	245.7	.91a
SEM	0.90	13.08	15.08	0.05

[ab]Means with different superscripts are significantly different (P < 0.05)
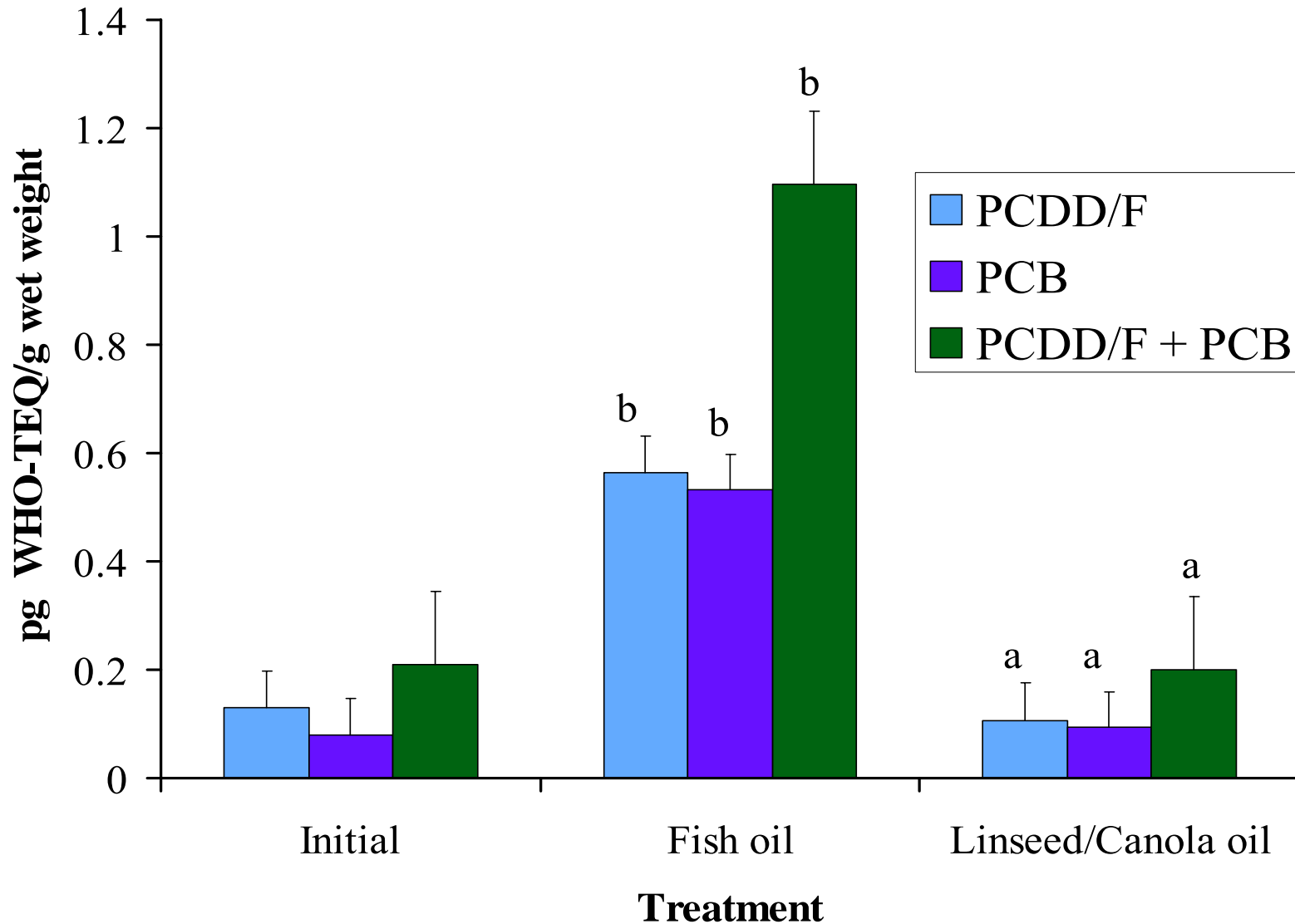
Fatty Acid Composition

Diet	18:2n-6 Linoleic	18:3n-3 ALA	20:5n-3 EPA	22:6n-3 DHA	Total n-3	Total n-6
Fish oil	4.7a	1.6a	8.2a	13.0a	29.6	6.0
Linseed/ Canola oil	14.8b	13.4b	1.6b	5.2b	24.7	15.4
SEM	1.58	2.28	.95	1.31		

[a,b]Means with different superscripts are significantly different (P < 0.05)

Content of PCDD/F and PCBs in feed ingredients and diets
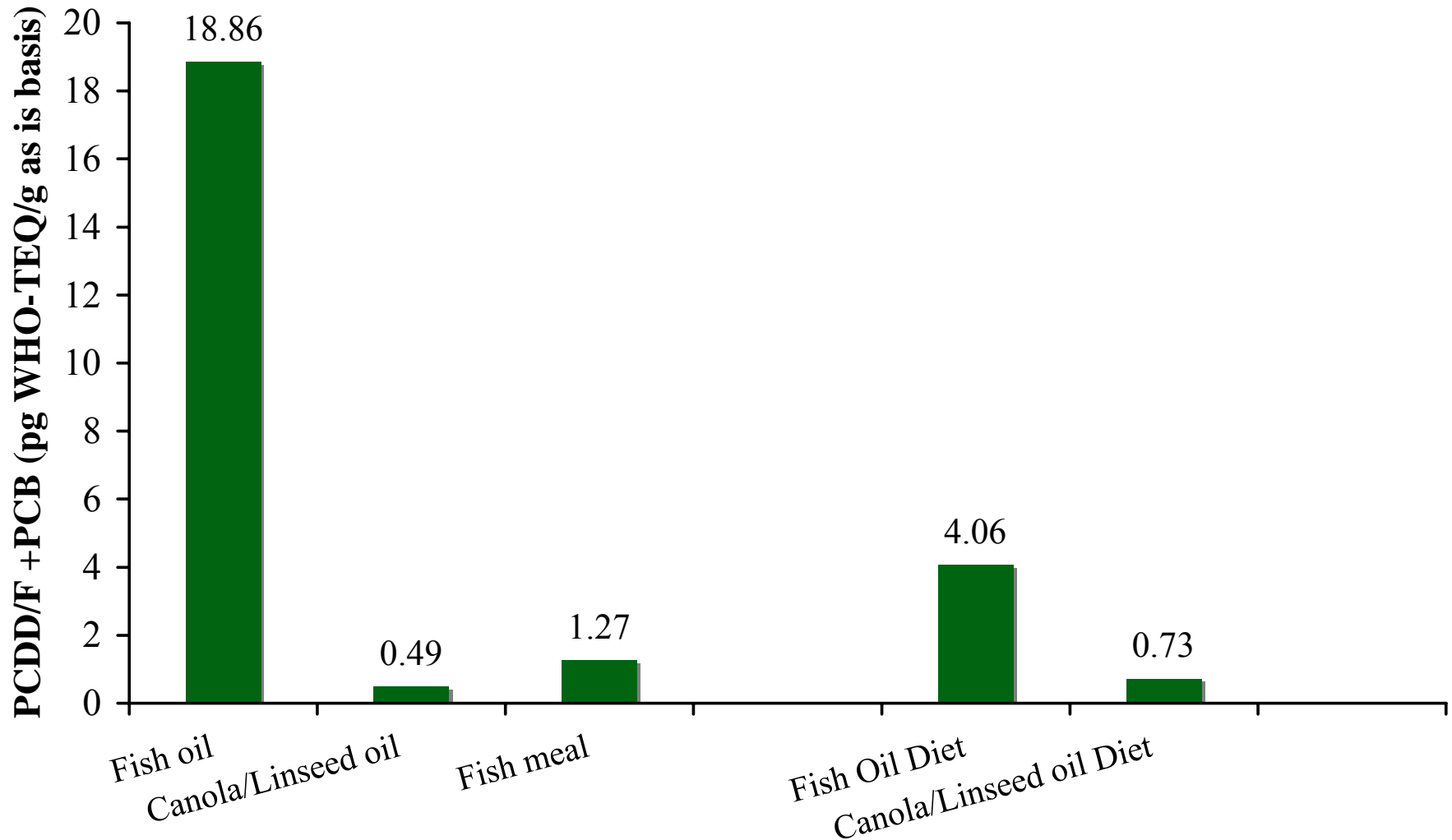
Content of PCDD/F and PCBs in trout fillets

# Soluble Canola Protein as a Feed Attractant

Diet Formulation

Ingredients(g kg^{-1})	Celite	Soluble CPC	Insoluble CPC	Betaine
Soyprotein Concentrate	308	308	308	308
Corn Gluten Meal	282	282	282	282
Canola Oil	245	245	245	245
Wheat flour	100	100	100	100
Dicalcium Phosphate	26	26	26	26
Blood Meal	20	20	20	20
Choline Chloride	4	4	4	4
Vitamin Premix	4	4	4	4
Mineral Premix	4	4	4	4
Vitamin C	1	1	1	1
Celite	10	0	0	0
Soluble CPC	0	10	0	0
Insoluble CPC	0	0	10	0
Betaine	0	0	0	10

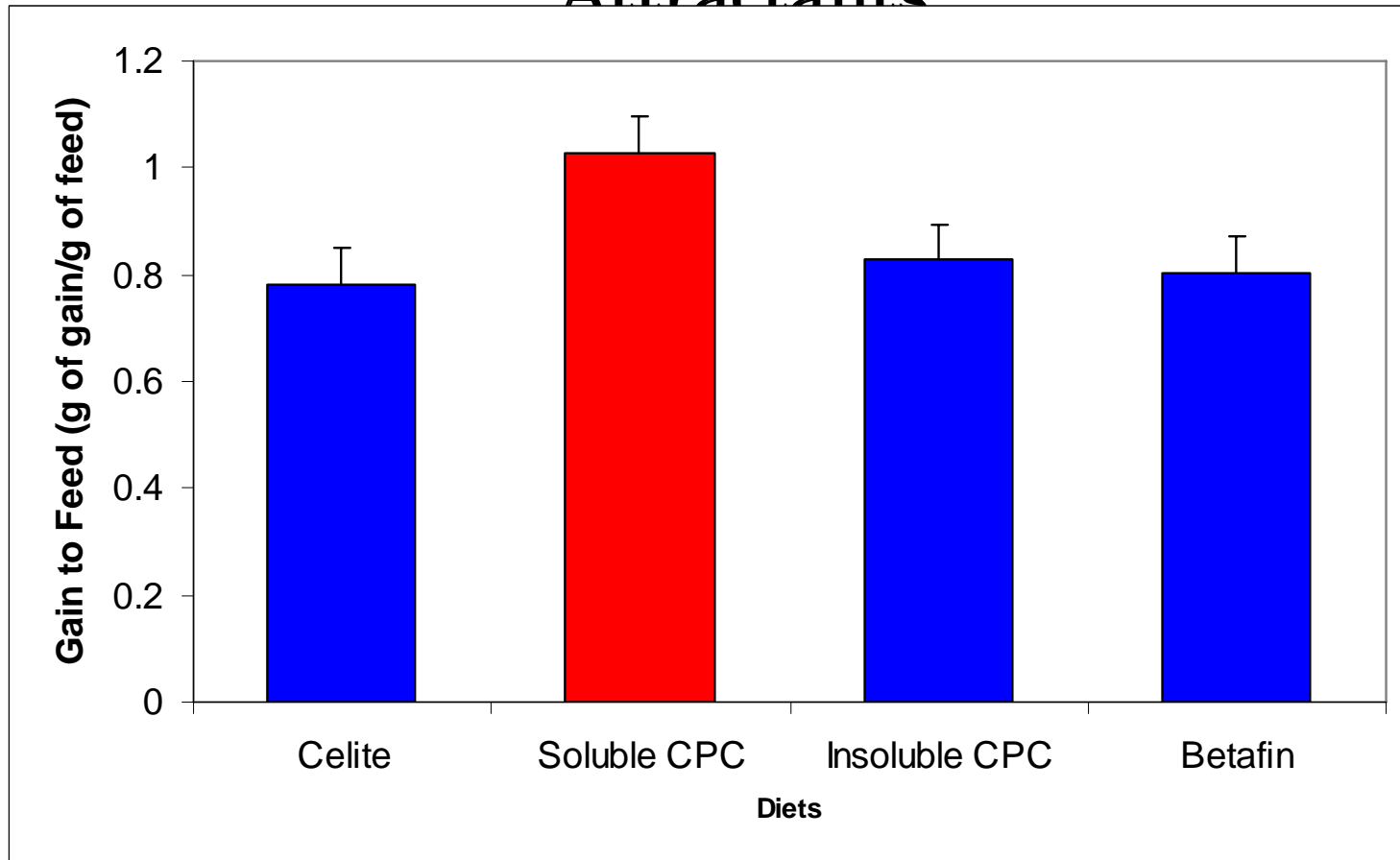# Average Daily Gain for Fish Fed Feed Attractants
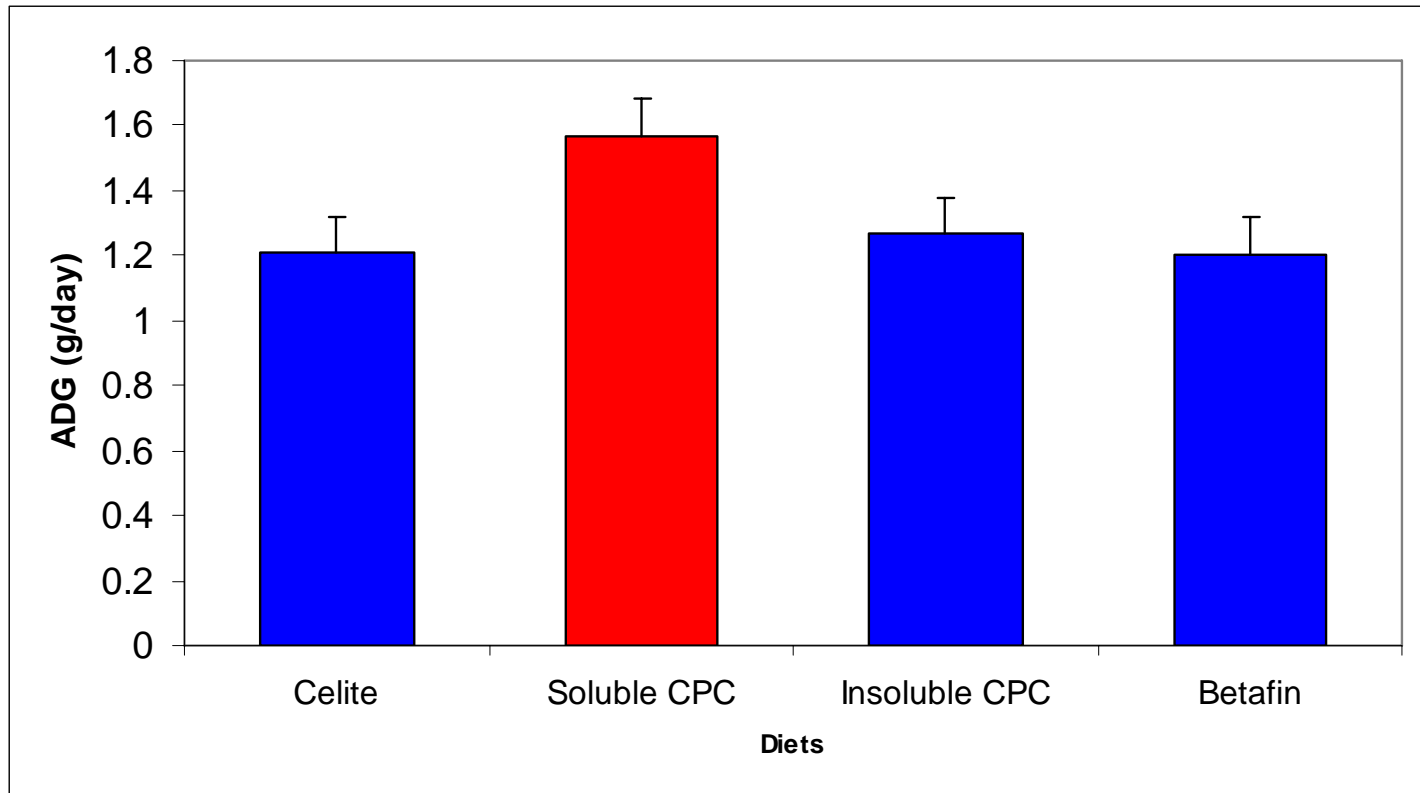
Bars with different colours are significantly different (*P* < 0.05)

Dry Matter Intake of Fish Fed Diets Containing Feed Attractants
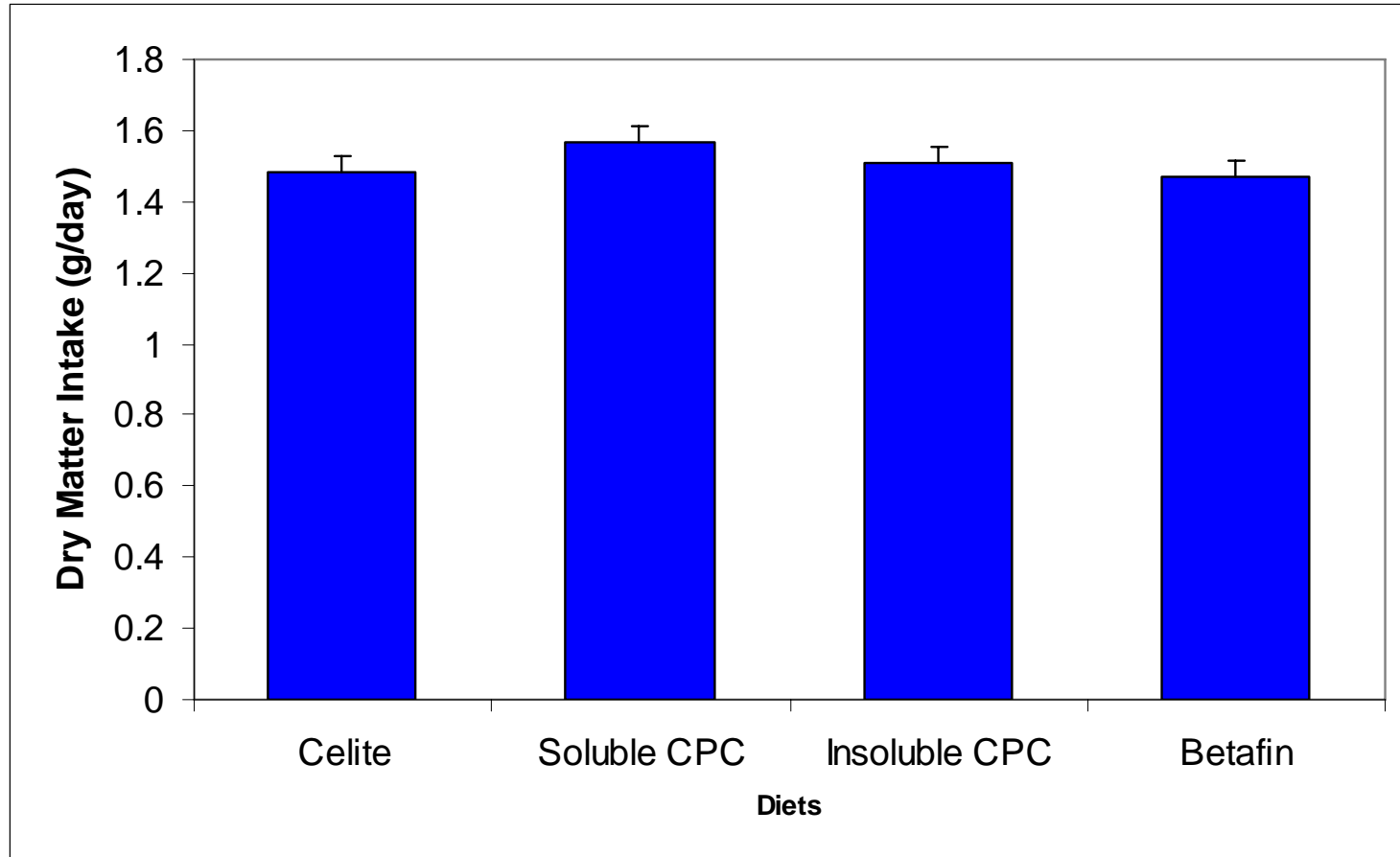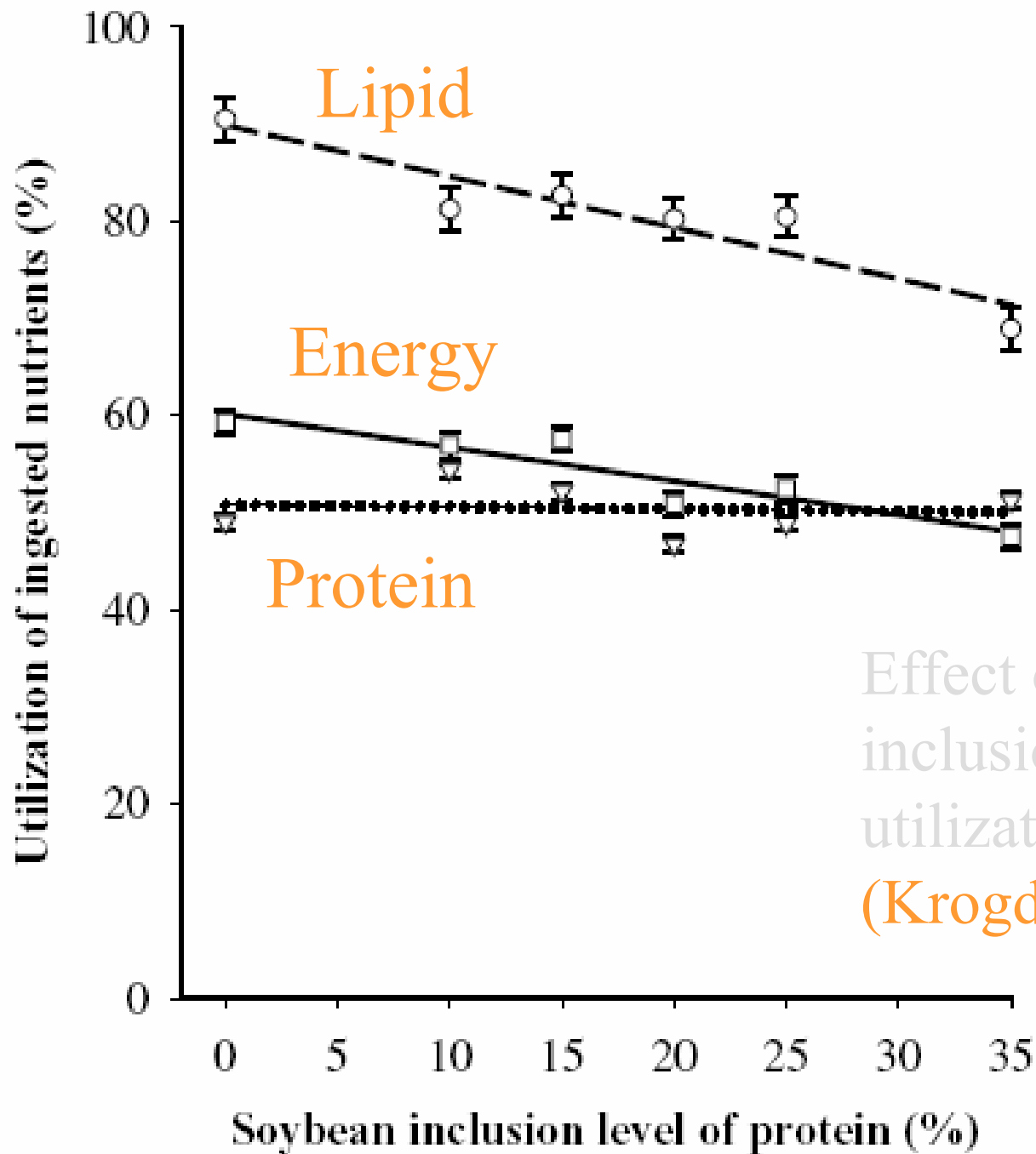
Gain to Feed Ratio for Fish Fed Feed Attractants

Bars with different colours are significantly different (*P* < 0.05)

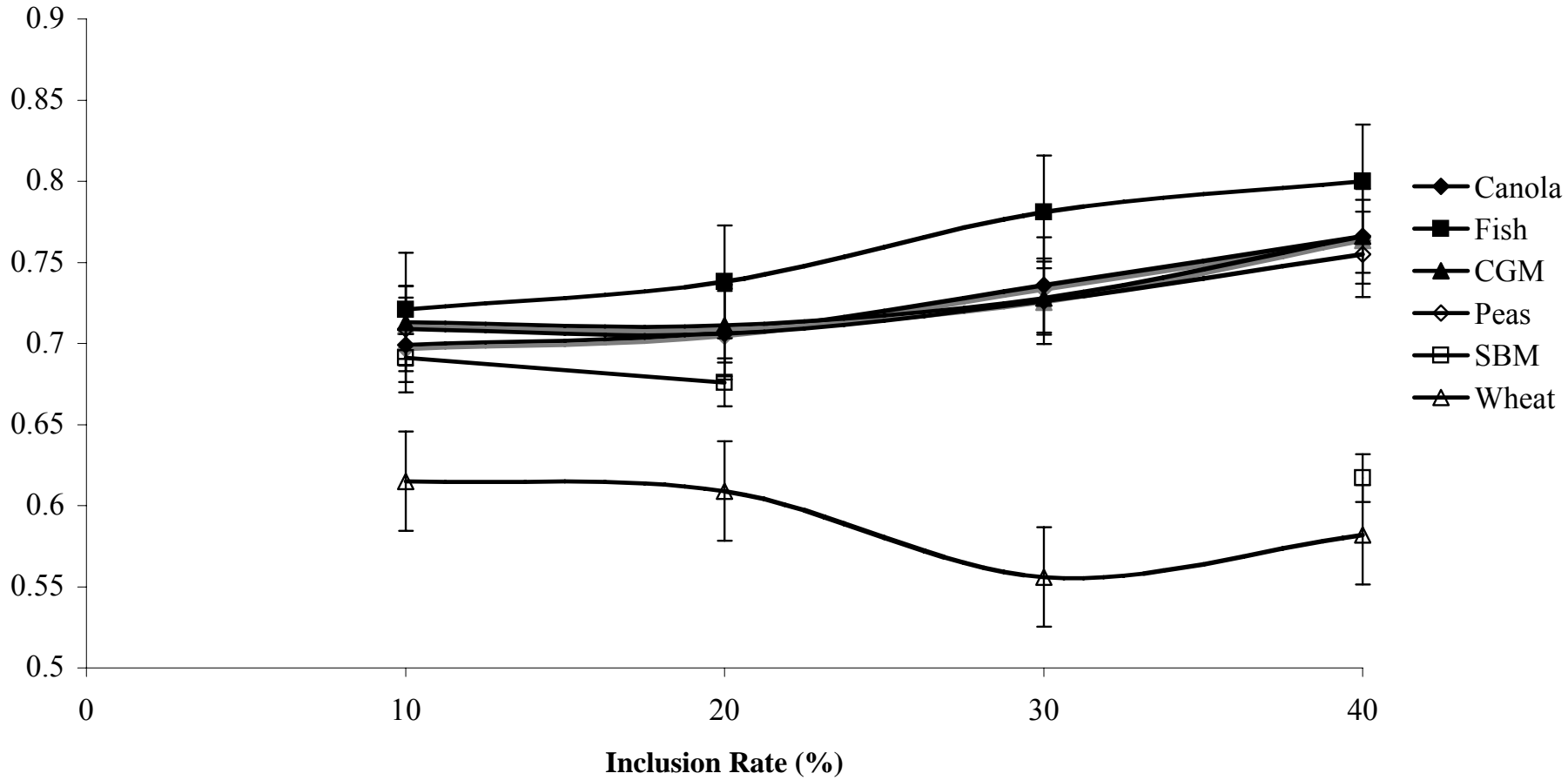# Data Collected on the Aggressiveness and Duration of Feeding

Diets	Aggressiveness	Duration
Celite	2.4^b	7.8^b
Soluble CPC	2.9^a	6.8^a
Insoluble CPC	2.6^{ab}	7.3^{ab}
Betafin	2.4^b	7.8^b

Means with different superscripts are significantly different ($P < 0.05$)
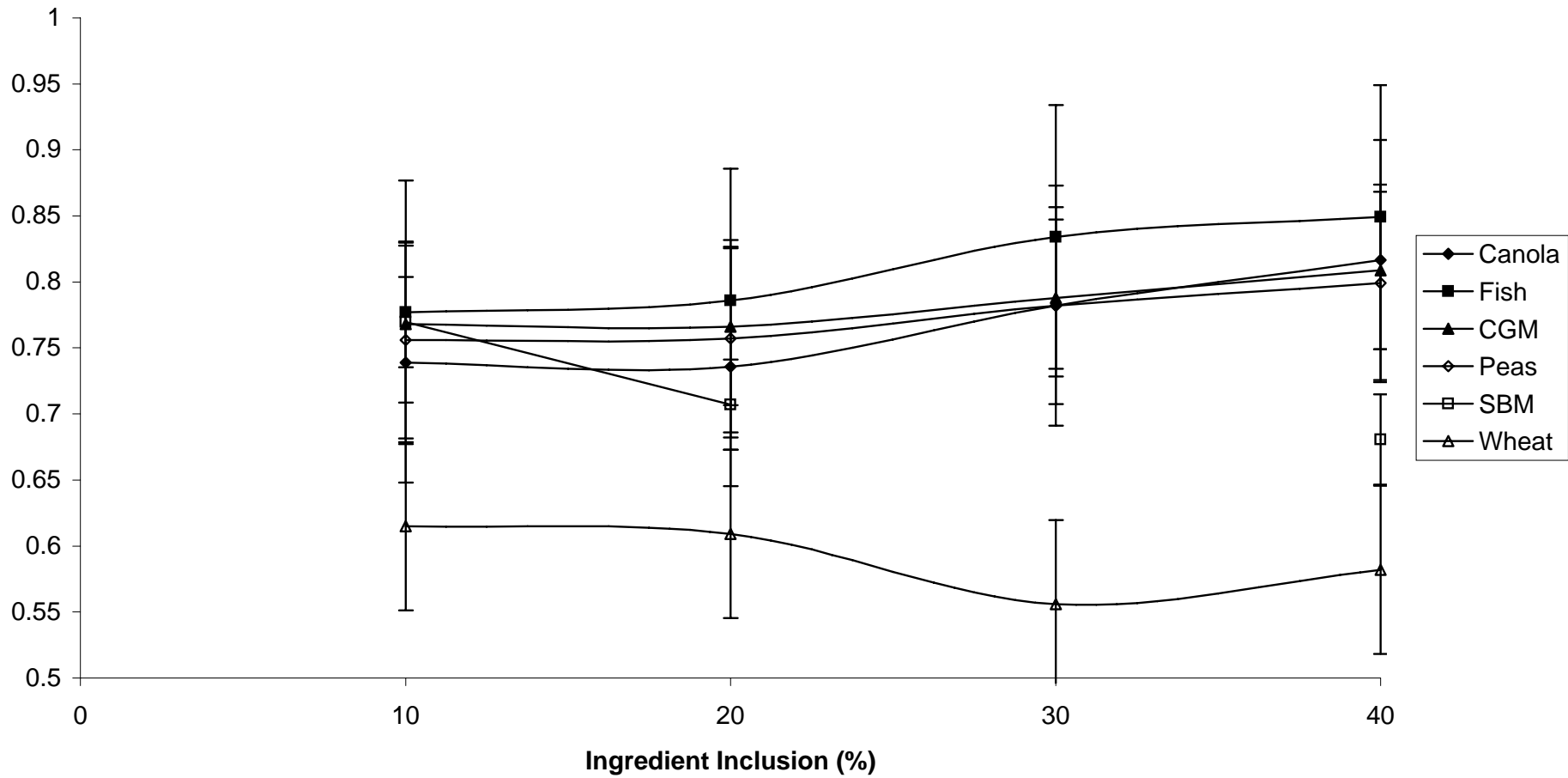
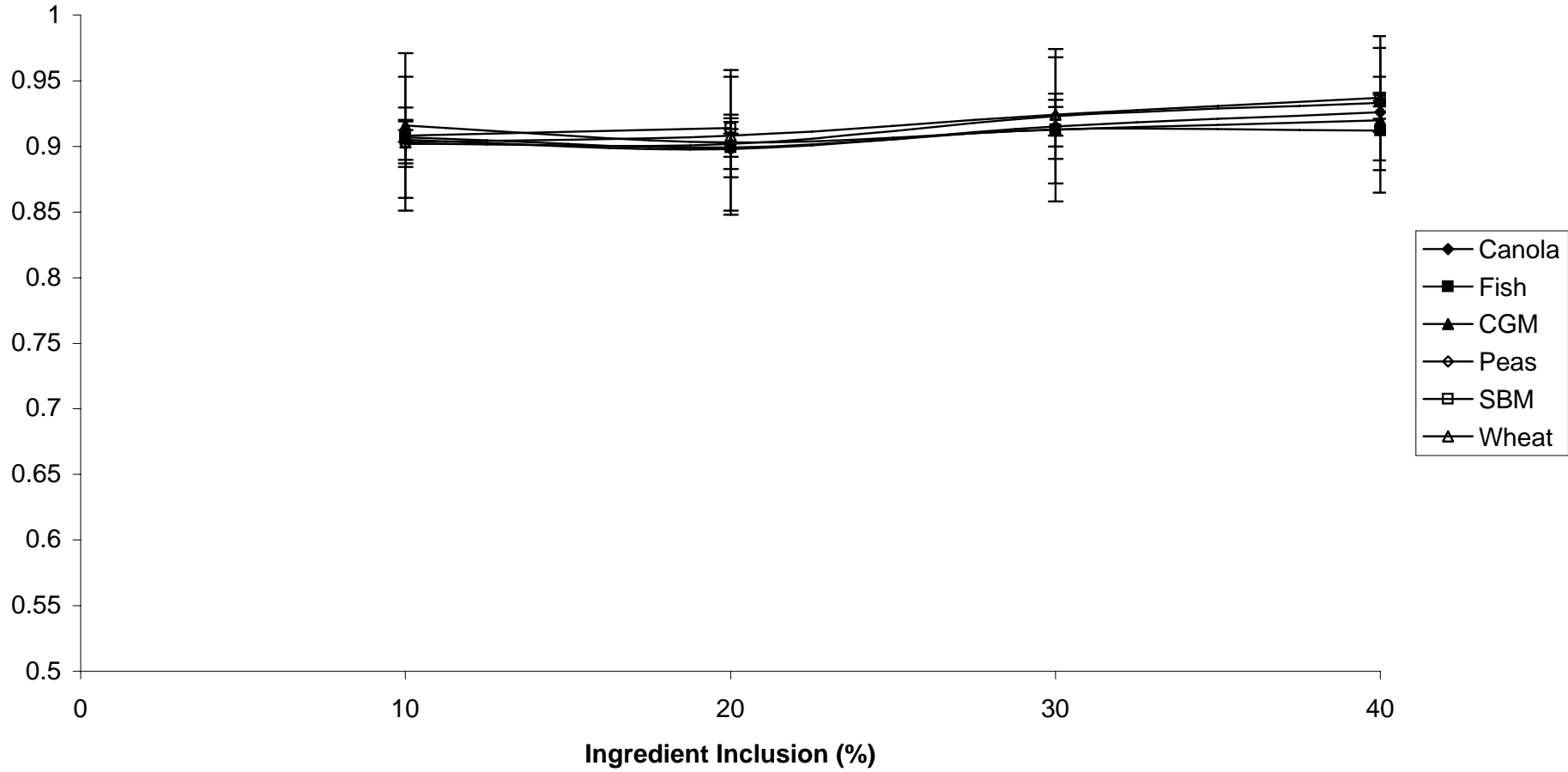Effect of soybean inclusion level on nutrient utilization in salmon (Krogdahl et al., 2003)

Dry Matter

Energy

Protein

Regression Analysis
Ingredient inclusion on
digestibility coefficients

Dry Matter

Ingredient	Coefficient	SEM	P-value
(Constant)	0.880	0.0887	< 0.01
Wheat	-0.006	0.0012	< 0.01
CGM	0.000	0.0012	0.769
SBM	-0.003	0.0011	< 0.01
Fish	0.001	0.0011	0.566
PPC	0.000	0.0011	0.785
CPC	0.000	0.0011	0.912

Energy

	Coefficient	SEM	P-value
(Constant)	0.914	0.0733	< 0.01
Wheat	-0.005	0.0010	< 0.01
CGM	0.000	0.0010	0.754
SBM	-0.003	0.0009	< 0.01
Fish	0.001	0.0009	0.536
PPC	0.000	0.0009	0.622
CPC	0.000	0.0009	0.806

Protein

	Coefficient	SEM	P-value
(Constant)	0.923	0.0055	< 0.01
Wheat	0.043	0.0006	0.968
CGM	-0.067	0.0004	0.955
SBM	-0.013	0.0003	0.978
Fish	0.000	0.0002	0.536
PPC	0.138	0.0003	0.968
CPC	0.011	0.0007	0.968

Where do we go from here?

- Improvement of canola varieties for aquaculture
  - Development of canola varieties with EPA and DHA?
  - Lower levels of fibre?
- Improvement of processing methods
  - Dehulled canola?
- Canola as a feed attractant
- Define the advantages of canola over other plant proteins and oils
- Tell our story to aquafeed producers

Acknowledgements

- Saskatchewan Canola Development Commission
- MCN Bioproducts
- Saskatchewan Agricultural Development Fund

Thank You