Effect of plant feedstuffs on nutritional physiology and gut histology of tilapia – *Preliminary results*

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Outline

- Introduction
  - Overview about gut health
  - Hypotheses and objectives
  - Soybean meal in salmon
  - Soybean meal in carp
  - Tilapia???
- Materials and methods
- Preliminary Results
- Conclusions

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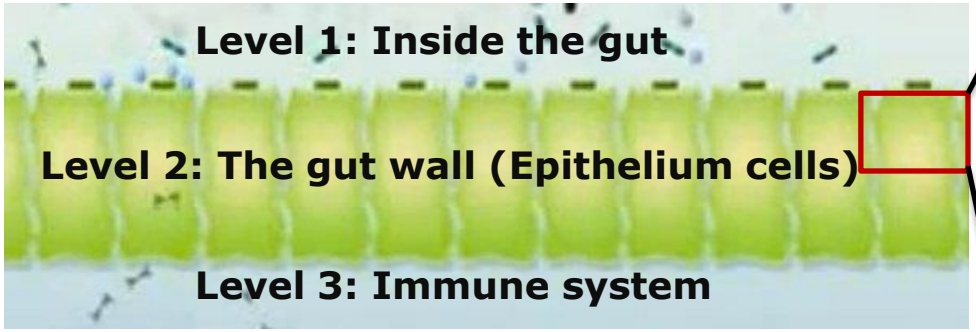
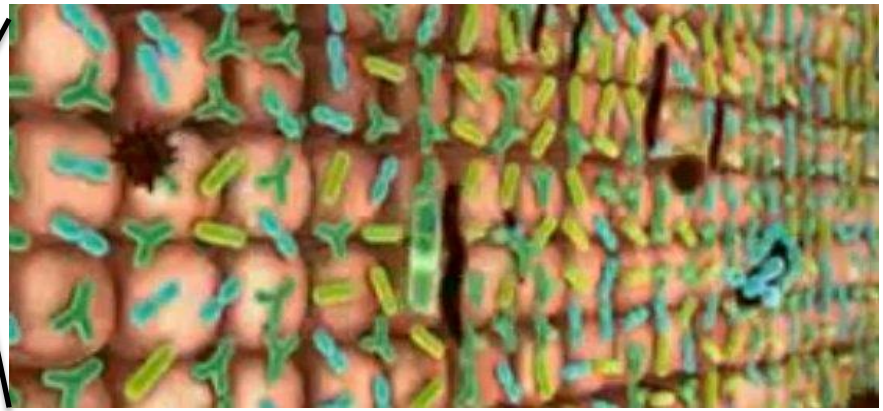
Introduction – gut health is...





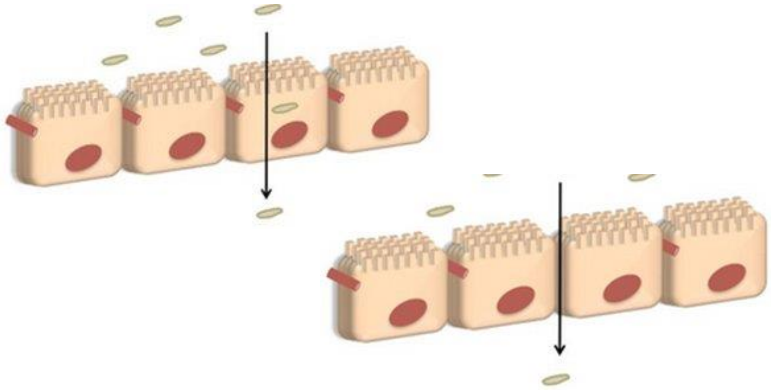
Gut barrier function is vital in gut health and maintaining general health of fish (Jutfelt, 2011, Sundhl, 2009)

Impairment →

Exchange of materials between gut lumen and body

Transcellular through transcytosis

Paracellular through tight junction



Stressors

Dietary composition

Environmental challenges

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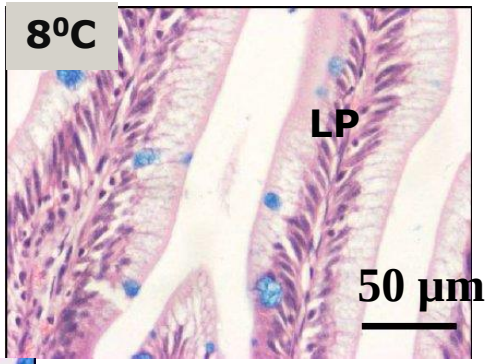
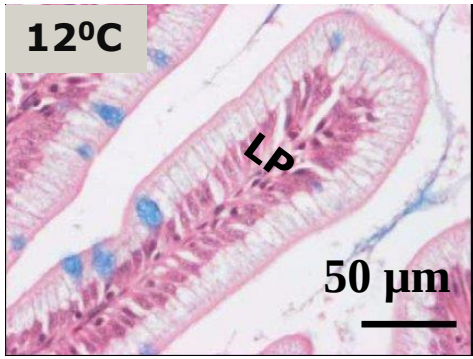
Introduction – intestinal disorders on Atlantic salmon

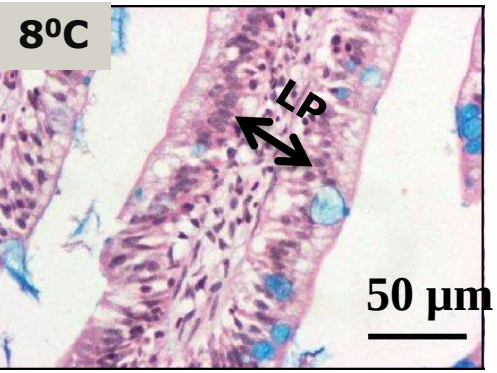
Fish are fed 20% of the dietary fishmeal replaced by soybean meal. The intestinal disorders were more severe in salmon reared at 12^{0}C compared to those reared at 8^{0}C. (*Urán, 2008)*

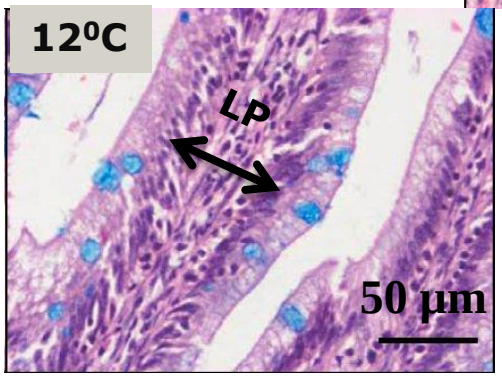
Fish fed the control diet



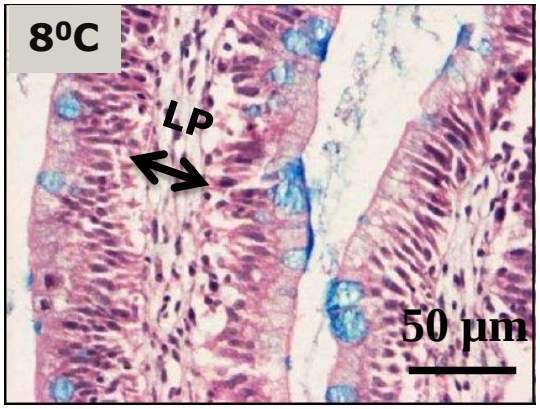


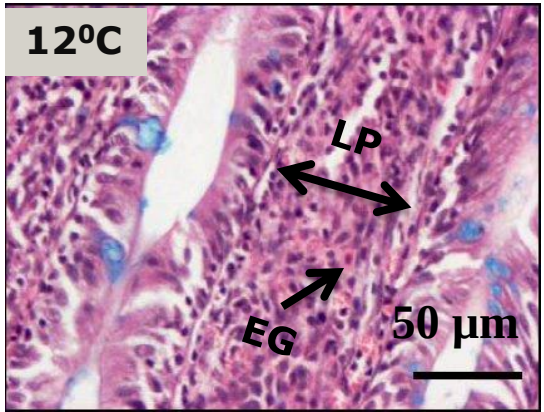
After 7 days of soybean meal feeding





After 20 days of soybean meal feeding





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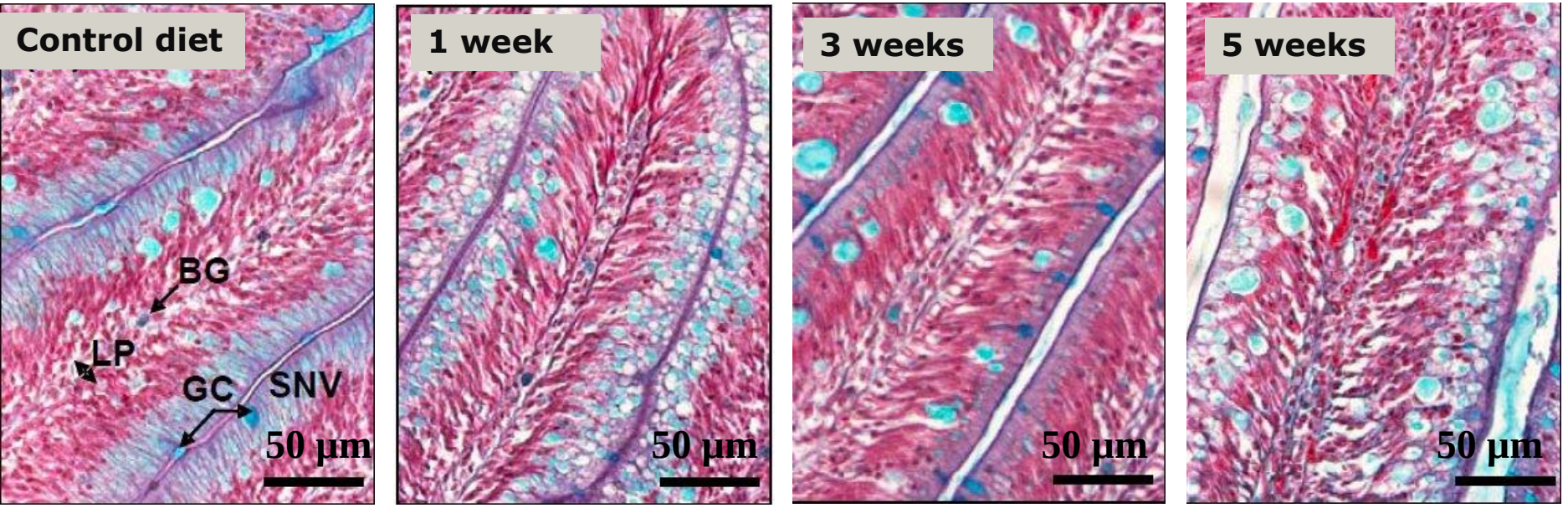
Introduction – enteritis is recovered on carp

Common carp

Fish are fed 20% of the dietary fishmeal replaced by soybean meal. The enteritis in the hindgut were present in week 1 and more severe in week 3. Common carp start to recover from 4 – 5 week (*Urán, 2008)*



SNV: supranuclear vacuoles; GC: goblet cells; BG: basophilic granulocytes, LP: lamina propria.

Introduction... On tilapia

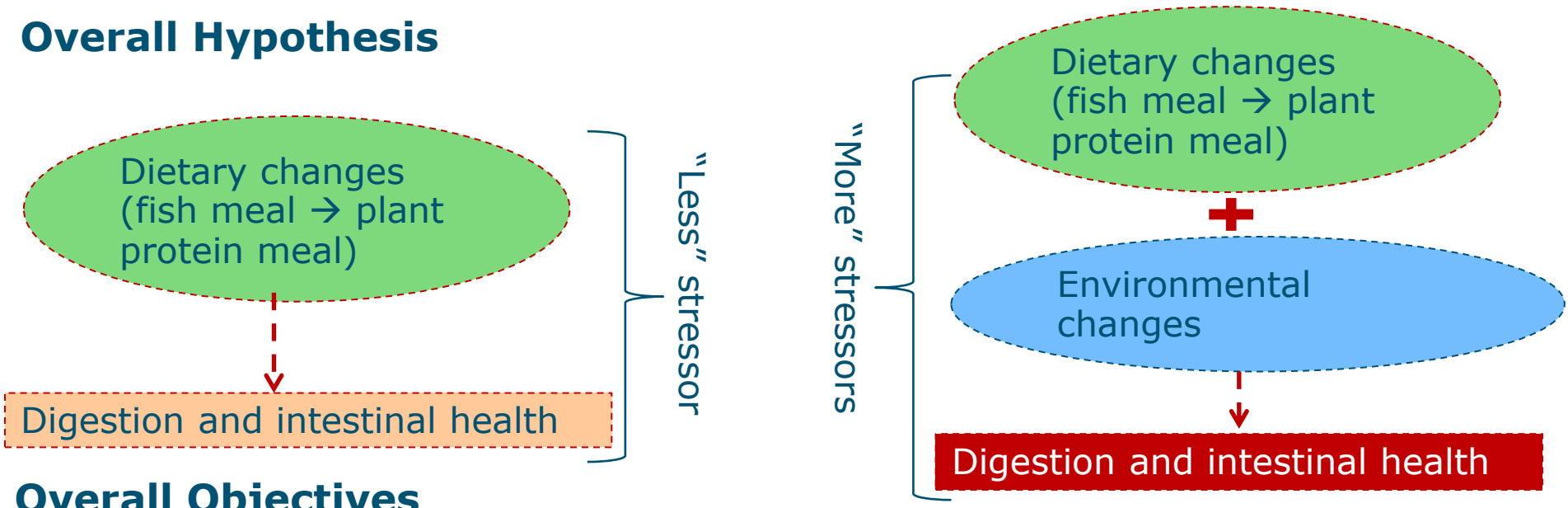
- Tilapia have a acid stomach and very long gut compared to other fish. Good for digestion, but maybe a bigger risk for pathogens.
- Many bacteria/virus pathogens in tilapia try to penetrate the gut barrier.
- Plant ingredients may affect gut barrier function in some fish species.
- What are dietary and environmental factors of importance in tilapia?

Stomach pH<2 →

The digestive tract of Nile tilapia has thin walls and is very long (6x body length) for efficient absorption of nutrients

Introduction – Hypothesis and objectives

Overall Hypothesis



Overall Objectives

1. The effect of plant feedstuffs on digestibility and gut histology of tilapia

2. The effect of environmental and dietary changes on digestibility and intestinal health

3. Gut health promotors that prevent intestinal health disorder induced by environmental or dietary challenges

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First experiment: Key questions to answer

1. Does dietary composition affect the apparent digestibility coefficients in time?

2. Does dietary composition (plant ingredient) alter histological intestine in time?

Canola meal
(rape seed meal)

Soy bean meal

Sunflower meal

Fish meal

Feather meal

DDGS

Rice bran

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Experimental diets

7 types of raw ingredients. Diet 1 is basal diet. Diet 2 – 7 are made of 70% basal diet +30% of particular raw material

Diet 1: Basal diet
Diet 2: 70% basal diet + 30% feather meal
Diet 3: 70% basal diet + 30% soybean meal
Diet 4: 70% basal diet + 30% rice bran
Diet 5: 70% basal diet + 30% canola meal
Diet 6: 70% basal diet + 30% sunflower meal
Diet 7: 70% basal diet + 30% DDGS
(dried distillers drains with soluble)

0.02 % yttrium oxide as marker

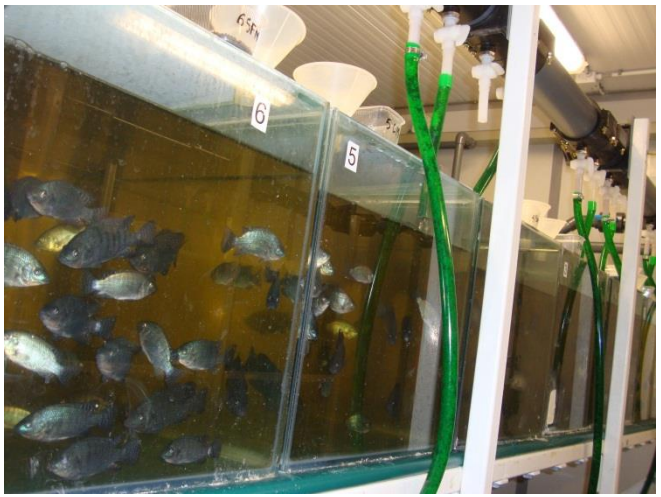
Composition of basal diet used to test digestibility

No.	Ingredients	%	Nutrition Composition	%
1	Fish meal	48.35	Gross energy (kJ/g)	18.4
2	Wheat meal	35.65	Crude protein	38
3	Wheat bran	10	Crude lipid	9.4
4	Fish oil	2	NFE	32.3
5	Soya oil	2	Ash	10.4
6	Vitamin Premix	1	Moisture	9.9
7	Mineral Premix	1		
8	Yttriumoxide	0.02		

Experimental facilities

Non-sex reversed Nile tilapia (*Oreochromis niloticus*): ± 10 g

7 diets, three replicate. 35 fish/ tank



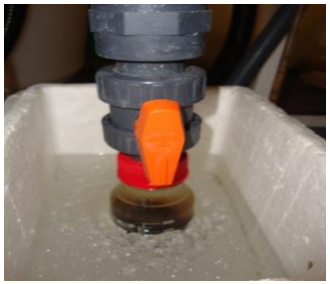
21 tanks of 120 L

Separate faeces settling unit

Faecal collection bottle is kept in ice → to avoid bacterial degradation of nutrients

Hand feed to 3% body weight per day, twice daily

Timeline for sampling



Collecting feaces

0 1 2 3 4 5 6 Week

sampling

sampling

sampling

2 fish/ tank → histology

Fish meal

Soy bean meal

Canola meal
(rape seed meal)

Feather meal

Sunflower meal

Rice bran

DDGS

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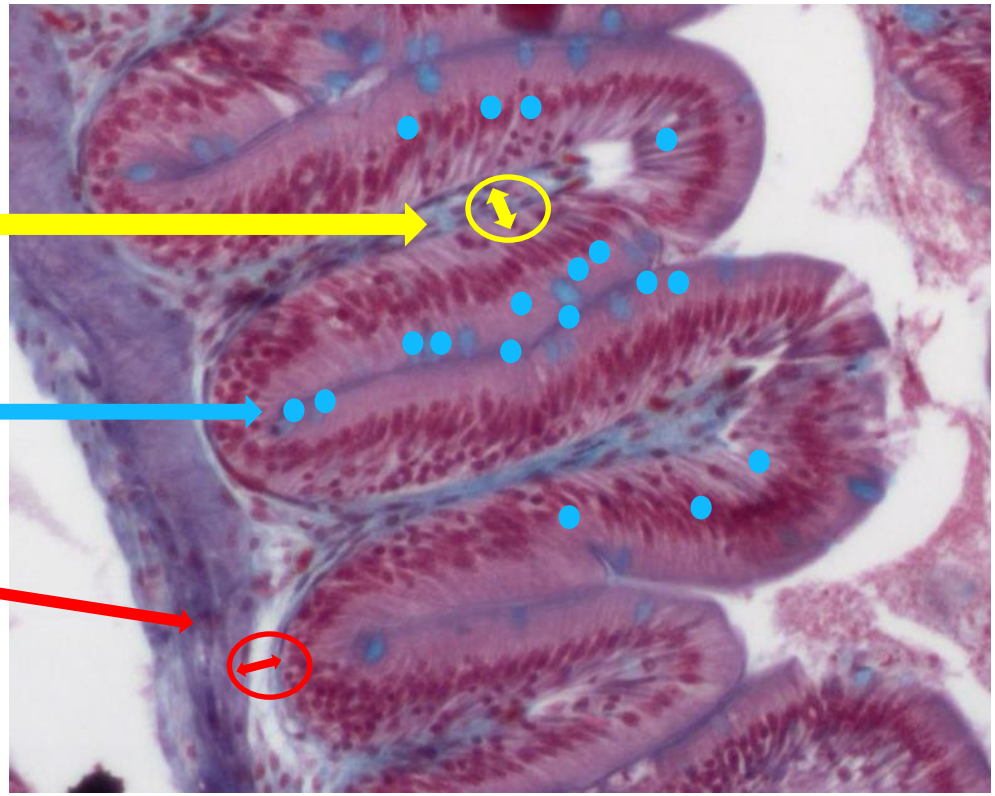
Measurement of gut histology

- Lamina propria thickness
- Goblet cell count/ surface area
- Submucosal epithelium thickness



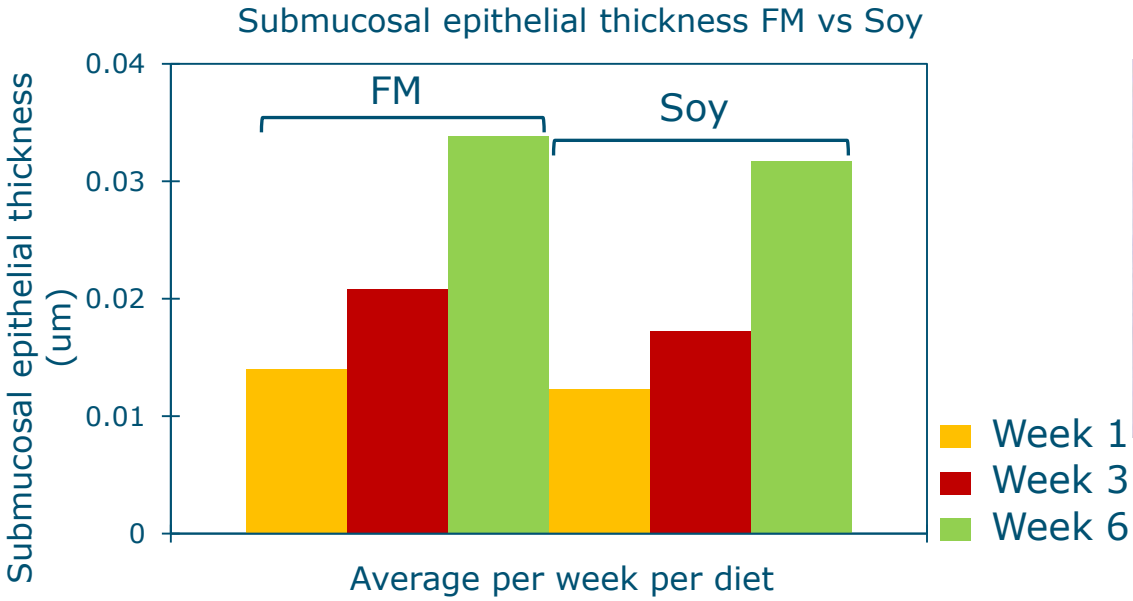
Results

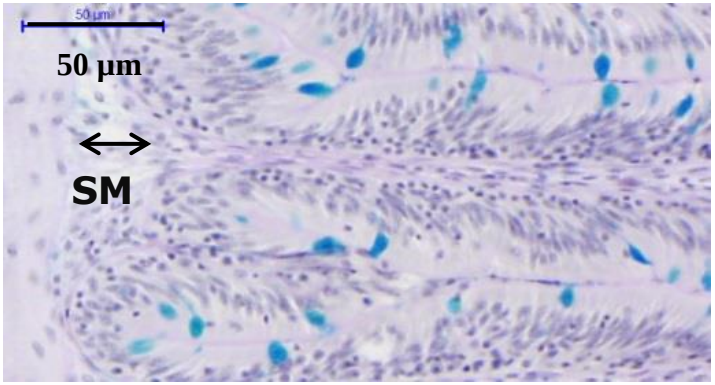
Apparent digestibility coefficients

Table: Digestibility at week 6

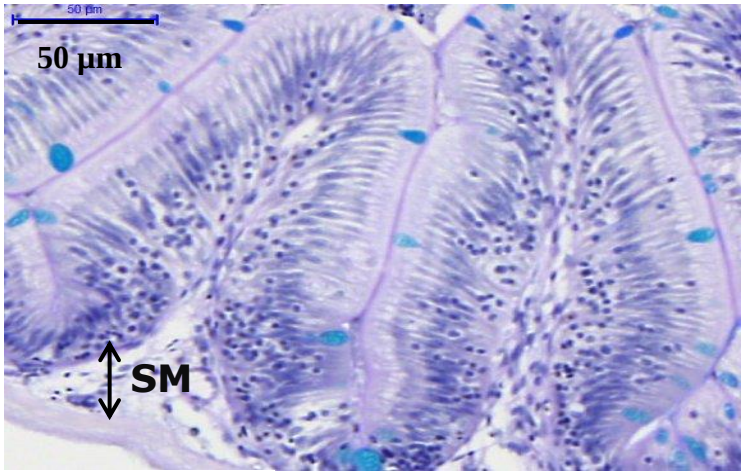
ADC_{diet} of nutrients	Basal diet (Fish diet)	+ 30% Feather meal	+ 30% Soybean meal	+ 30% Rice bran meal	+ 30% Canola meal	+ 30% Sunflower meal	+ 30% DDGS meal
Dry matter	80.18 ± 0.10^{a}	78.15 ± 0.30^{a}	78.31 ± 1.75^{a}	71.34 ± 0.81^{bc}	71.31 ± 0.56^{bc}	69.86 ± 3.35^{c}	73.66 ± 0.82^{b}
Crude Protein	92.29 ± 0.49^{a}	87.44 ± 0.47^{d}	92.14 ± 0.98^{a}	88.99 ± 0.86^{c}	88.68 ± 0.40^{c}	90.87 ± 0.75^{b}	89.90 ± 0.76^{bc}
Crude Fat	94.11 ± 0.91^{a}	84.78 ± 2.30^{d}	93.47 ± 0.64^{ab}	86.85 ± 1.35^{d}	90.39 ± 0.41^{c}	91.44 ± 0.82^{bc}	92.93 ± 0.85^{ab}
Phosphorus	56.36 ± 2.60^{a}	55.76 ± 0.53^{a}	54.83 ± 5.20^{a}	36.72 ± 1.70^{c}	46.16 ± 5.30^{b}	48.82 ± 4.61^{b}	60.09 ± 3.50^{a}
Ash	47.05 ± 2.10^{a}	38.34 ± 4.50^{b}	50.73 ± 0.76^{a}	28.84 ± 1.30^{c}	36.75 ± 1.62^{b}	40.15 ± 7.33^{b}	50.57 ± 2.67^{a}
Energy	85.14 ± 0.23^{a}	81.64 ± 0.79^{b}	83.39 ± 0.64^{ab}	70.70 ± 1.14^{cd}	76.82 ± 0.75^{cd}	74.85 ± 2.57^{d}	77.99 ± 0.97^{c}

Results - SM increases for both diets

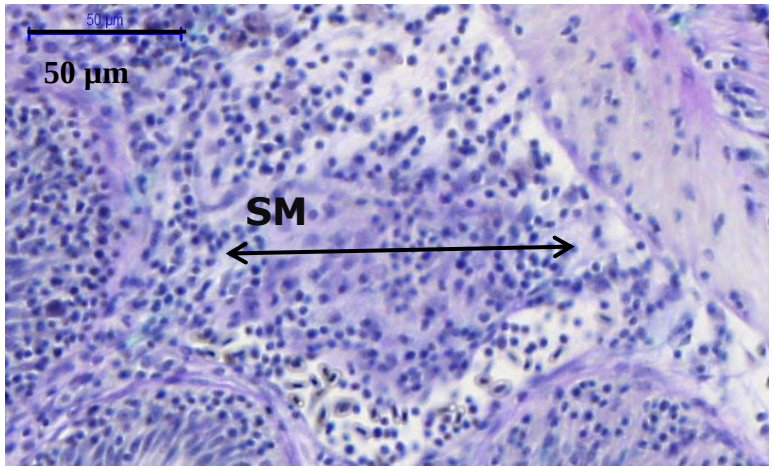




SOY Week 1

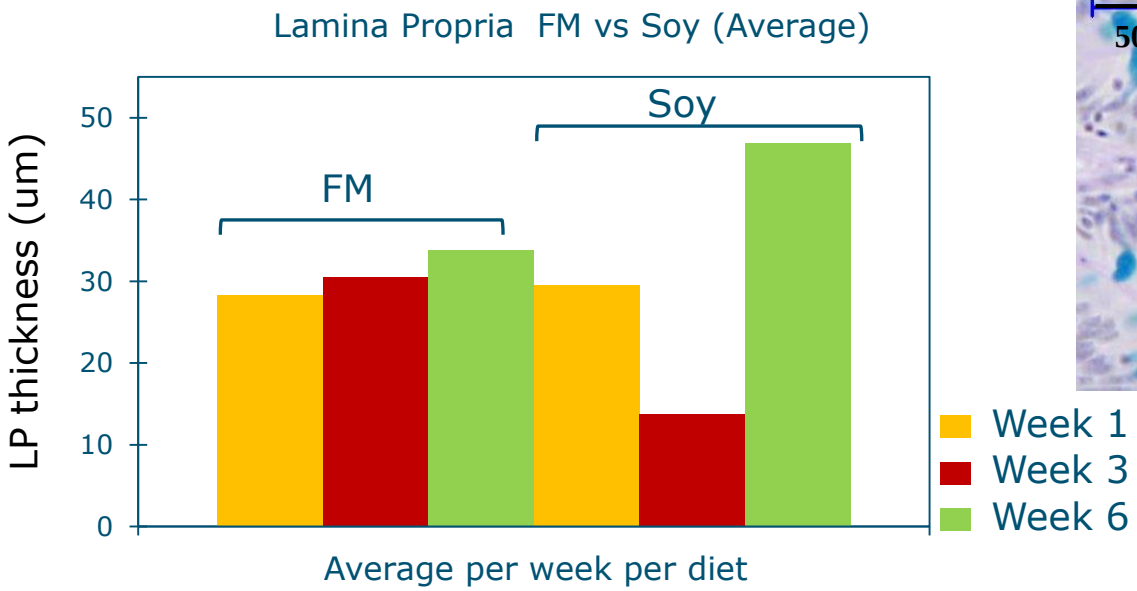


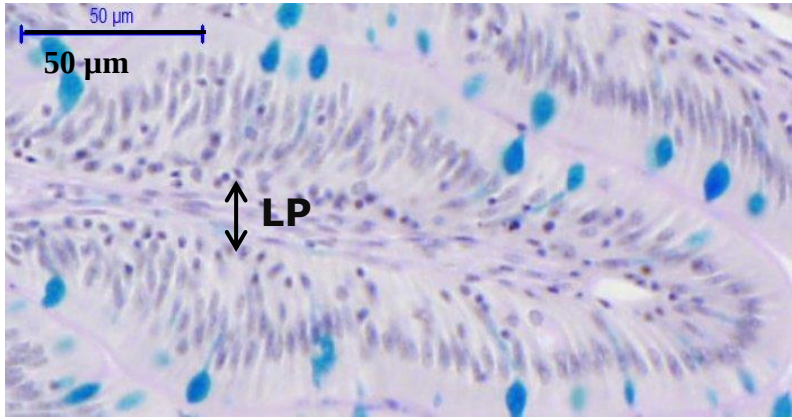
SOY Week 3



SOY Week 6

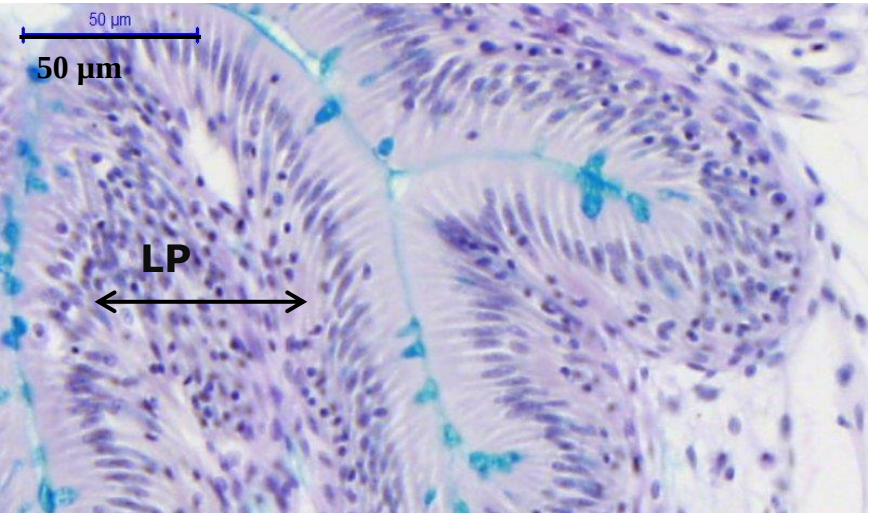
Results – LP increase in week 6 at SBM feeding



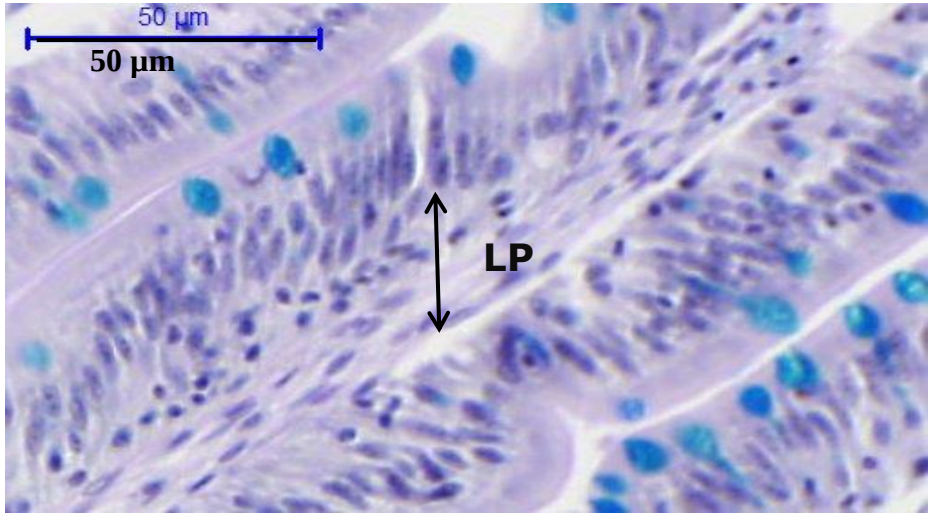


SOY Week 1

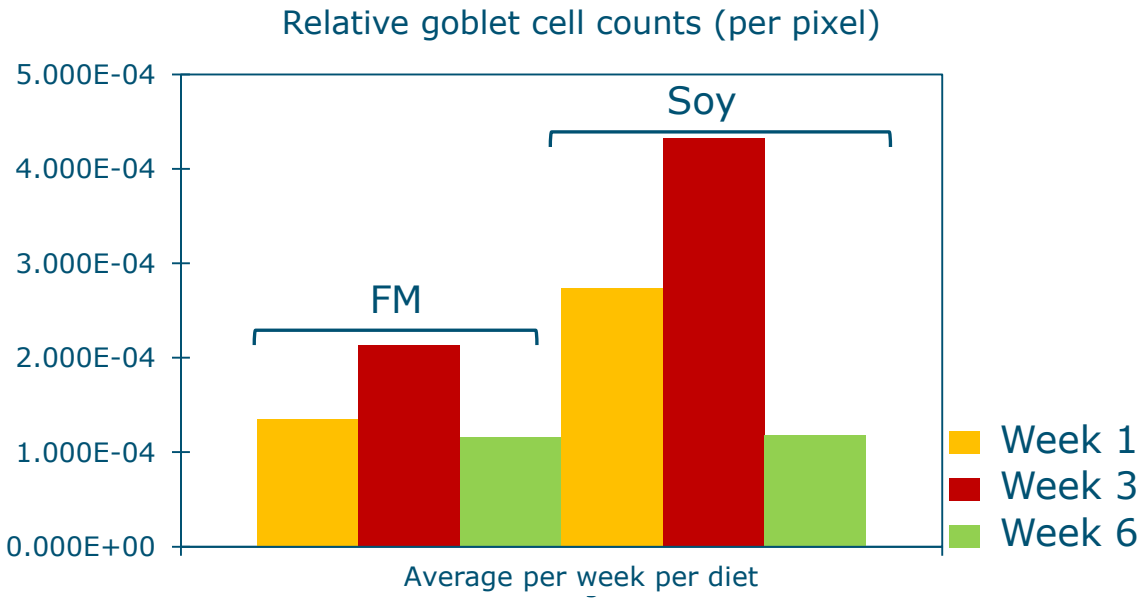
SOY Week 6

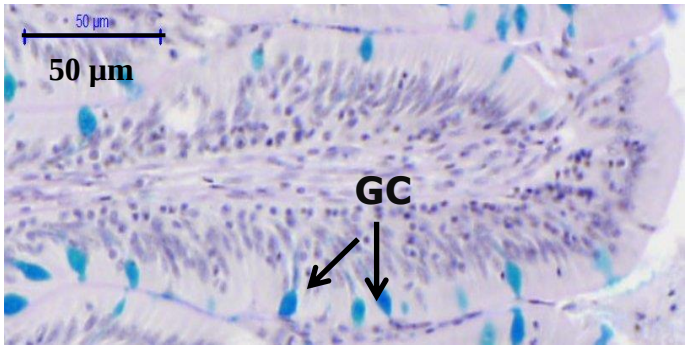


SOY Week 3

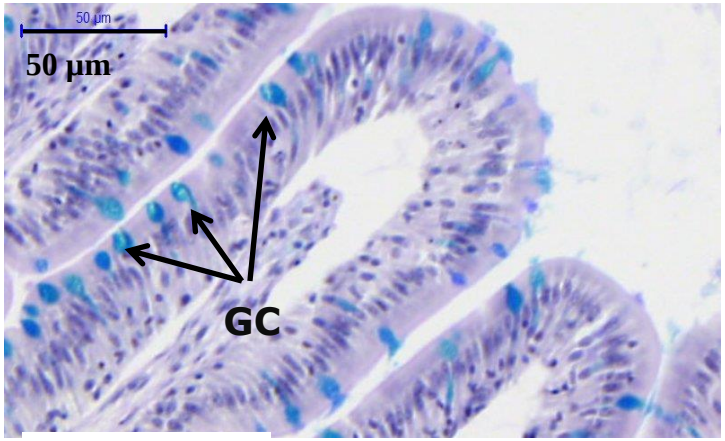


Results – Goblet cell go up and down at SBM feeding

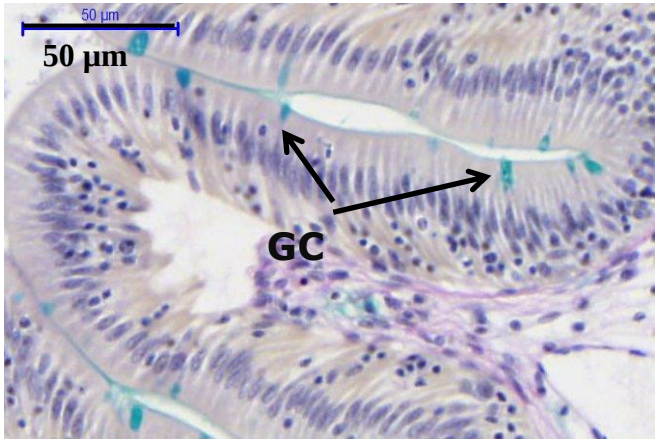




SOY Week 1



SOY Week 3



SOY Week 6

Conclusions

1. Crude protein digestibility around 90% for all diets except feather and canola meal. Tilapia seem to adapt plant protein diets quite well. Soybean meal did not reduce crude fat digestibility as reported in salmon

2. Tilapia change to diet with 30% soybean meal did not develop a severe enteritis as reported in salmon

3. There was a trend of minor changes in gut histology of tilapia fed soybean meal:
- Sub mucosal had increased size for both fish and soybean meal diet.
- Lamina propria increased after 6 weeks for soybean meal diet
- Goblet cell count increased up till week 3. At week 6, that symptom returned back to normal for soybean meal diet.

4 The Goblet cell count may indicate that the intestine of tilapia can adapt to soybean meal feeding as reported in common carp

Thank you

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