Effects of dietary inulin on growth performance and health status of juvenile Nile tilapia

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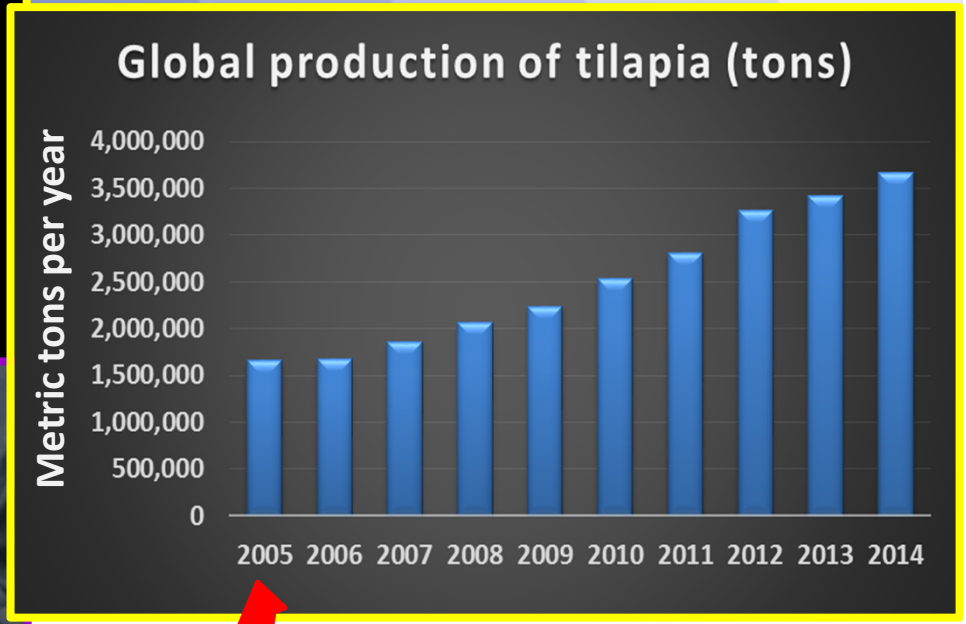
Introduction



(FAO FishStat, 2016)

❖ **Nile tilapia** is the second most important farmed fish after carps (Fitzsimmons, 2015).

❖ **Tilapia is also the most important freshwater aquaculture species in Thailand** with a volume of 200,000 tons in 2014 and exporting around 20,000 tons of total production (Fisheries, 2015).

Prebiotic provides an alternative biotherapy for fish production

PREBIOTICS

Definition of prebiotics

(Gibson & Roberfroid, 1995)

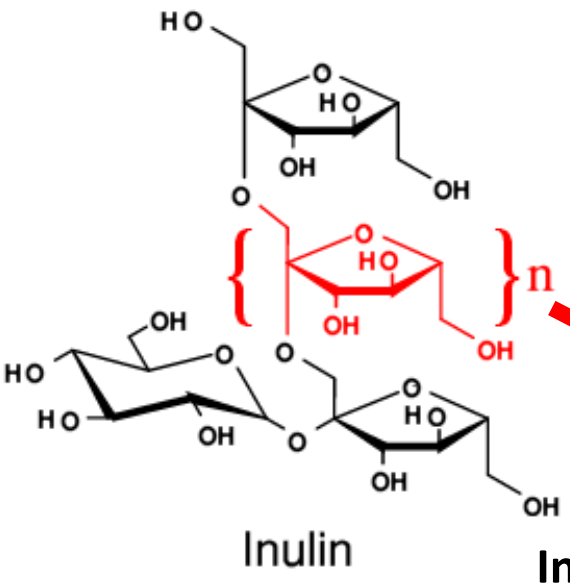
Prebiotics are "non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and activity of bacteria in the colon, which can improve the host health."

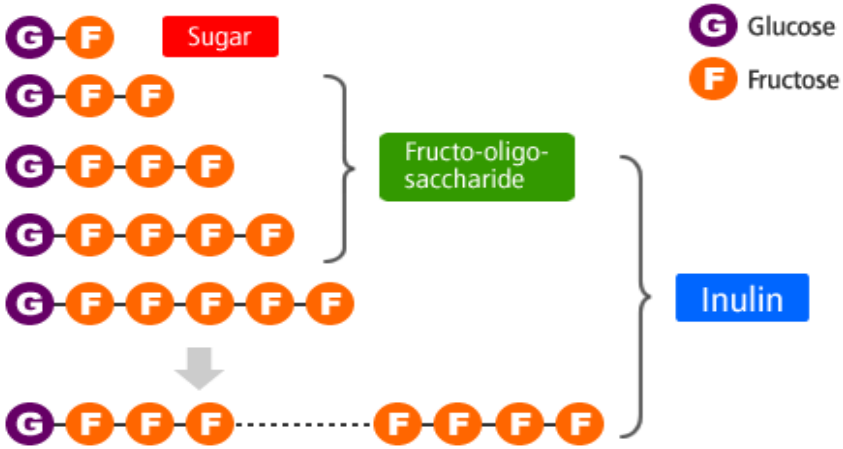
- ✓ Resistance to gastric acidity, hydrolysis by digestive enzymes.
- ✓ Fermentation by intestinal microbiota.
- ✓ Selective stimulation of the growth of intestinal bacteria associated with health.

Inulin, which belongs to a class of carbohydrates known as fructans, **is one of the most common prebiotics used in aquatic animals**.




Inulin





Inulin is composed of fructose linked by β (2-1) bonds

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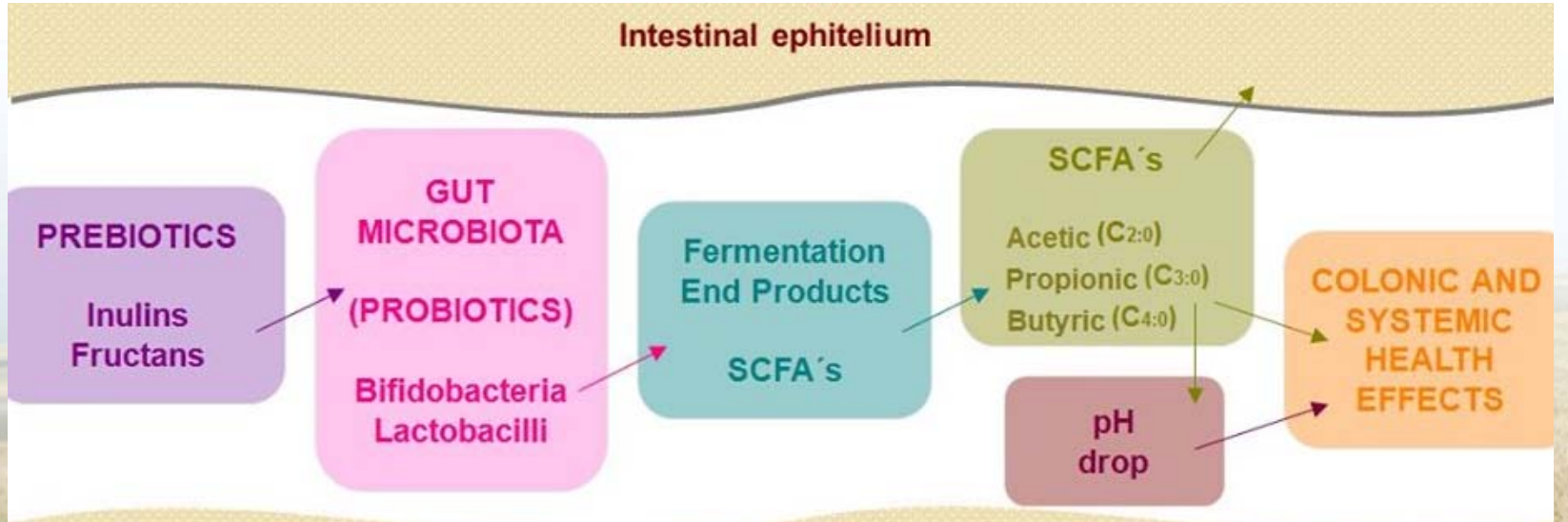


In humans and monogastric animals, inulin generally cannot be hydrolysed by digestive enzymes in the proximal intestinal tract.

Table 1 Effect of inulin on growth and health status in fishes.

Prebiotics	Fish species	Results	References
10, 20 g kg^{-1} Inulin	African catfish 	Growth rate ↑	Mahious and Ollevier (2005)
20 g kg^{-1} Inulin	Siberian sturgeon 	Growth rate ↑	Mahious et al. (2006a)
5 g kg^{-1} Inulin	Kutum 	Growth rate, Survival ↑ Total lactic acid bacteria ↑	Mira et al. (2011)
5, 10 g kg^{-1} Inulin	Rainbow trout 	Growth rate ↑	Ortiz et al. (2012)
5 g kg^{-1} Inulin	Hybrid surubim 	RBC, WBC, Ht → Total Ig ↑	Mourino et al. (2012)
20 g kg^{-1} Inulin	Turbot 	Growth rate → Total bacteria, *Vibrio* sp. →	Mahious et al. (2006b)
10, 20, 30 g kg^{-1} Inulin	Beluga 	Growth rate ↓ WBC, Hb, Ht ↓	Reza et al. (2009)

Symbols represent an increase (↑), no effect (→) and decrease (↓) on the specified response.

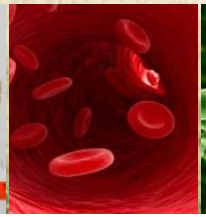
Objective

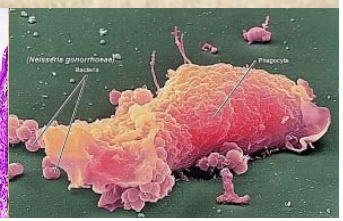
The prebiotic effects of inulin on juvenile Nile tilapia were investigated in terms of

- ✓ **Growth performance**
- ✓ **Body composition**
- ✓ **Hematology and blood chemistry**
- ✓ **Non-specific immune**
- ✓ **and intestinal morphology**





Materials and methods

1. Test prebiotic product

Inulin was a commercial product#(PREBIOFEED88; Warcoing, Belgium) extracted by diffusion from cichory roots.

2. Experimental design and pellet preparation

Group	Treatment	Dose
1	Control	Basal diet
2	2.5 Inulin	basal diet supplemented with inulin 2.5 g kg^{-1}
3	5.0 Inulin	basal diet supplemented with inulin 5 g kg^{-1}

Table 2 The basal dietary ingredients and proximate composition for Nile tilapia.

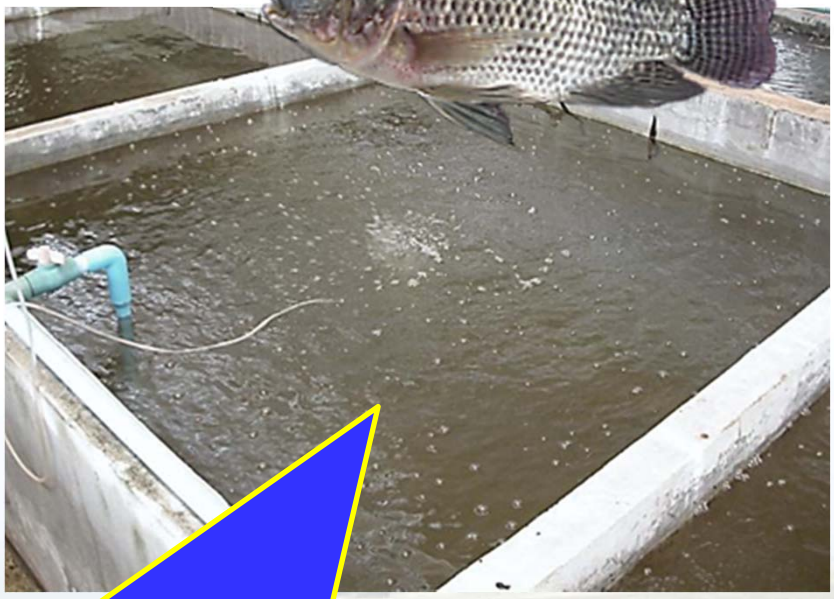
Ingredients	g kg^{-1}
Fish meal (56.2% crude protein)	300
Soybean meal (44.4% crude protein)	270
Rice bran	150
Corn meal	145
Cassava chips	120
Premix	10
Vitamin C	5
Proximate composition (g kg^{-1}dry weight)	
Dry matter	933
Crude protein	343
Crude lipid	79
Ash	104
Crude fiber	42
Nitrogen-free extract	365




3. Experimental fish and fish culture

Fish were hand-fed ad libitum twice daily throughout the experiment for 8 weeks.

Nile tilapia
44.43 g.



Thirty fish were distributed in each experimental pond (2 x 2 x 1 m^3).

- ✓ Water temperature was measured daily and was 25-28 °C.
- ✓ DO content and pH were measured weekly and values were 5.24-5.98 mg L^{-1} and 7.48-8.16, respectively.

4. Sample collections and analysis

At the end of the experimental period (8 weeks)

- Growth performance
  - Survival rate
- Whole body composition
- Health status
  - Hematology
    - Blood chemistry
      - Non-specific immune
- Morphology of intestine

- All data were analyzed by one-way analysis of variance (ANOVA).
- When significant differences were found among the groups, Duncan's multiple range tests were used to rank the groups.

Results and discussion

Table 3 Effect of dietary inulin on growth performance of Nile tilapia juveniles for 8 weeks.

Diet	Initial weight (g)	Final weight (g)	SGR (% day^{-1})	Feed intake (g day^{-1})	FCR	Survival rate (%)
Control	44.6	233.4^{a}	2.76^{a}	4.33^{b}	1.49^{c}	99.2
2.5 Inulin	44.4	257.9^{b}	2.93^{b}	4.35^{b}	1.33^{b}	100.0
5.0 Inulin	44.3	280.3^{c}	3.07^{c}	4.18^{a}	1.16^{a}	99.2
Pooled SEM	0.1	8.1	0.04	0.04	0.05	0.3

Table 4 Effect of dietary inulin on whole body composition of Nile tilapia juveniles for 8 weeks.

Diet	Moisture (g kg^{-1})	Crude protein (g kg^{-1})	Crude lipid (g kg^{-1})	Ash (g kg^{-1})
Control	700.3	120.3	38.5	40.4
2.5 Inulin	700.5	122.1	38.6	40.9
5.0 Inulin	710.6	123.1	42.4	43.7
Pooled SEM	3.5	0.9	1.0	0.8





Table 5 Effect of dietary inulin on hematological parameters of Nile tilapia juveniles for 8 weeks.

Diet	RBC (cell × 10^{12} L^{-1})	Hemoglobin (g L^{-1})	Hematocrit (L L^{-1})
Control	2.22[a]	84.80	0.34
2.5 Inulin	2.33[b]	86.70	0.35
5.0 Inulin	2.34[b]	88.30	0.35
Pooled SEM	0.01	0.63	0.00







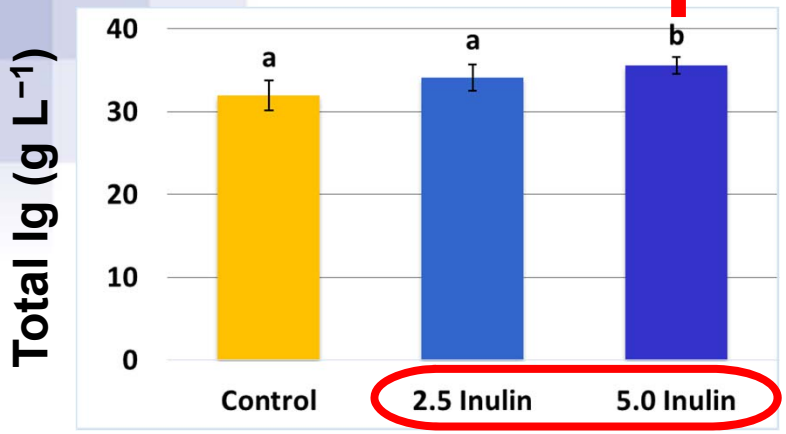
Table 6 Effect of dietary inulin on blood chemical parameters of Nile tilapia juveniles for 8 weeks.

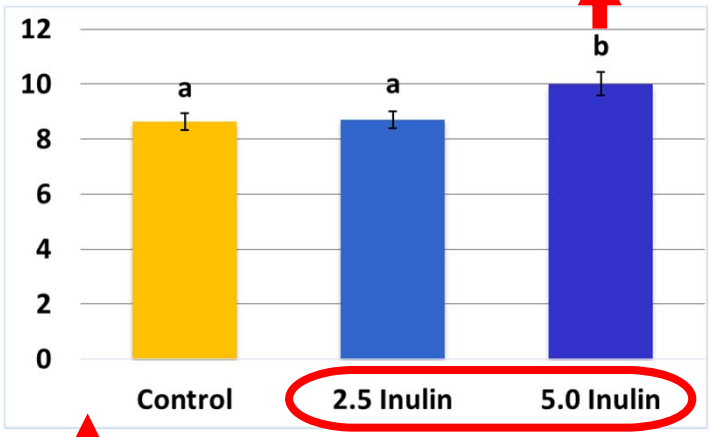
Blood chemical Parameter	Diet			
	Control	2.5 Inulin	5.0 Inulin	Pooled SEM
Cholesterol (mmol L^{-1})	4.10	4.19	4.69	0.08
Triglycerides (mmol L^{-1})	1.70	1.66	1.71	0.04
BUN (mmol L^{-1})	0.85	0.82	0.80	0.02
Total bilirubin (µmol L^{-1})	4.62	3.42	2.99	0.34
Direct bilirubin (µmol L^{-1})	2.39	1.71	1.50	0.17
SGOT (U L^{-1})	34.52	33.18	32.04	0.99
SGPT (U L^{-1})	21.00	20.86	19.90	0.31
Chloride (mmol L^{-1})	130.70	128.20	132.70	2.81
Calcium (mmol L^{-1})	3.48	3.46	3.59	0.07
Magnesium (mmol L^{-1})	1.00^{a}	0.96^{a}	1.14^{b}	0.03
Iron (µmol L^{-1})	12.00^{a}	13.73^{ab}	14.04^{b}	0.44

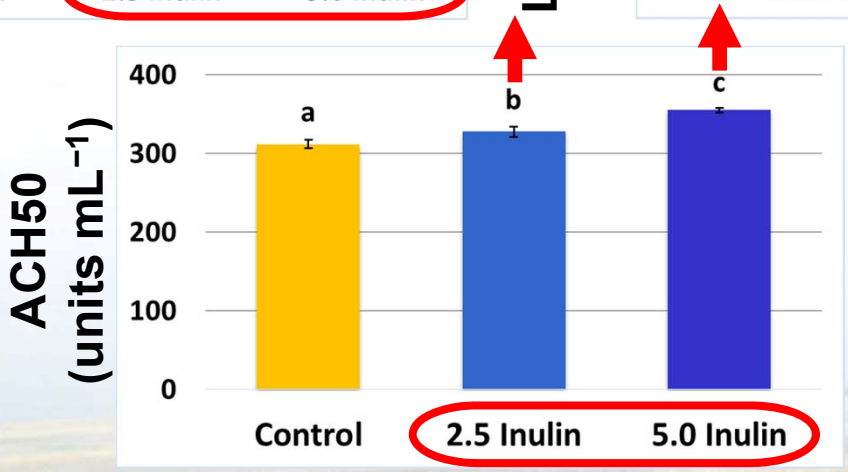



Intestinal fermentation of inulin might affect intestinal acidification, and low pH would enhance mineral absorption.

Fig. 1 Effect of dietary inulin on immunological parameters of Nile tilapia juveniles for 8 weeks.



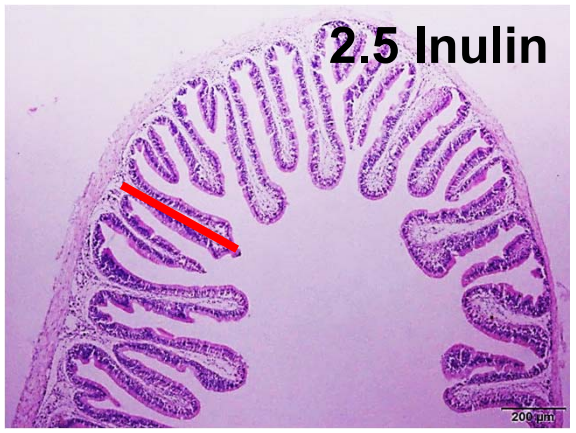


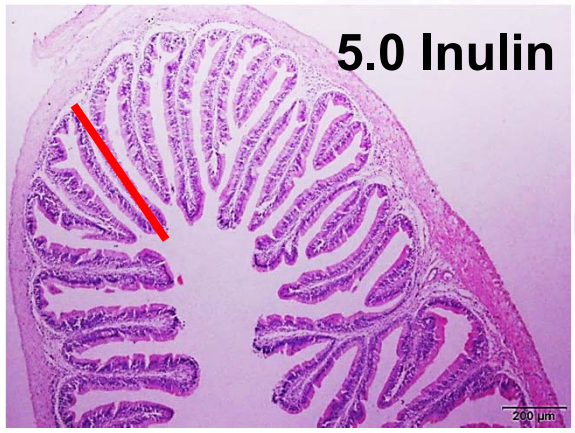


Fish fed inulin (2.5 and 5.0 g kg^{-1}) exhibited increased humoral innate immune responses, including total immunoglobulin, lysozyme and ACH50 activities.

Table 7 Effect of dietary inulin on intestinal villus height of Nile tilapia juveniles for 8 weeks.

Diet	Anterior	Middle	Posterior
	Villus height (µm)	Villus height (µm)	Villus height (µm)
Control	408.59^{a}	309.61^{a}	206.45
2.5 Inulin	421.37^{ab}	321.66^{ab}	213.76
5.0 Inulin	525.58^{b}	392.37^{b}	225.19
Pooled SEM	20.94	13.74	7.33

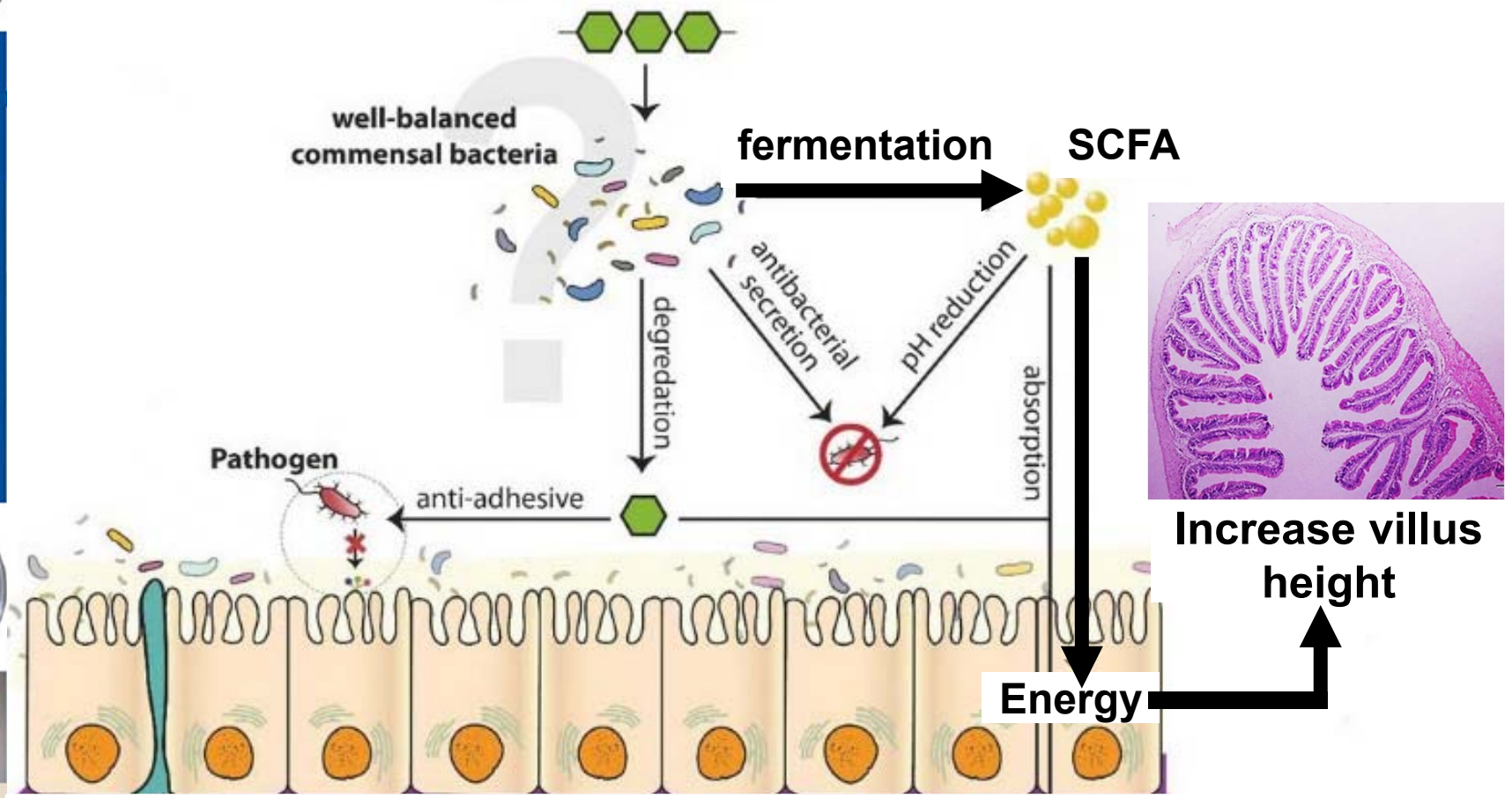




Diet	Initial weight (g)	Final weight (g)	FCR
Control	44.6	233.4^{a}	1.49^{c}
2.5 Inulin	44.4	257.9^{b}	1.33^{b}
5.0 Inulin	44.3	280.3^{c}	1.16^{a}
Pooled SEM	0.1	8.1	0.05

These increase in villi height would contribute the improvement of growth response and feed utilization efficiency.

Inulin



Pourabedin and Zhao (2015)

Intestinal epithelium

Results	2.5 Inulin	5.0 Inulin
Growth response	✓	✓
FCR	✓	✓
Whole body composition		
RBC number	✓	✓
Serum magnesium and iron		✓
Total Ig, lysozyme	✓	✓
ACH50 activities		✓
Intestinal villus height		✓

-These findings indicate that inulin at 5 g kg^{-1} had beneficial prebiotic effects on growth and health of juvenile Nile tilapia.

-Thus, inulin have great potential for use as prebiotics in juvenile Nile tilapia feed.