Unlock the growth potential: The role of saponins in enhancing shrimp gut health

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Agenda

- Gut health and the importance for performance improvement
- Saponins in Aquaculture
- Influence of saponins on shrimp and fish gut health
- Conclusions

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How can we improve gut health and functionality?

5

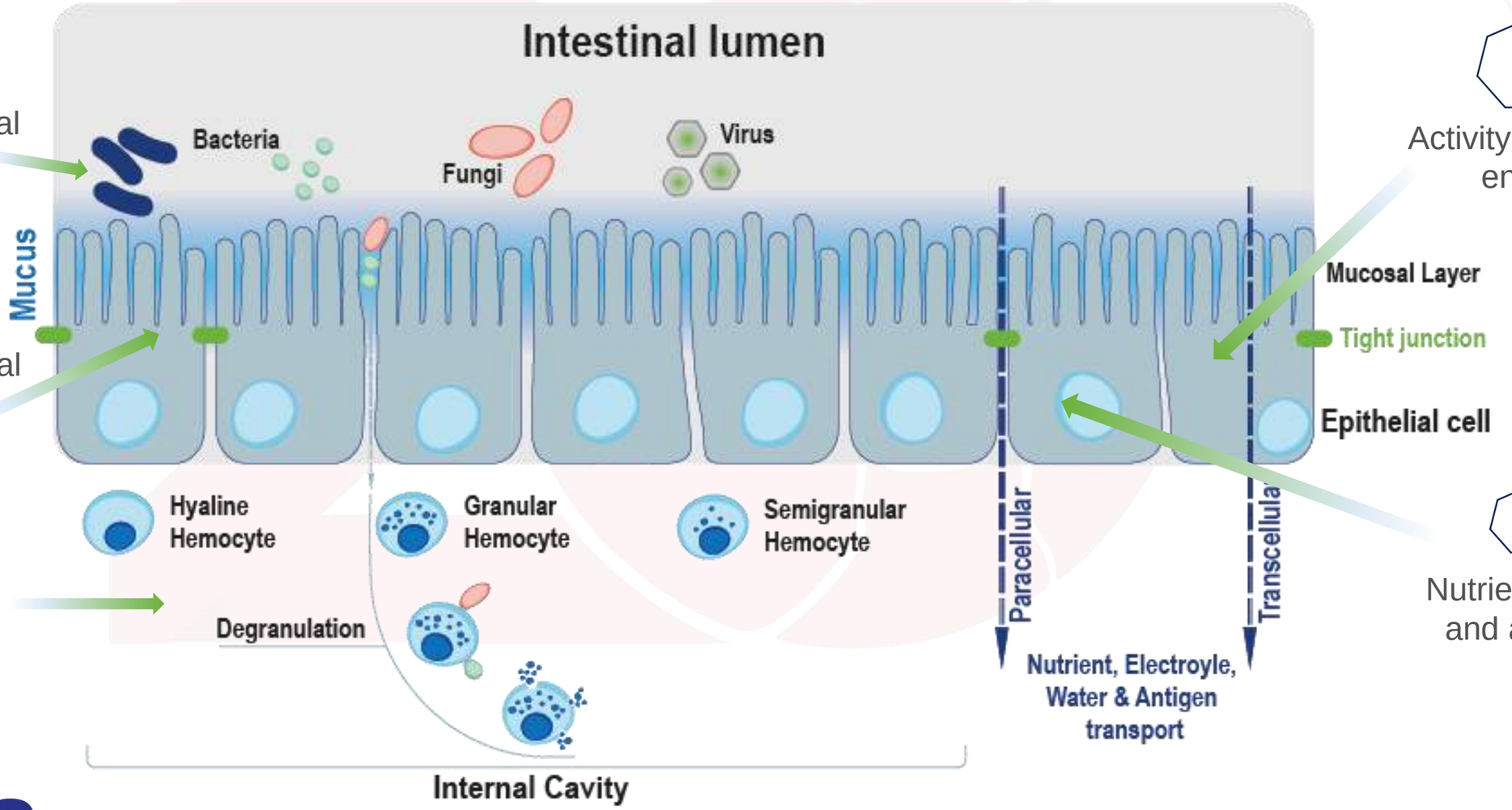
Balanced microbial gut community

4

Enhanced intestinal morphology

3

Modulate the immune system



1

Activity of digestive enzymes

2

Nutrient digestion and absorption

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What are Saponins?

- Secondary plant compounds.
- Contain lipophilic part & hydrophilic sugar side chains.
- Can be found in several molecular forms.
- Known for their hemolytic and piscicidal effects.
- Can be found in several plant sources:

  - Ginseng
  - Quillaia
  - Yucca
  - Soy
  - Asparagus
  - Alfalfa

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Literature review of benefit of Saponin in aquafeed

Quillaja saponaria and/or *Yucca schidigera* ameliorate water quality, growth performance, blood health, intestine and gills histomorphology of Nile tilapia, *Oreochromis niloticus*

Ahmed M. Abozeid[1] | Mohamed M. Abdel-Rahim[2] | Fatma Abouelenien[3] |

Research Article

The biological action of saponins in animal systems: a review

George Francis[1], Zohar Kerem[2], Harinder P. S. Makkar[3] and Klaus Becker[1]*

Research Article

The effects of *Yucca schidigera* and *Quillaja saponaria* on growth performance and enzymes activities of juvenile shrimp *Litopenaeus vannamei*

Quillaja saponins—a natural growth promoter for fish

George Francis[a], Harinder P.S. Makkar[b], Klaus Becker[a,*]

Abstract

Environmental concerns and the forthcoming ban on antibiotics in the European Union have renewed interest in renewable and non-persistent plant-based growth promoters in fish feeds. A review of the published literature and unpublished recent results following addition of a *Quillaja* saponin mixture in the diets of common carp and Nile tilapia are presented. It emerges that *Quillaja* saponins have the potential to increase growth in culture fish species, reduce their metabolic rate and suppress reproduction in tilapia. The current study is the first to have demonstrated beneficial effects of a *Quillaja* saponin-rich fraction when used as a feed additive in fish diet. It is hoped that this collation of information and synthesis of results, discussion and conclusions will act as a catalyst for future research on isolation of the active fraction, its optimum concentration for obtaining the desired effects, and physiological mechanisms of action for the diverse biological effects of these compounds.

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Keywords: Saponins; Fish; Carp; Tilapia; Performance; Reproduction

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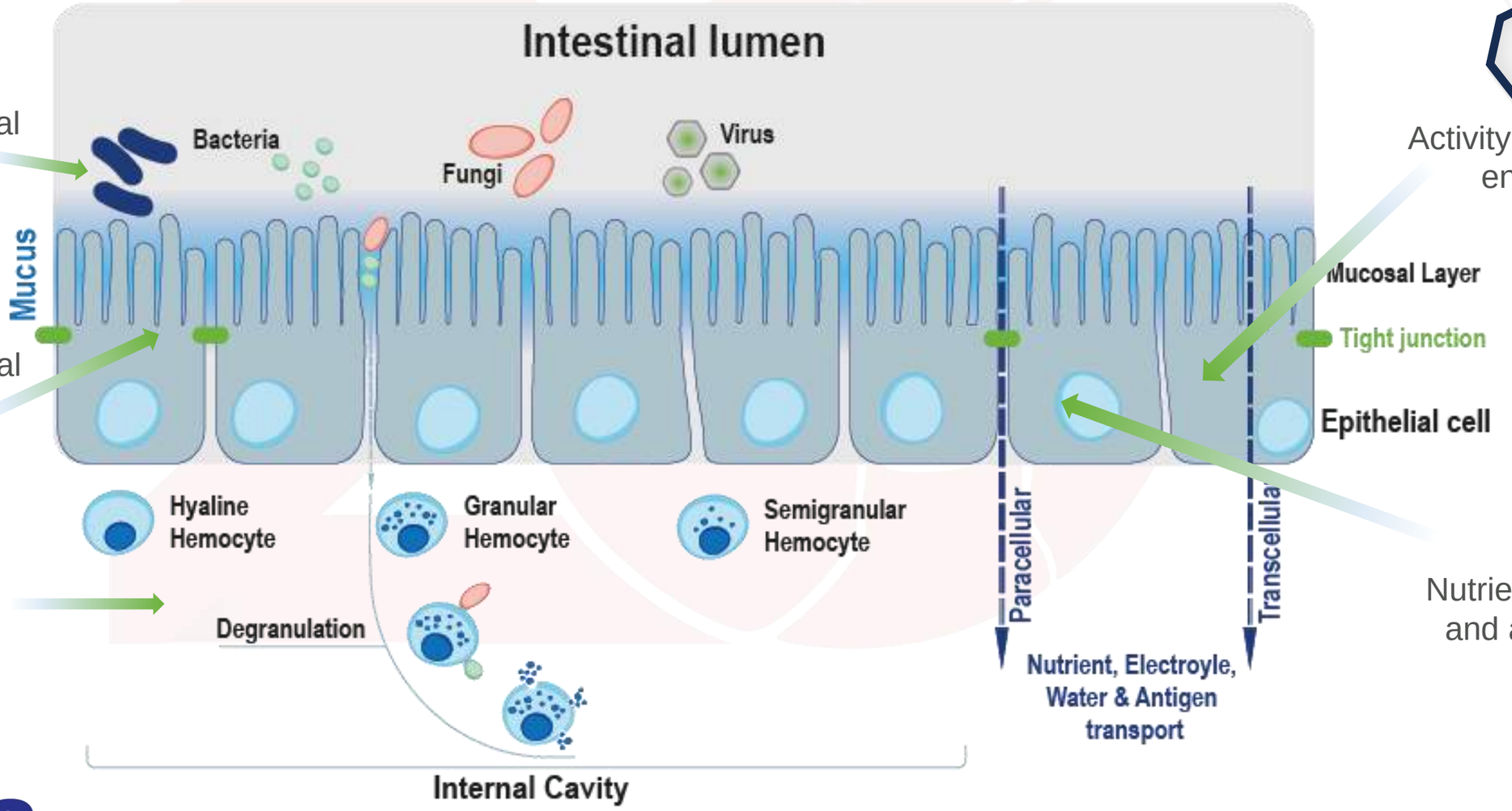

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Evaluation of saponin-based supplement (SBS) on the enzymatic activity of Pacific white shrimp, *Litopenaeus vannamei*

Production of digestive enzymes

Species	Shrimp
Treatment	Control vs SBS
Number Replicas	4
Duration	28 days
Stocking	30 Shrimps/tank
Initial Weight	2g
Inclusion of SBS	2kg/MT

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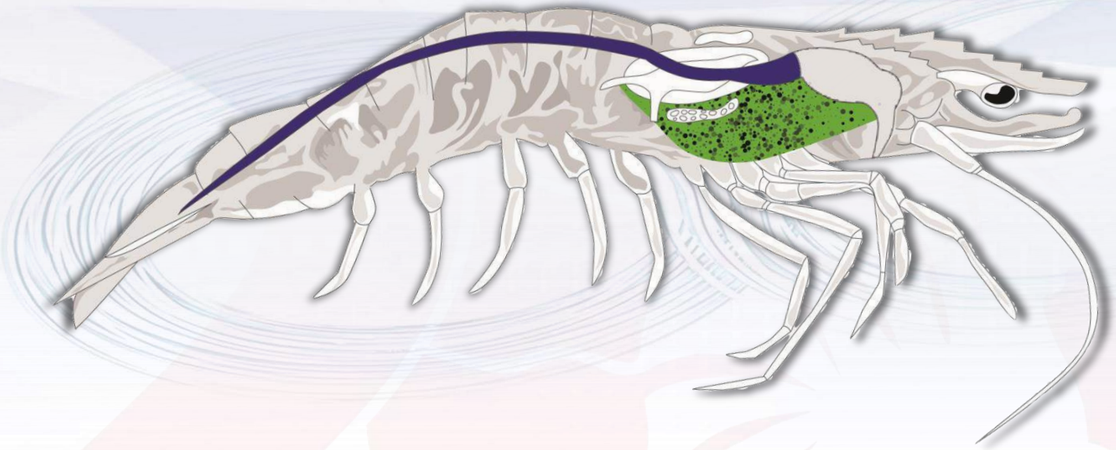
Enhanced enzyme activity



Enzyme activity in the hepatopancreas

Enzyme (UI/g)	Control	SBS
Amylase	311.79 ±175	**378.63 ±129***
Lipase	58 ± 28	57.03 ± 42

Enzyme activity in the gut

Enzyme (IU/g)	Control	SBS
Amylase	1242±384	**1811±312***
Lipase	104±25	**123±50***

Results are in line with Hernandez-Acosta et al. (2016)

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Enhanced enzyme activity

Amylase activity

Saponin supplement: Yucca (15%) and Quillaia (85%): ≥ 3.0 % w/w of saponin

Higher amylase activity leads to better chitin synthesis = induce growth

Saponins = glucosides that consist of a polycyclic aglycones

Shrimp molting is made of chitin that made of mono-sugars

Polycyclic aglycones trigger amylase activity

Amylase is an enzyme that catalyzes the hydrolysis of starch into sugars

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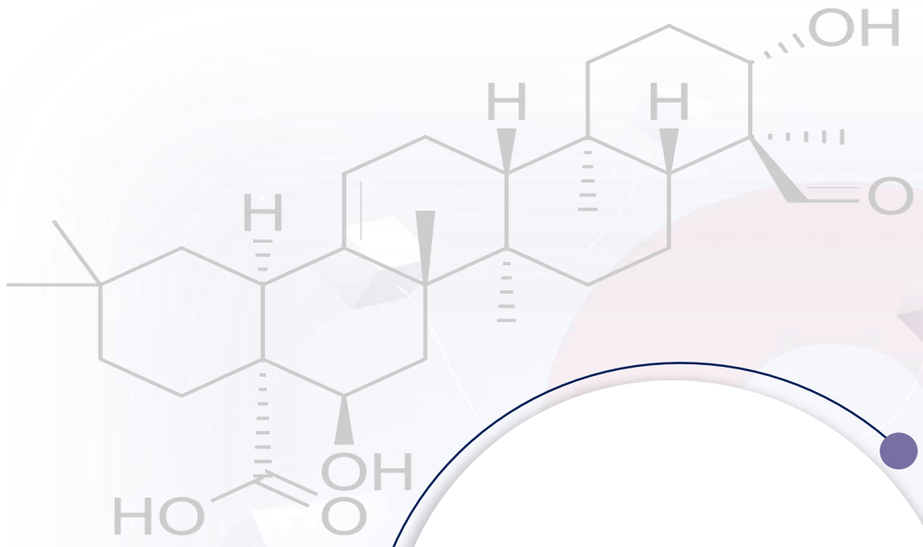
Lipase activity



Lipid requirement in shrimp is limited to 5-8%.

Enhanced lipase activity enable better extraction of fatty acids.

Inducing lipase activity can lead to optimum growth by improving digestibility of fatty acids within the lipid constraint.

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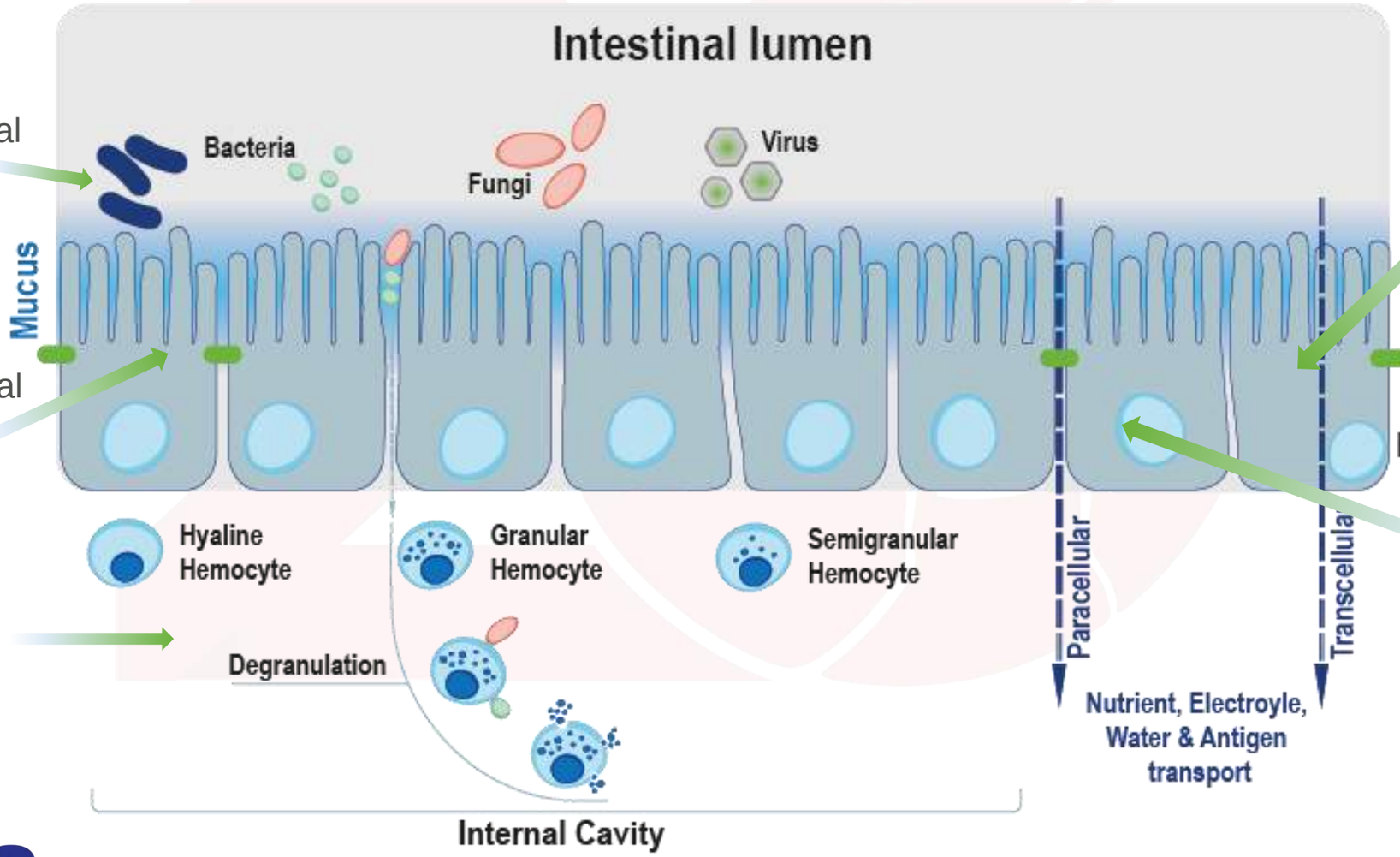

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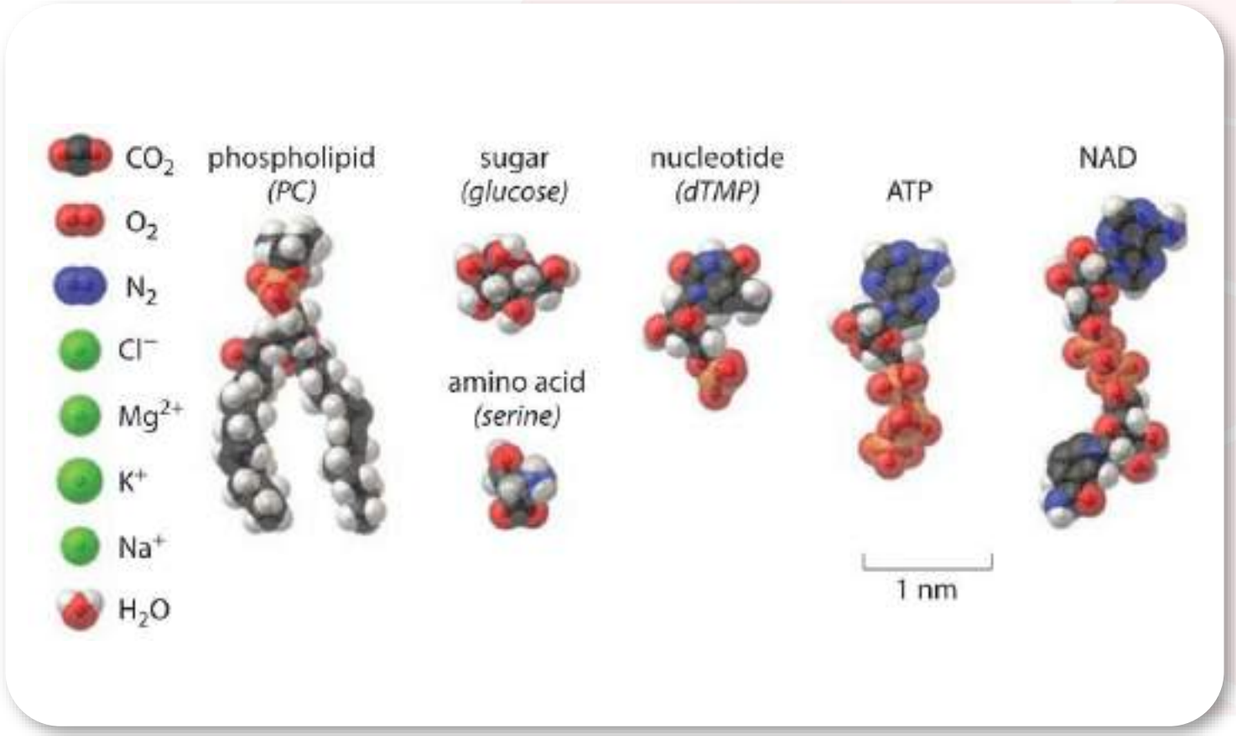
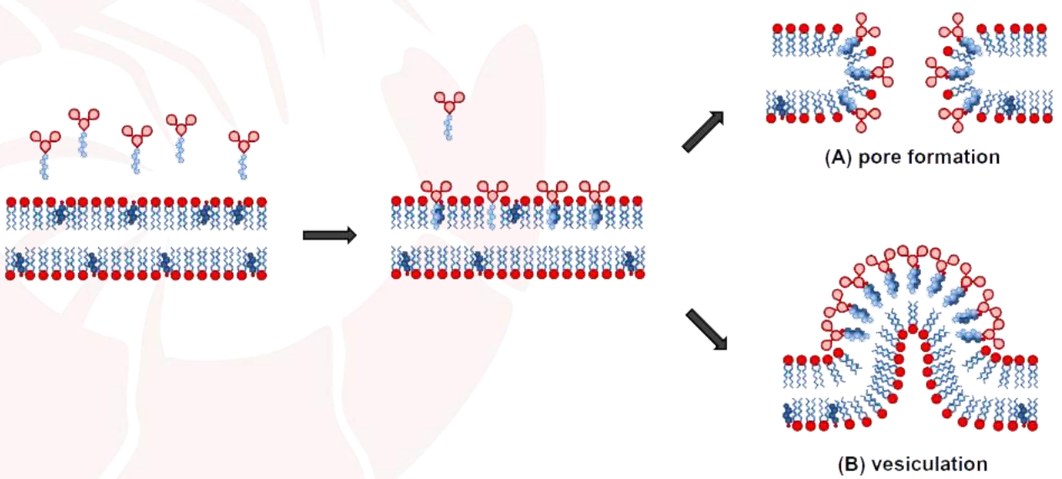
The ability of Saponins to form pores and membrane elasticity



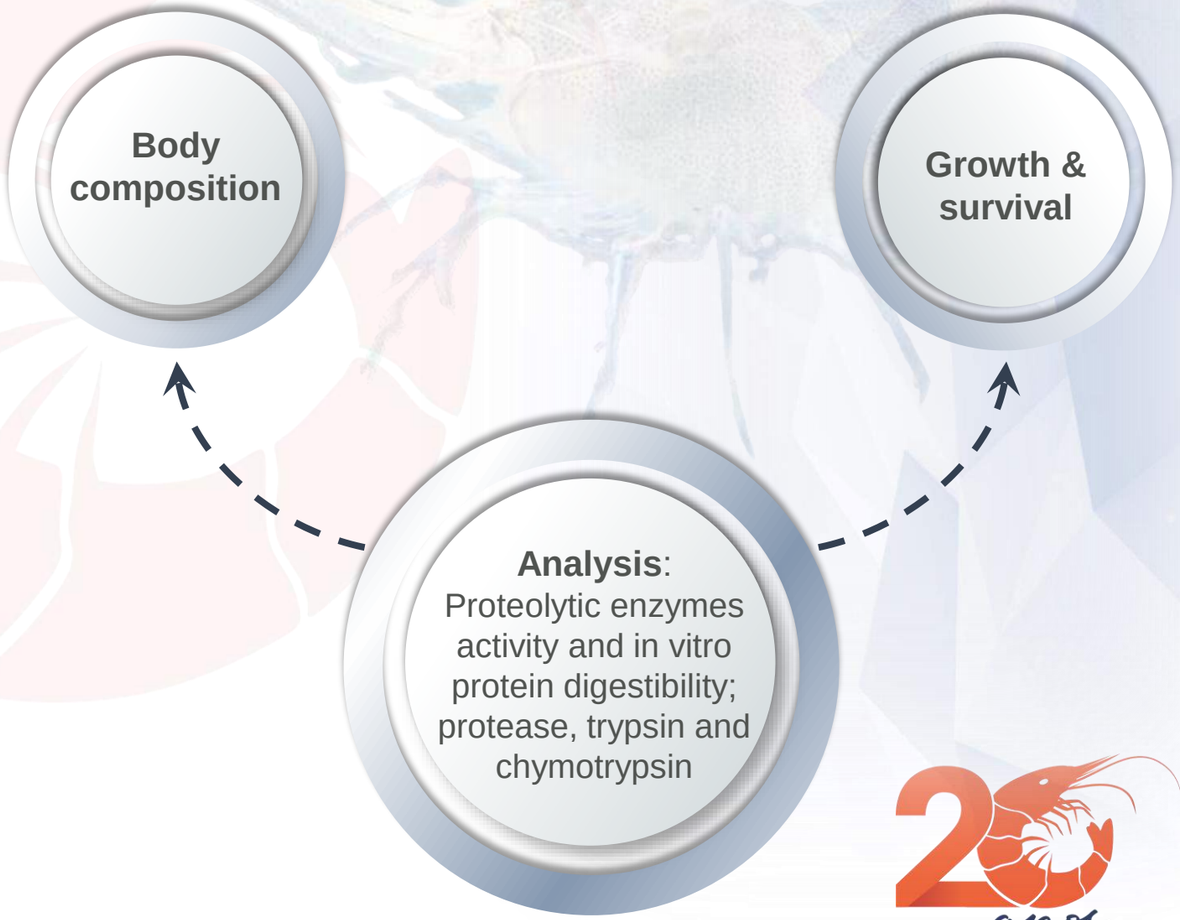


J.M. Augustin et al. / Phytochemistry 72 (2011) 435–457

Effect of SBS on digestibility of soybean-meal-based diet in *L. vannamei*

Improvement in digestion and absorption

Species	Shrimp
Treatment	Control vs SBS • Control (9% fishmeal inclusion) without SBS • Negative control (0% fishmeal inclusion Soybean based meal) without SBS • Negative control with SBS 1kg/MT
Number Replicas	4
Duration	60 days
Stocking	100 Shrimps/tank
Initial Weight	0.51± 0.10g



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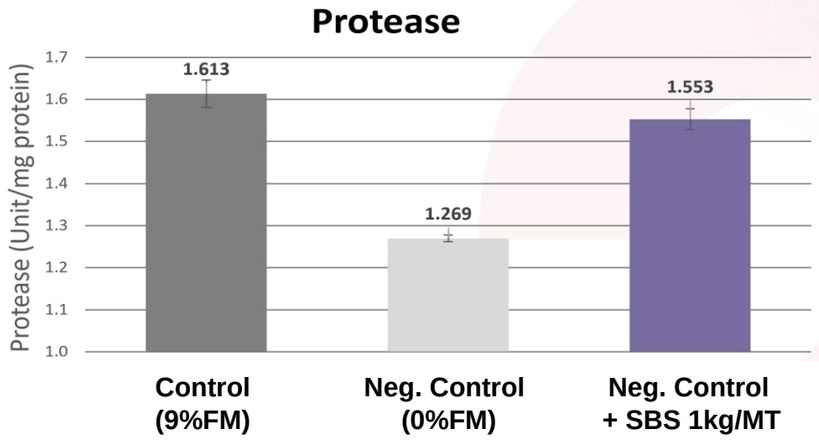
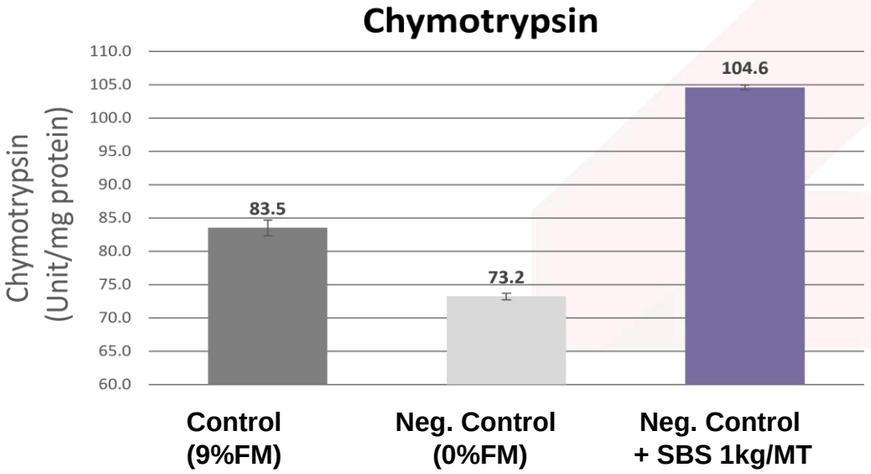
Effect of SBS on digestibility of high soybean meal diet with L.vannamei





	Control (9%FM)	Neg. control (0%FM)	Neg. control + SBS 1kg/MT
Protein	75.8±1.1	75.0±0.7	**75.3±2.1**
Arginine	7.74	7.93	**8.95**
Histidine	0.71	0.73	**0.74**
Isolucine	1.2	1.3	**1.59**
Leucine	1.99	1.93	**2.44**
Lysine	3.69	3.76	**4.44**
Methionine	0.79	0.81	**0.85**
Phenylalanine	1.37	1.34	**1.17**
Threonine	1.21	1.36	**1.07**
Tryptophan	0.53	0.39	**0.42**
Valine	1.21	0.35	**1.32**
Sum EAA	20.4	19.9	**22.9**

*EAA (Essential Amino Acids)

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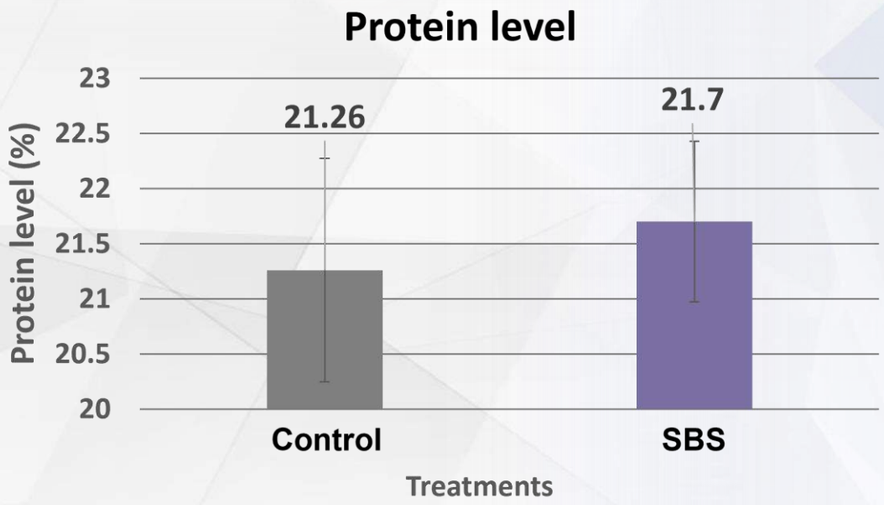
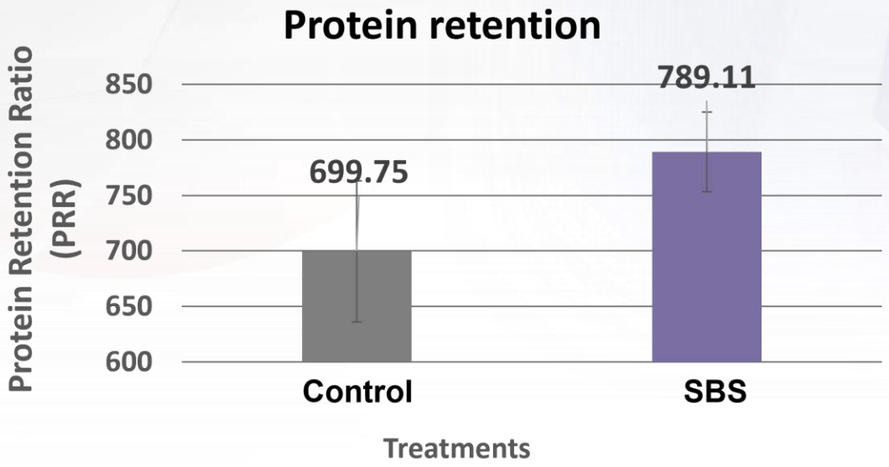
SBS Metabolic analyses of shrimp – protein level and retention

Batam Dae Hae Seng research station, Indonesia

Species	Shrimp
Treatment	Control vs SBS
Number Replicas	6
Duration	60 days
Stocking	180 Shrimps/tank
Initial Weight	Size- 4.24±0,03 g initial weight with *L. vannamei*
Inclusion of SBS	2kg/MT

- **Analysis:**
  - Protein level %: Kjeldahl method
  - Protein retention ratio (PRR)





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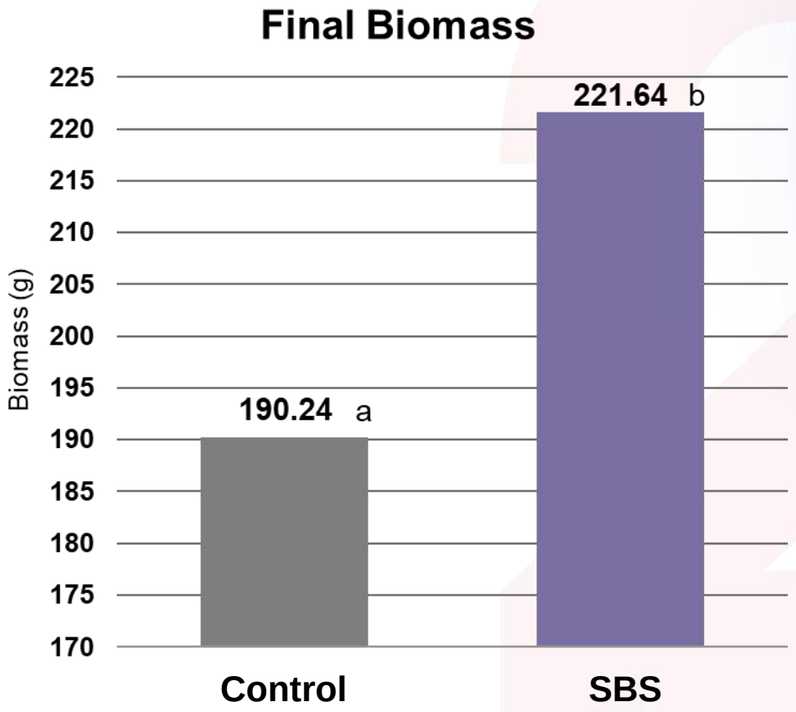
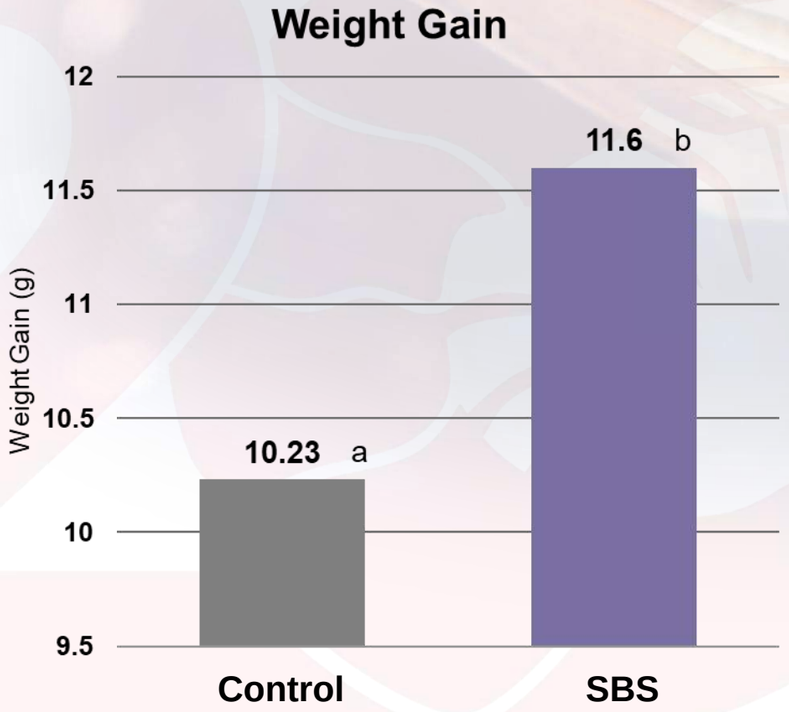
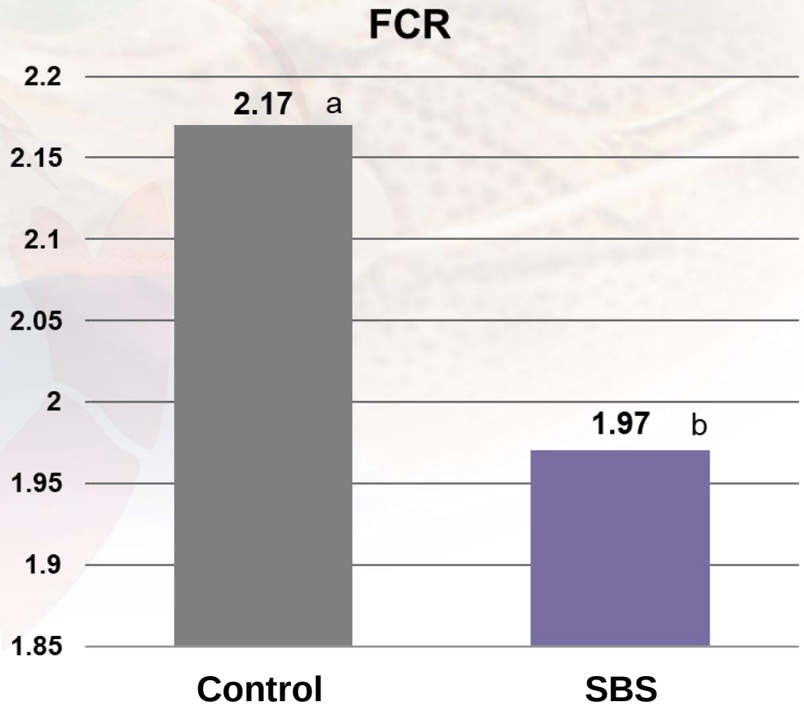
Results

Performance







* Indicates significantly difference p<0.05

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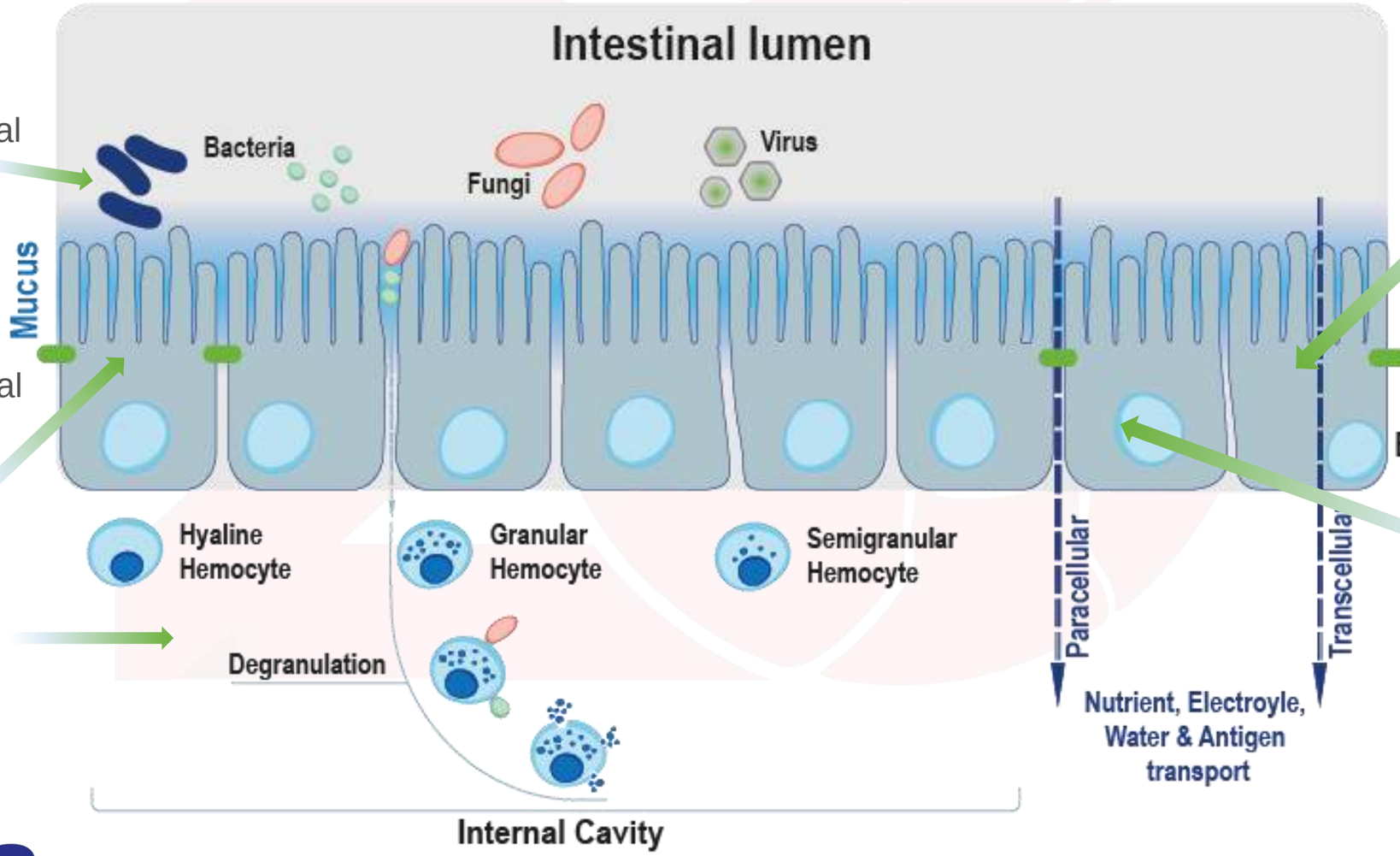

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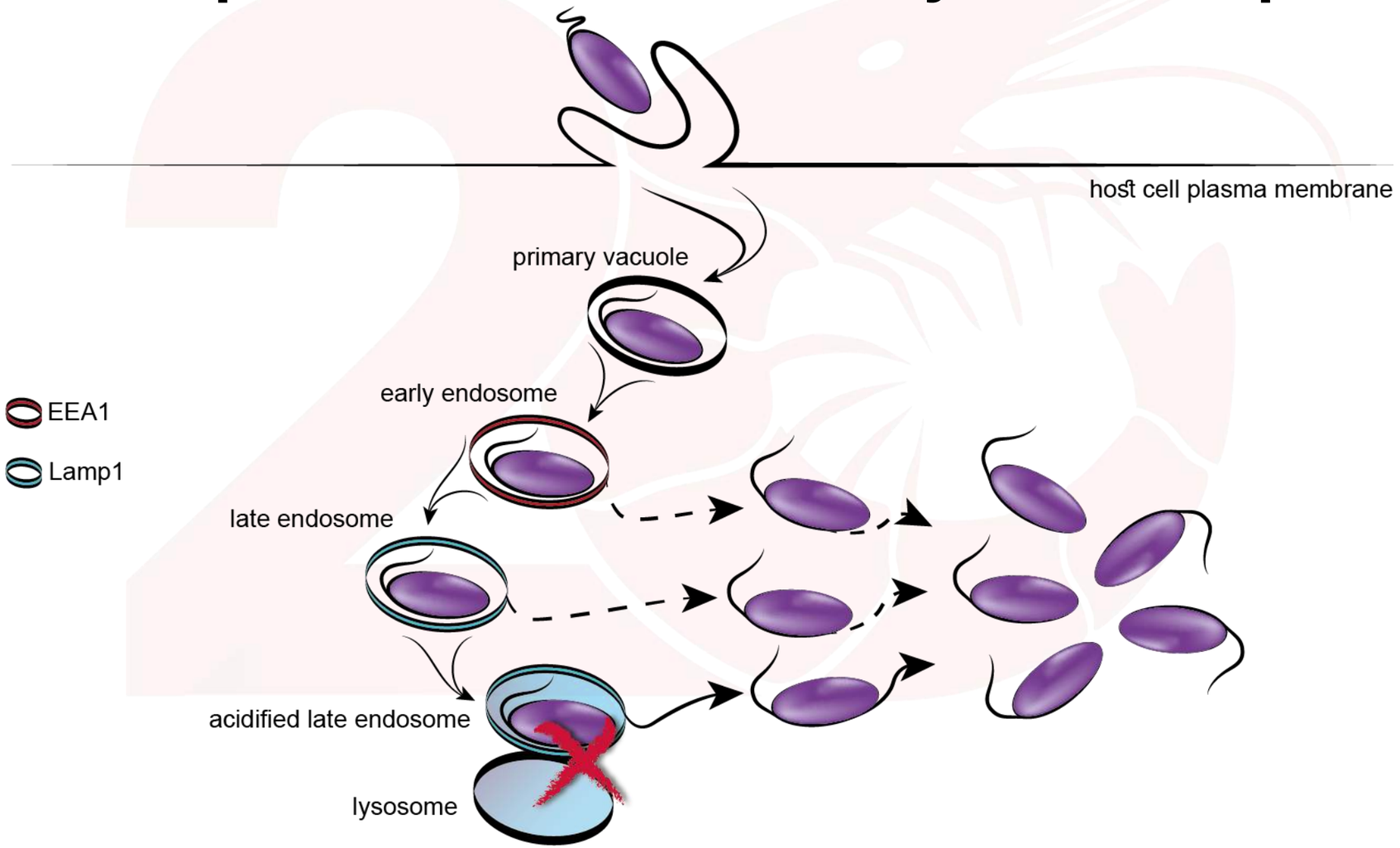
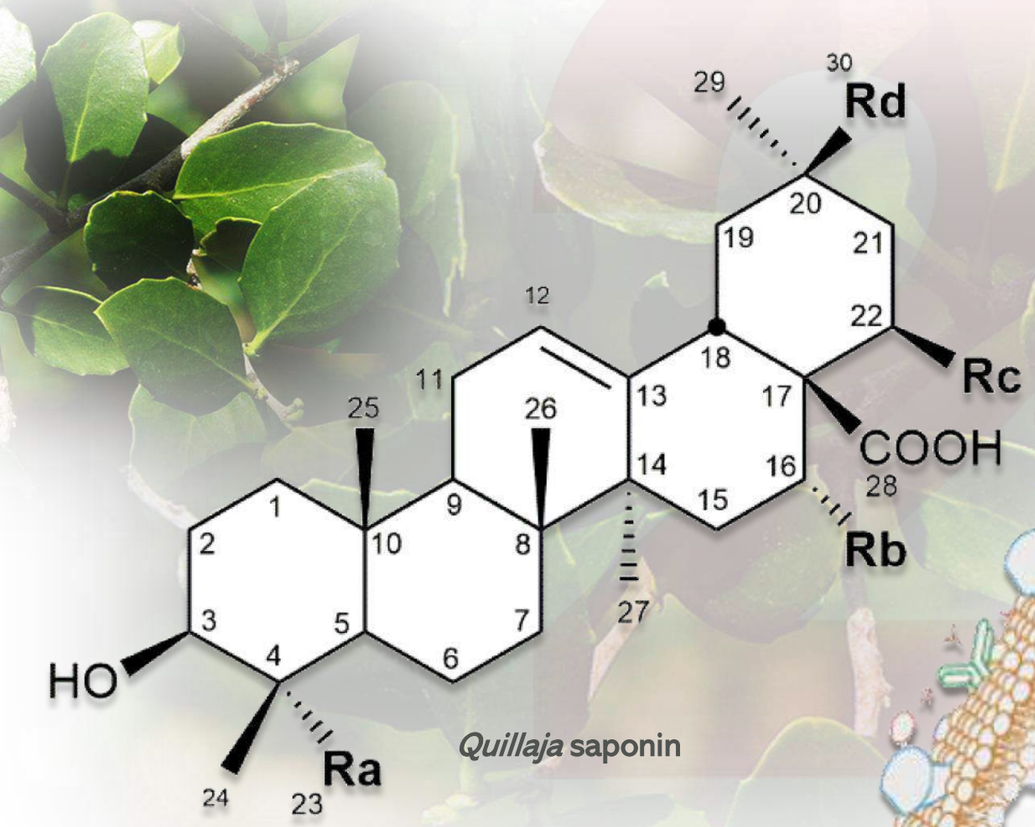
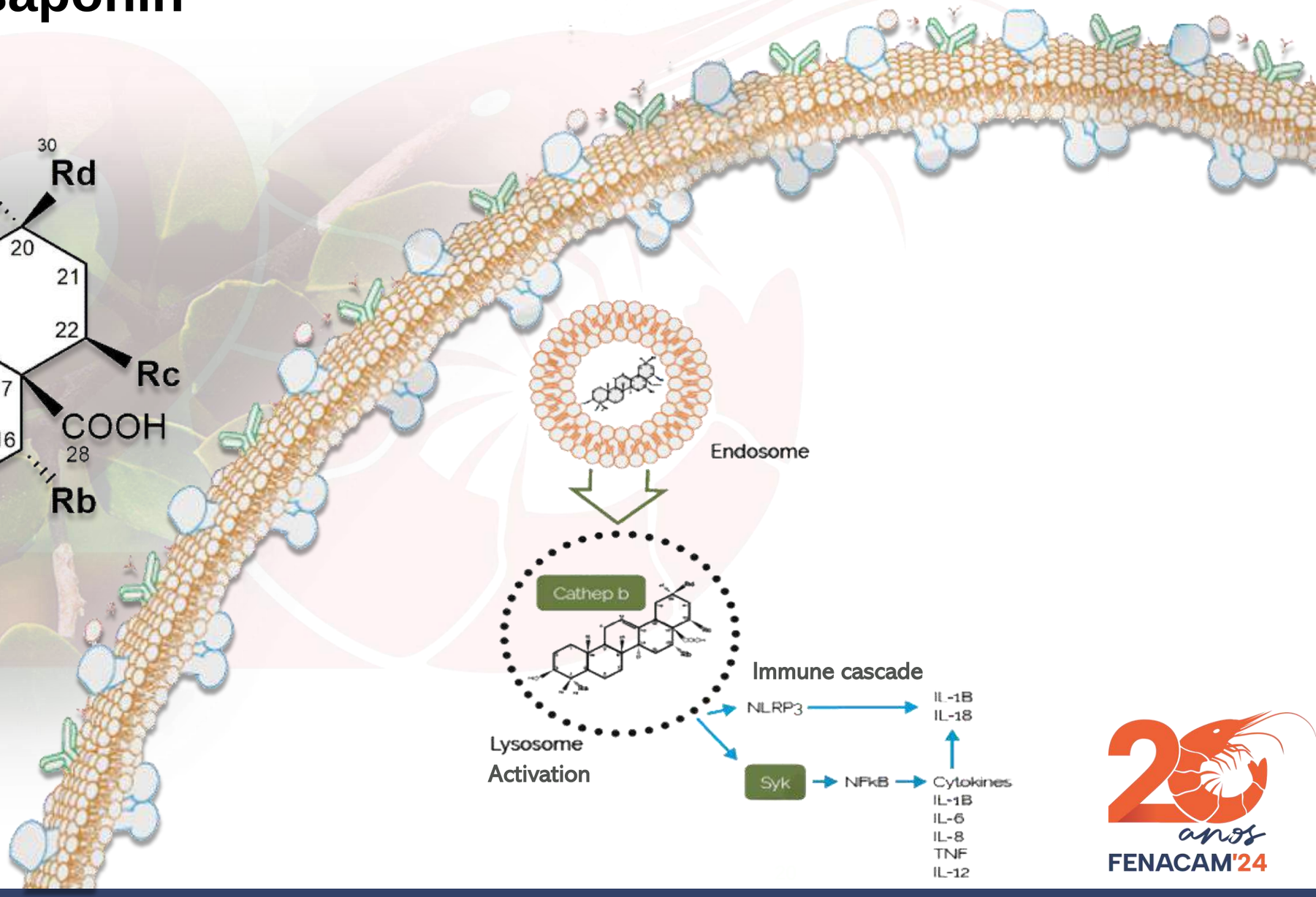
Intracellular *Vibrio parahaemolyticus* escapes the vacuole and establishes a replicative niche in the cytosol of epithelial cells



Adapted from: de Souza Santos M, Orth K. 2014

Proposed mechanism of enhancement of immune response in shrimp by *Quillaja* saponin





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Evaluating the effect of SBS on growth performance and overall health status of *Litopenaeus vannamei* culture under normal and challenge conditions

Kasetsart University, Thailand - 2021

Species	Shrimp *L. vannamei*
Treatment	Control vs SBS 3 Kg/MT feed
Number Replicas	6
Duration	8 weeks
Stocking	25 Shrimps/tank
Initial Weight	Size 2±0.05g
Challenge	*Vibrio parahemolyticus*

Analysis:

- Growth performance
- Blood and biochemistry
- Bacteria count

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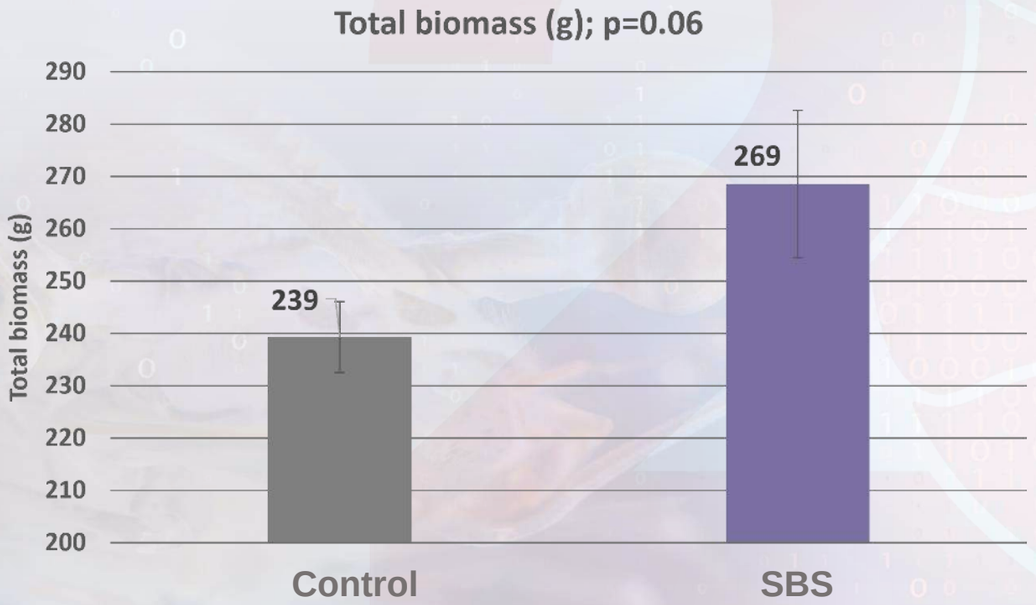
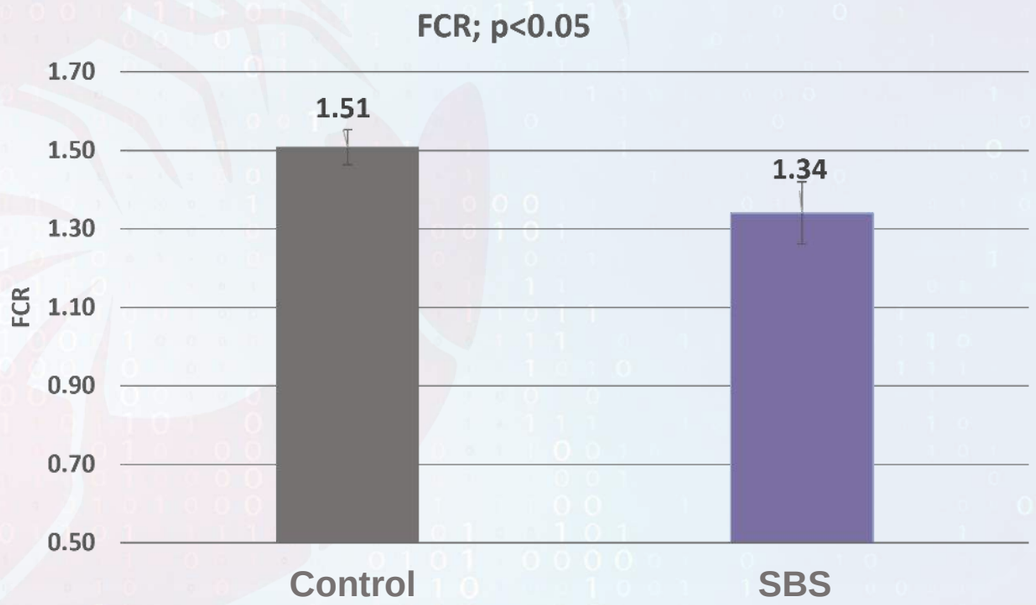
Growth performance normal conditions





Survival was higher with SBS

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Evaluating the effect of SBS on growth performance and overall health status of *Litopenaeus vannamei* culture under challenge conditions

Immune parameters under challenge, one week after challenge

	Hemocyte count (x10^5 cell/ml)	Hemolymph Protein (g/dL)	Phenoloxidase activity(unit/min/mg Protein)	Lysosyme	Superoxide dismutase (SODN)	Glutathionine
Control	29.7	1.0	250.6	30.0	7.4	30.3
SBS	**32.7**	**2.1**	**284.3**	**43.3**	**11.1**	**32.4**
P value	0.02	0.31	0.21	0.001	0.04	0.01

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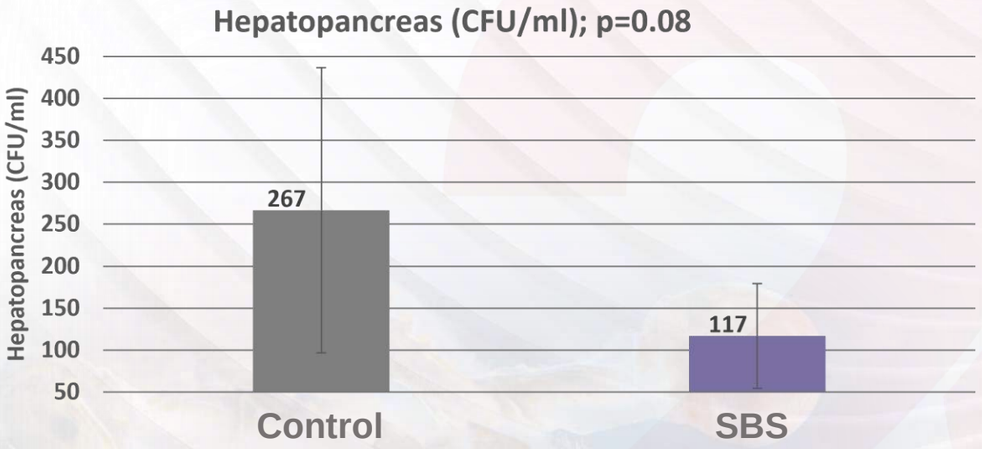
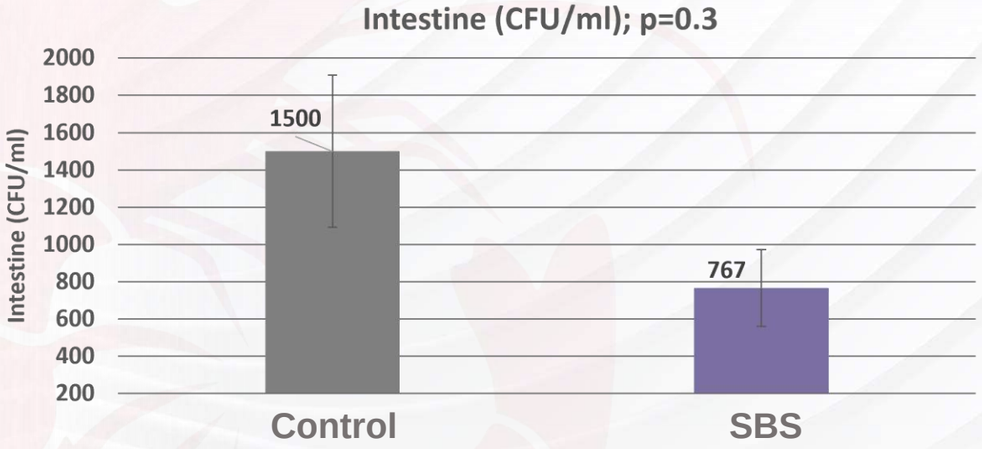
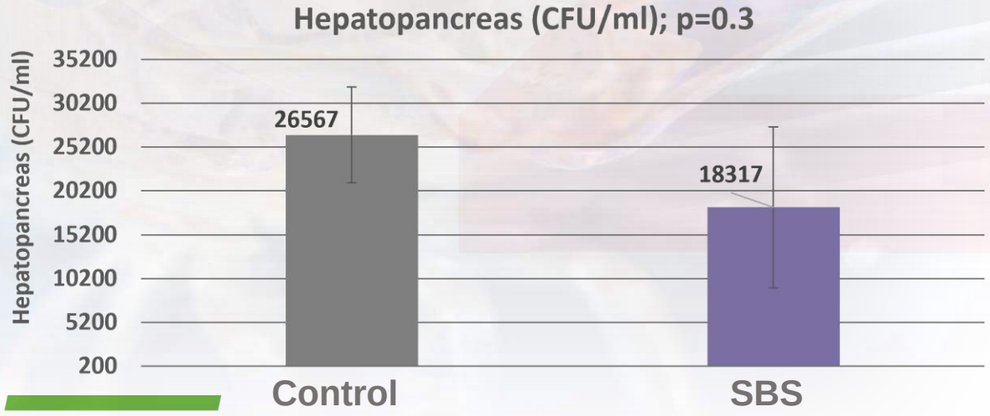
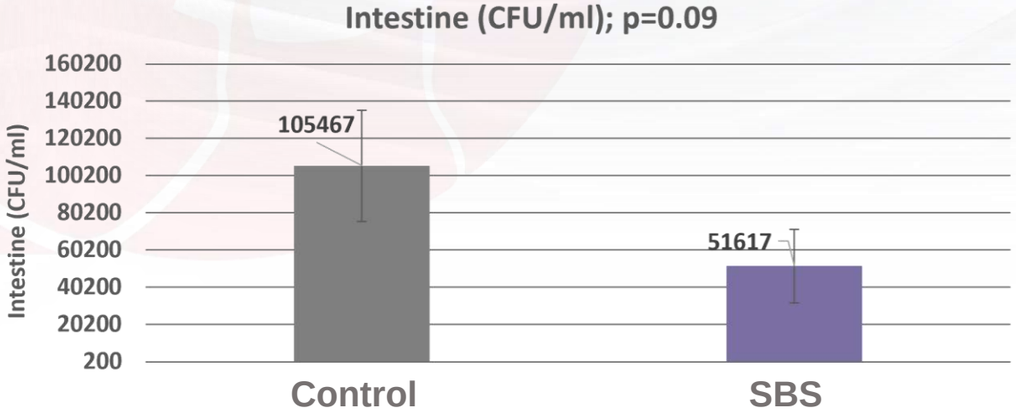
Bacteria count under normal condition





Bacteria count after challenge





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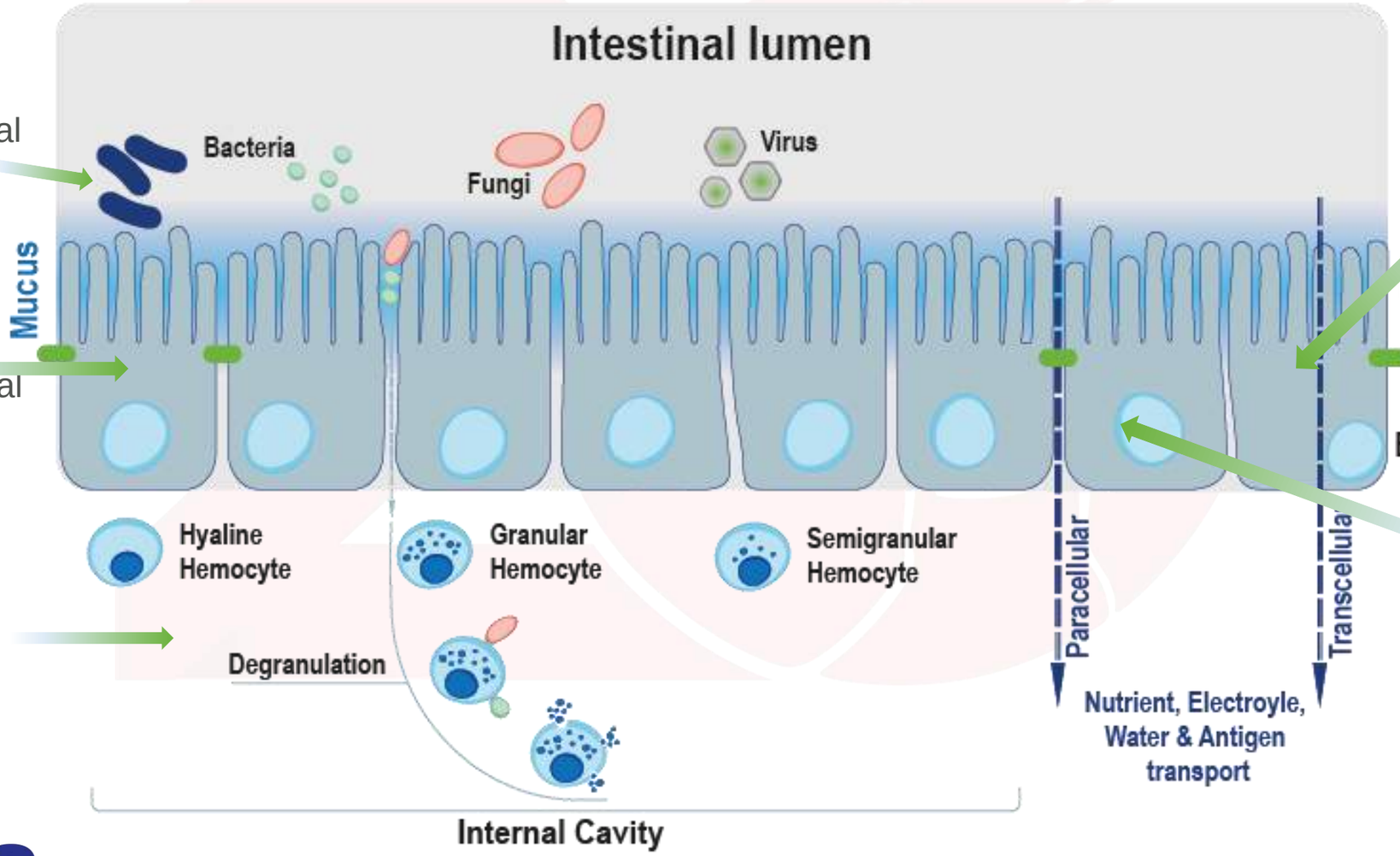

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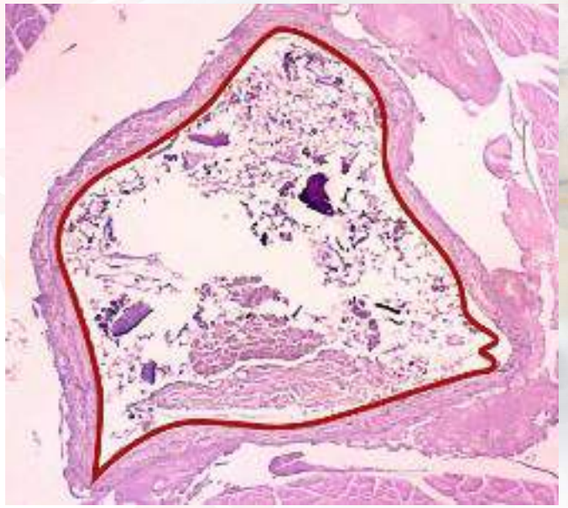
Inclusion effect of SBS in plant-based diet on histomorphology conditions of white-leg shrimp, *Litopenaeus vannamei*

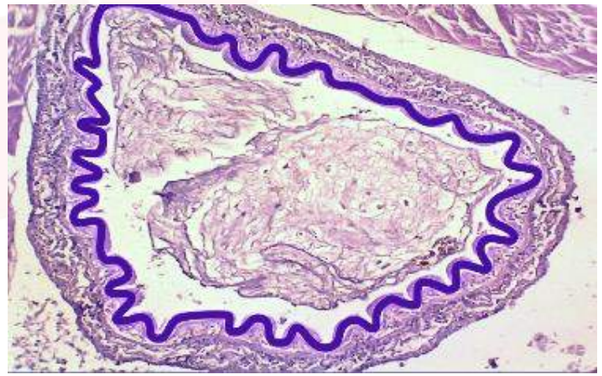
Treatment	- Commercial feed - Commercial feed + 2kg/MT of SBS
Animals	*Litopenaeus vannamei, 2g (initial weight) 15 shrimp/aquarium*
Duration	90 days
Facility	24 aquariums tanks: 75 x 40 x 40 cm (100 L each)
Temp	26 ^{0}c
Replicates	8
Location	Center for marine and fisheries, Jakarta Technical University of Fisheries located in Serang, Banten, Indonesia.

Growth performance was significantly better at the SBS treatment



1. Commercial feed

Grade 0 – Low level to no intestinal folds



2. Commercial feed + 2kg/MT of SBS

Grade 4 – High level of intestinal folds

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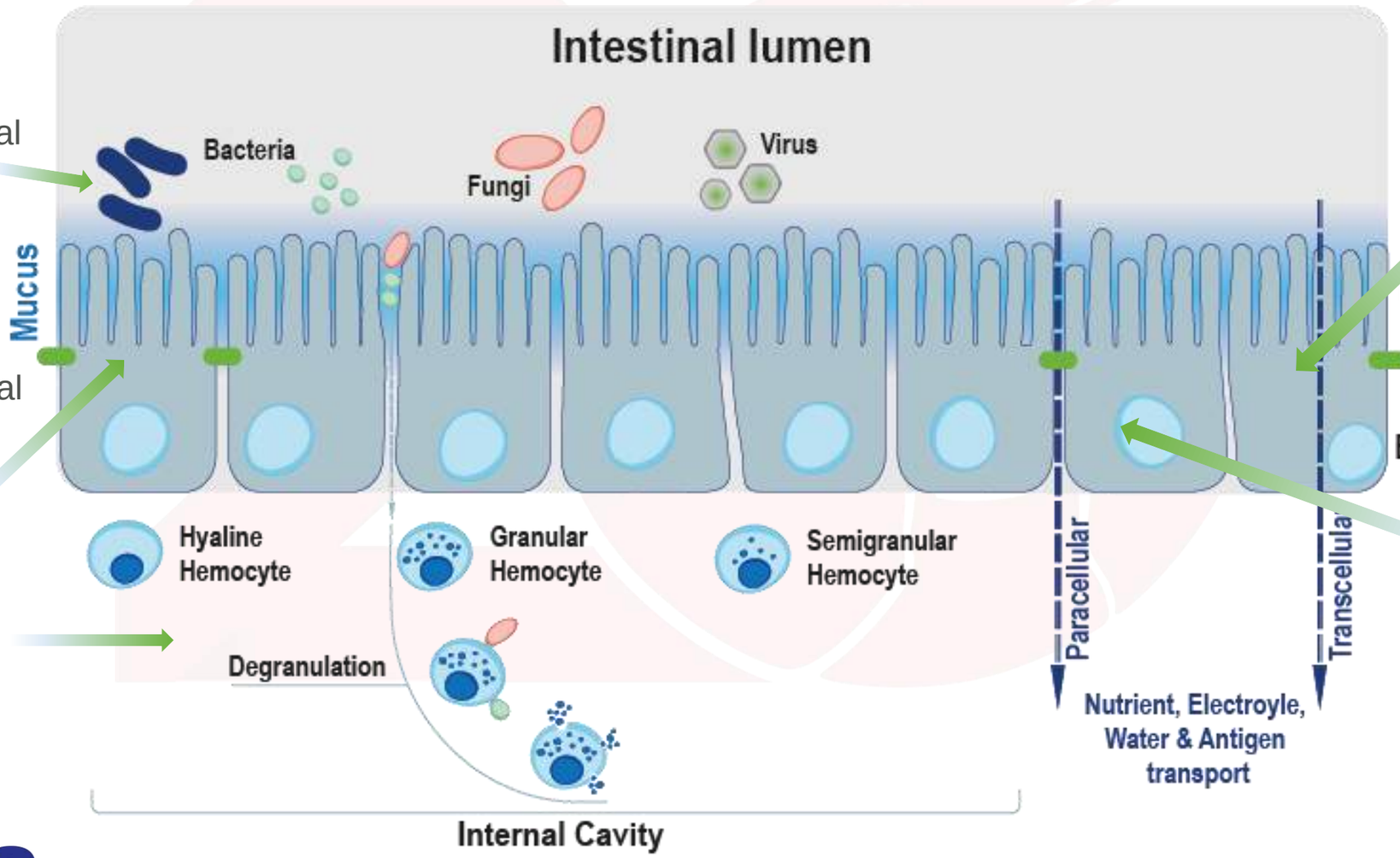

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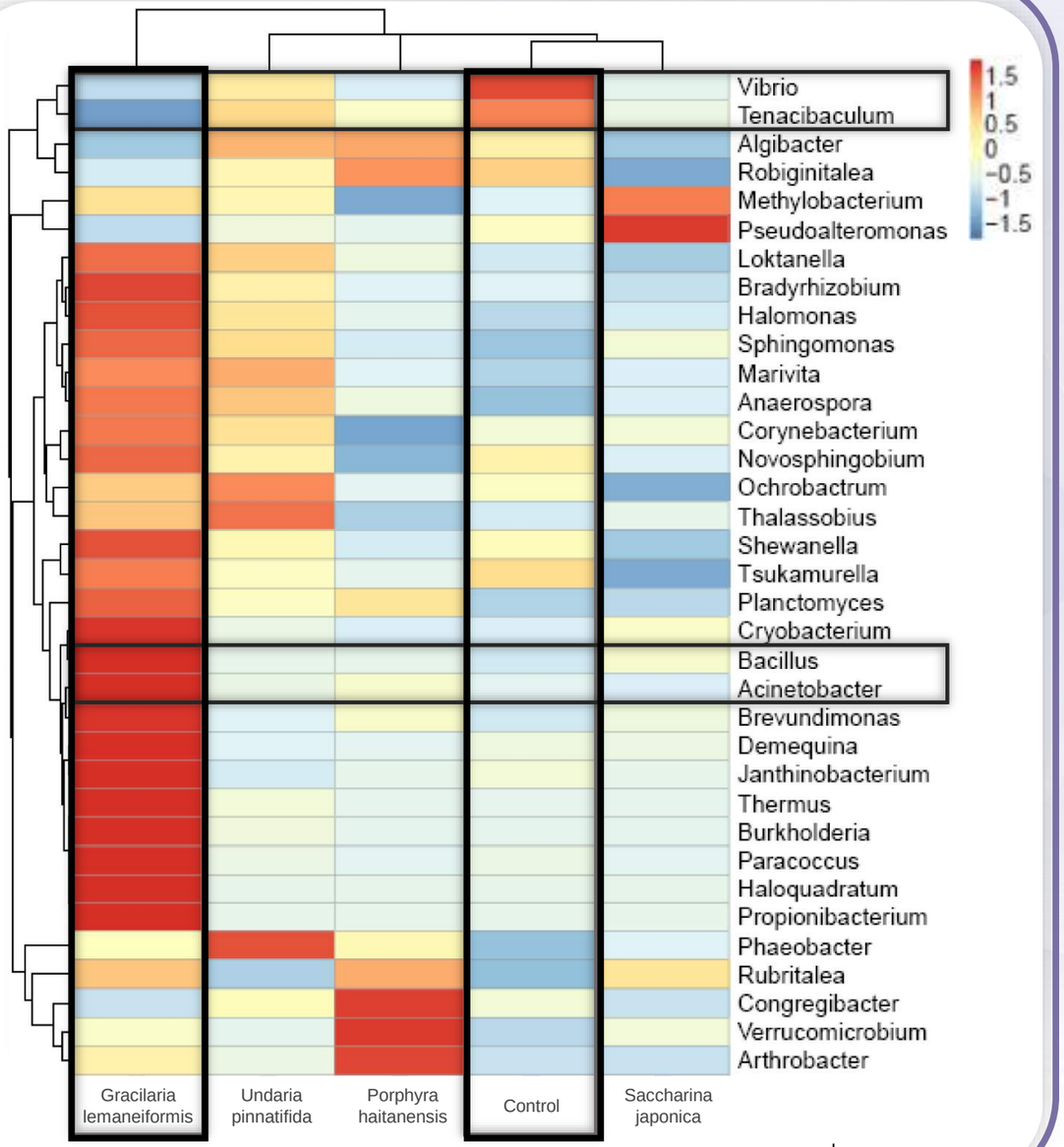
The Effect of Phytogenic on Microbiome in Shrimp Gut

- Intestinal microbiota supplies the host with nutritional and energy, acts as a pathogenic barrier, and exerts great influence on the maintenance of immune homeostasis
- *Gracilaria lemaneiformis* contains triterpenic saponins.
- *Gracilaria lemaneiformis* increased α-diversity of microbes in the intestine.
- We see significant impact on the microbial community vs control



Heatmap analysis of the species abundance clustering in the top 35 genus | Niu J; 2018

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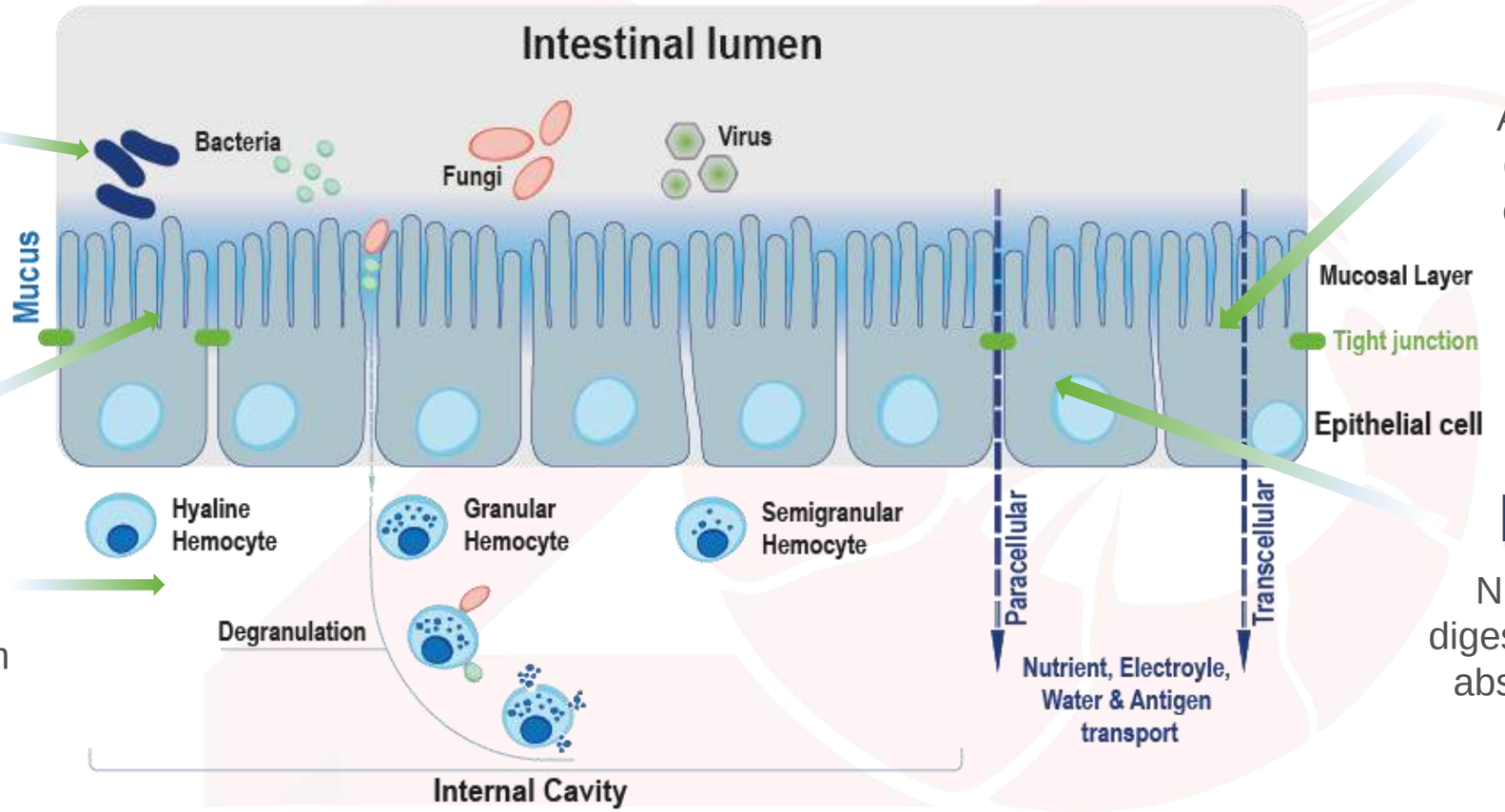

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