Romi Novriadi
Lecturer
Jakarta Technical University of Fisheries
Indonesia
Email: novriadiromi@yahoo.com

Production and Economic Sustainability in Indonesia's Aquafeed Industry

Abstract

Indonesia's production of farmed fish and shrimp was 5,226 million tonnes in 2020, representing around 6.75% contribution to the production outcome in Asia (FAO, 2022). Indonesia is ambitious when it comes to increasing exports of farmed shrimp and fish, and its domestic supply for local consumption. The government plans to increase marine shrimp production massively through 2 strategic plans: shrimp estate system and revitalization of the traditional production system. The shrimp estate project will produce around 60,000 tonnes of shrimp with export quality per year until 2024 and the revitalization program through feed intervention will increase the productivity from 0.6 tonnes/ha/year into 2 tonnes/ha/year. In addition, to securing local needs, the government has established a network of hundreds of villages with aquaculture farms.

In the coming years, the development of the aquaculture production system will focus on three pillars, namely: (1) Sovereignty, (2) Sustainability, and (3) Prosperity to balance the ecology and economy of the production system. Therefore, improving water quality, implementation of wastewater treatment, technology, proper biosecurity and applying Good Aquaculture Practices which are main factors contributing to a sustainable aquaculture system. This also includes a significant reduction on the use of fishmeal in aquafeed. Alternative plant-protein sources have been used to replace fishmeal, such as corn distillers dried grain solubles, soy-protein and advanced products of plant-protein sources.

Farmers seek effective yet cheap feed and local ingredients such as palm kernel meal (PKM) which has become an ingredient in fish feed formulation for a more efficient production cost. To overcome the high fibre content and low digestibility of PKM, the addition of protease to hydrolyze the peptide bonds and conversion into shorter polypeptides and amino acids could be a solution to optimize the nutritional profile and digestibility of PKM.

Lastly, to replace ingredients in aquafeeds also needs consideration of specific nutritional needs of fish and shrimp. Thus, the aquafeed production in Indonesia has move towards the application of functional ingredients, such as the use of enzymes, nucleotides, phytogenic, yeast, and other substances, to fulfill the specific needs and optimize the growth, as well as the health condition of fish and shrimp.

PRODUCTION AND ECONOMIC SUSTAINABILITY IN INDONESIA'S AQUAFEED INDUSTRY

DR. ROMI NOVRIADI

Jakarta Technical University of Fisheries
Politeknik Ahli Usaha Perikanan – Jakarta
Ministry of Marine Affairs and Fisheries, Republic of Indonesia

TARS 2022
The Aquaculture Roundtable Series

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A shared vision for aquaculture in Asia
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AQUAFEEDS
A New Equilibrium

"Ocean, sea, strait and bay are the future of our civilization,"

INDONESIA has more than **17,500 islands** with at least **108,000 km²** coastline

Indonesia as world's maritime axis

275,77 miliion people and the majority live in coastal areas

12,1 million tonnes for fisheries production

3,36 million ha for mangroves

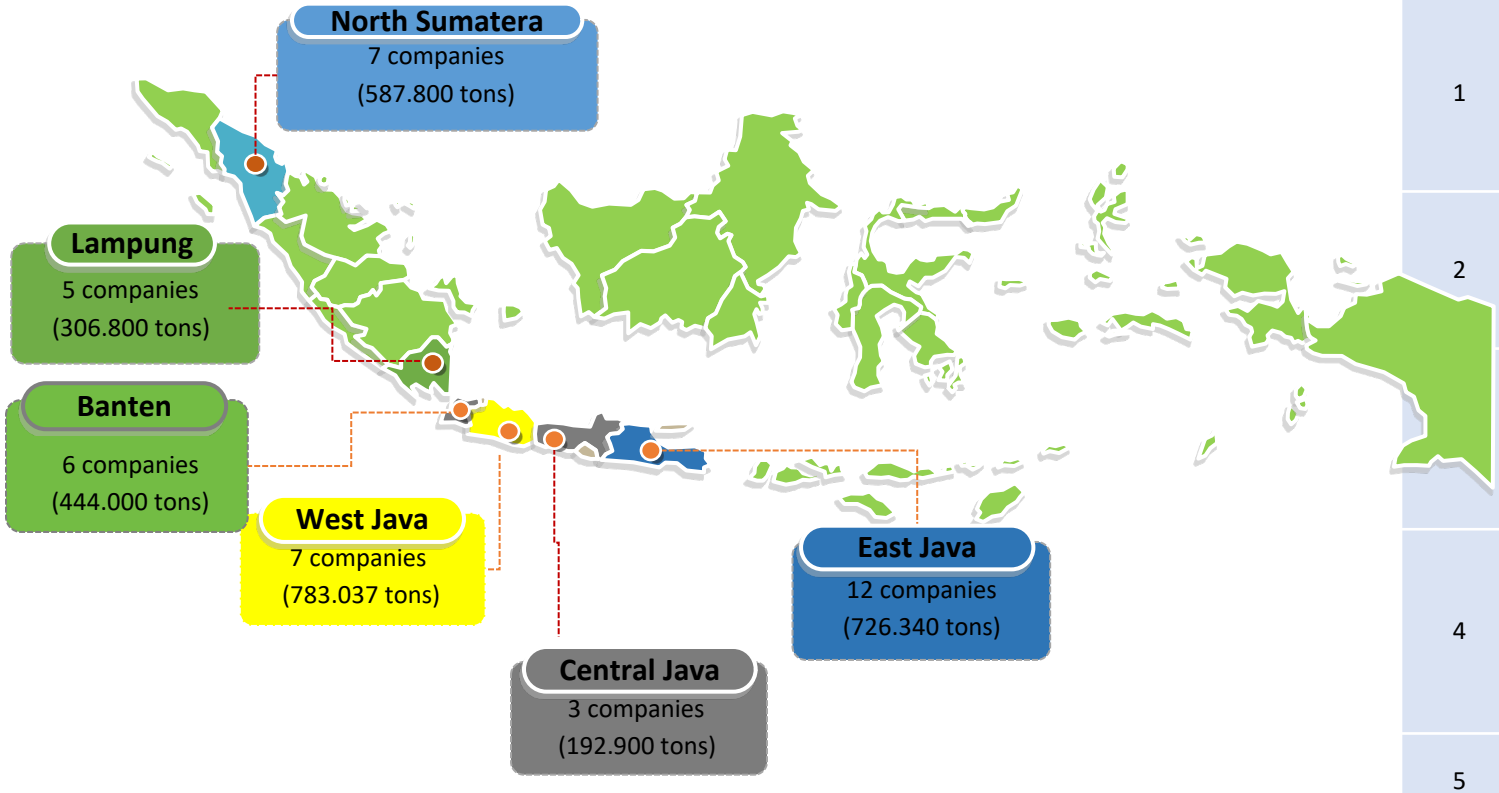
Need to balance the ecological and economical sustainability

AQUACULTURE INDUSTRY

Species	2015	2016	2017	2018	2019	2020
Milk fish	672.196	747.445	701.427	875.592	824.239	811.883
Giant gouramy	113.407	132.334	234.084	173.345	190.389	152.669
Others	344.128	591.197	590.945	358.249	343.368	311.331
Asian sebass	6.558	7.890	8.432	9.583	7.228	5.418
Groupers	16.795	11.504	70.294	16.414	13.829	9.478
Cat fishes	719.619	764.797	1.125.526	944.779	1.088.945	993.768
Common carp	461.546	497.208	316.649	534.215	620.831	560.669
Nile tilapia	1.084.281	1.114.156	1.280.126	1.171.236	1.317.561	1.172.633
Pangasius/catfish	339.069	392.918	319.967	373.262	380.130	327.146
Shrimps	607.152	692.568	919.988	911.857	863.119	881.599
Total	**4.364.751**	**4.952.018**	**5.567.439**	**5.368.532**	**5.649.639**	**5.226.594**

Data source: Ministry of Marine Affairs and Fisheries, Republic of Indonesia

LOCATION AND CAPACITY OF FEED MILL IN INDONESIA



No.	Province	Feedmill	Production Capacity (tons per year)
1	**NORTH-SUMATERA (587.800 tons)**	1. PT. Central Proteina Prima* 2. PT. Mabar Feed Indonesia 3. PT. Intraco Agroindustri 4. PT. Aquafarm Nusantara 5. PT. Leong Hup Jayaindo* 6. PT. Indojaya Agrinusa* 7. PT. Cargil Indonesia	29.400 198.000 40.000 8.400 250.000 32.000 30.000
2	**LAMPUNG (340.640 tons)**	1. PT. Central Pertiwibahari* 2. PT. CJ Feed Lampung 3. PT. Gold Coin Specialities, Lampung* 4. PT. Evergreen Agriculture 5. PT. Suri Tani Pemuka-Lampung*	180.000 50.000 12.000 14.400 84.240
	BANTEN (444.000 tons)	1. PT. Grobest Indomakmur* 2. PT. Cargil Indonesia 3. PT. Wonokoyo Jaya Kusuma 4. PT. New Hope Aqua Feed Indonesia 5. PT. CJ Superfeed 6. PT. Citra Mandiri Kencana	72.000 200.000 24.000 100.000 24.000 24.000
4	**WEST JAVA (738.037 tons)**	1. PT. Allieds Feed 2. PT. Central Pangan Pertiwi* 3. PT. Universal Agri Bisnisindo 4. PT. Gold Coin Indonesia* 5. PT. Sinta Prima Feedmil 6. PT. Suri Tani Pemuka – Purwakarta* 7. PT. Tong Wei Indonesia*	159.984 200.000 24.000 40.800 150.000 113.253 50.000
5	**CENTRAL JAVA (192.900 tons)**	1. PT. CJ Feed Semarang 2. PT. Havindo Pakan Optima* 3. PT. Cargil Indonesia	24.900 150.000 18.000
6	**JAKARTA (222.768 tons)**	1. PT. Malindo Feedmill	222.768
7	**EAST JAVA (726.340 tons)**	1. PT. Central Proteina Prima* 2. PT. Matahari Sakti* 3. PT. CJ Feed Jombang 4. CV. Mentari Nusantara 5. PT. Wirifa Sakti 6. PT. Sekar Golden Harvesta Indonesia 7. PT. Panca Patriot 8. PT. Wonokoyo Jaya Corporindo 9. PT. Sarifeed 10. PT. Haida Agriculture Indonesia* 11. PT. Suri Tani Pemuka-Gresik* 12. PT. Suri Tani Pemuka-Banyuwangi*	189.540 108.000 48.000 24.000 13.000 34.800 72.000 24.000 25.000 50.000 97.200 40.800

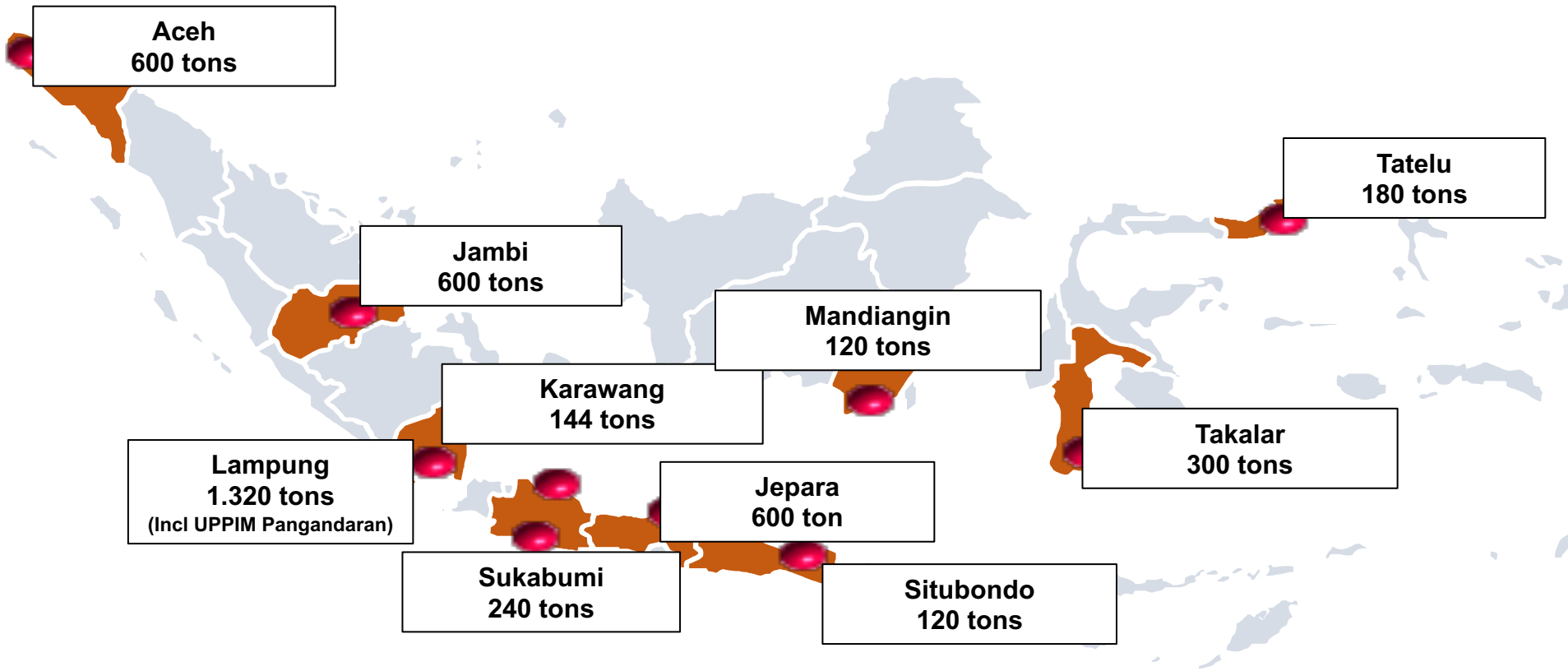
Registered Feed Mills: 44 companies

Total Production Capacity: 3.408.485 tonnes

Majority feed mills in Java and Sumatera

Urgent need to have feed mill in East Indonesia

LOCATION AND CAPACITY OF SMALL SCALE FEED MILL RUN BY GOVERNMENT



No	Implementation Unit	Total Production (tons)
1	BBPBAP Ujung Batee	600
2	BPBAT Jambi	600
3	BBPBL Lampung	120
	UPPIM Pangandaran	1.200
4	BBPBAT Sukabumi	240
5	BLUPPB Karawang	144
6	BBPBAP Jepara	600
7	BPBAP Situbondo	120
8	BPBAT Mandiangin	120
9	BPBAT Tatelu	180
10	BPBAP Takalar	300
Total		**4.224**

Note:

1. Based on the working hours of 6h/day for 200 working days/year
2. Based on the yearly budget to purchase the raw materials, man-power, and other equipment and materials

Directorate General of Aquaculture : 11 units

Total Production: 4.224 tons/year

KEY AREA FOR THE DEVELOPMENT OF AQUAFEED

Novel feed ingredients

Fish meal and fish oil replacement as well as digestibility of alternative ingredients

Registration process??

1. Crude protein/lipid not as the standard
2. Specific nutrient requirement

Assessing the functionality of natural feed additives and supplements

Nutritional immunology

Enhance the immune system and non-specific system for shrimp

Minimum 40% of locally source ingredients for aquafeed

Blending strategy with enzymes and others

STATUS OF INGREDIENTS (IMPORT)

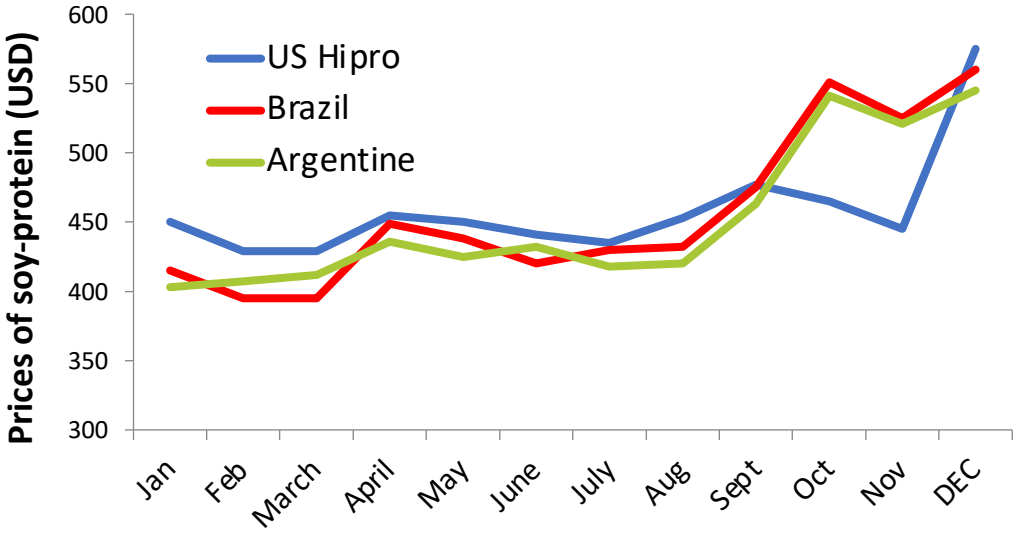
Ingredients	Import Quantity (Metric tons)				
	2017	2018	2019	2020	2021
Soybean	270.205,93	175.814,44	246.938,51	282.877,36	353.969,03
Fish Meal	72.978,52	112.469,80	99.572,67	104.760,09	77.889,23
Wheat	63.983,38	78.298,21	107.649,99	48.617,60	39.038,12
Fish/Squid Paste/Powder	30.444,15	30.194,40	28.178,95	2.073,15	1.496,01
Oil	11.823,69	12.641,61	13.217,49	9.052,87	9.297,51
Vitamin/Mineral	3.777,41	1.115,00	961,50	723,50	2.517,18
Yeast	2.740,40	4.312,25	1.556,78	1.499,33	1.592,00
Crustacean/Squid Meal	1.031,50	1.877,31	1.934,43	31.014,38	34.917,04
Corn	18.591,42	27.070,99	36.057,74	35.831,82	36.945,62
Others **)	10.583,81	7.215,83	10.898,68	13.300,12	18.653,21
TOTAL	**486.160,21**	**451.009,85**	**546.966,73**	**529.750,21**	**576.314,93**

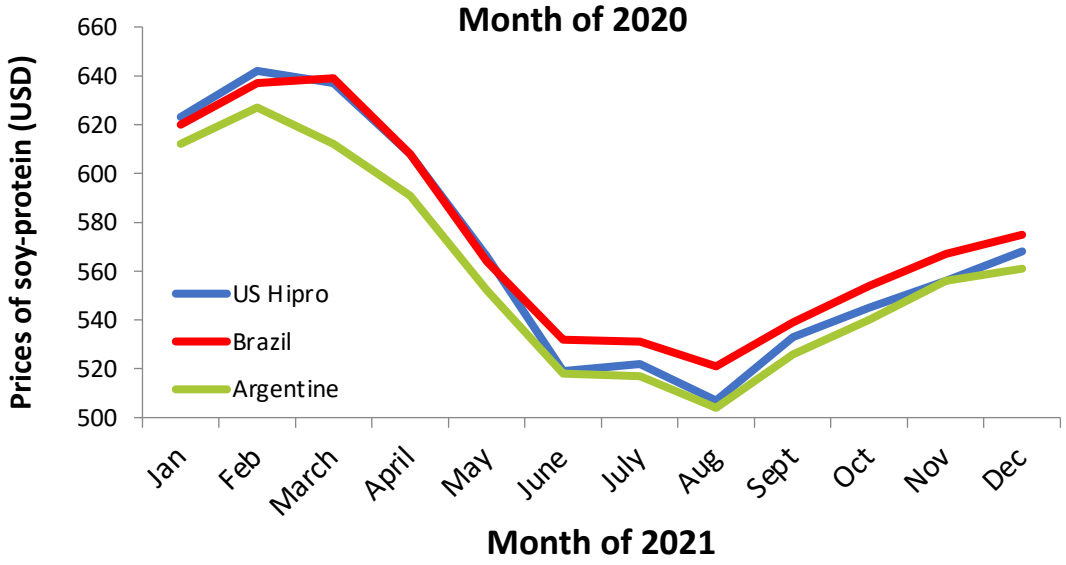
SOYBEAN VALUE AND MARKET PRICES

Among alternative protein sources, processed soybean (*Glycine max*) possesses many qualities:

- Favorable amino acid profile
- Widely available
- Highly digestible
- Easily shipped
- Sustainable
- Competitive price

Anti-nutrients	Method of removal, reduction, or deactivation
Proteinase inhibitors	Heat treatments
Lectins	Heat treatments
Phytic acid	Enzyme treatment, alcohol extraction or fermentation
Saponins	Enzyme treatment, alcohol extraction or fermentation
Phytoestrogens	Heat treatments
Anti-vitamins	Heat treatments





Source: US Soybean Council Indonesia

ALTERNATIVE (LOCAL AND SUSTAINABLE) INGREDIENTS

Local Insect Meal

- ✓ Lipid content ± 30% DW
- ✓ Proteins = 40% DW with favorable amino acid profile
- ✓ Shows as good additives (antimicrobial peptide)
  1. Enhance the immune function
  2. Reduce intestinal inflammation

Corn with low aflatoxin

Local Vitamin/Mineral premix

Palm Kernel Meal

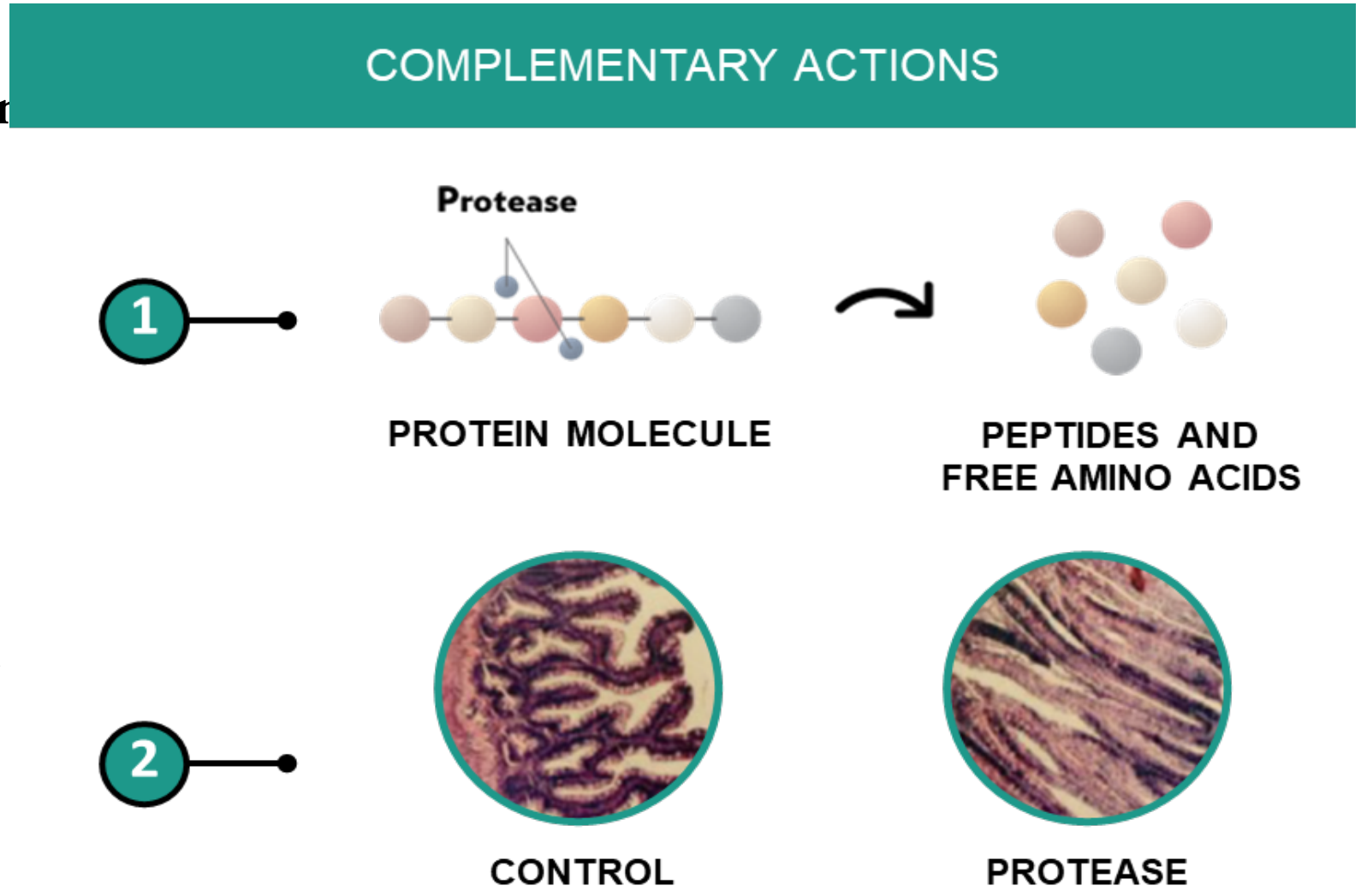
Good nutritional value

High fiber content as a challenge?
Blending with Enzyme?

BLENDING STRATEGY: PALM KERNEL MEAL + PROTEASE

> Promotes protein breakdown
- more smaller peptides
- free amino acids
- easier absorption
- better utilization

> Better gut health
- increased villi size and number
- higher absorption capacity



Research Design

1. Units = 40 hapa nets (2 x 2 m^2 each)
2. Stocking density = 50 post larvae / m^2
3. Trial duration: 90 days
4. There are 4 (four) dietary treatments:

- ❑ Control = Commercial formulation + 0,175 Protease
- ❑ 5 JPKM = 5 % PKM + 0,175 Protease
- ❑ 0 PKM = Commercial formulation minus protease
- ❑ 5 PKM = 5 % PKM no protease

1. Feed inputs were pre-programmed assuming the normal growth of shrimp and FCR1.5.
2. Daily allowances of feed were adjusted based on observed feed consumption and weekly survival

OBJECTIVE OF RESEARCH

- **Evaluate the inclusion effect of protease to enhance the nutritional value of palm kernel meal to replace soybean meal for the growth of Pacific white shrimp *Litopenaeus vannamei***

- **Evaluate the inclusion effect of protease to enhance the nutritional value of palm kernel meal to replace soybean meal for the health condition of Pacific white shrimp *Litopenaeus vannamei***

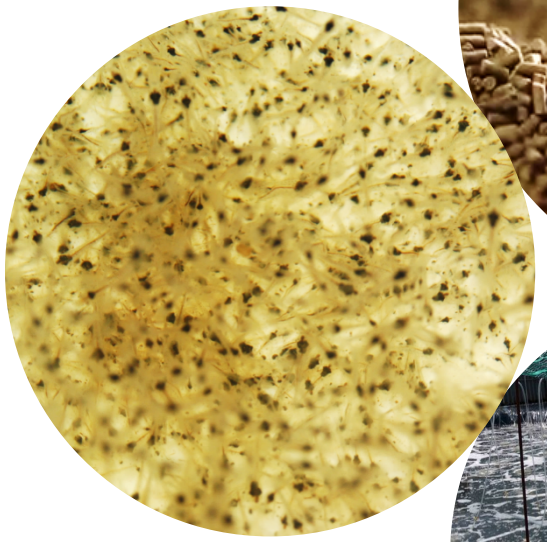
Research location:
Business Service Center for Aquaculture Production (BSCAP) Karawang, West Java (March – June 2022)

DIET FORMULATION TABLE

Diet name	Control (J)	5JPKM	0PKM	5PKM
Menhaden fishmeal	10,00	10,00	10,00	10,00
Poultry meal (2018 analyis ref)	12,00	12,00	12,00	12,00
Soybean meal	40,00	35,00	40,00	35,00
Palm Kernel Meal (PKM)	0,00	5,00	0,00	5,00
Menhaden fish oil	3,30	3,30	3,30	3,30
Lecithin (soy)	1,00	1,00	1,00	1,00
Cholesterol	0,01	0,01	0,01	0,01
Corn Starch	14,21	13,96	14,39	14,14
Whole wheat	17,00	17,00	17,00	17,00
Mineral premix (shrimp)	0,50	0,50	0,50	0,50
Vitamin premix (shrimp)	0,50	0,50	0,50	0,50
Choline chloride (0.2% all diets)	0,20	0,20	0,20	0,20
Rovimix Stay-C 35%	0,10	0,10	0,10	0,10
CaP-dibasic	0,80	0,80	0,80	0,80
Lysine (78.8%)	0,10	0,20	0,10	0,20
Methionine	0,10	0,25	0,10	0,25
Protease (JEFO)	0,18	0,18	0,00	0,00
Total	100,00	100,00	100,00	100,00

PROXIMATE AND AMINO ACID COMPOSITION

Composition	Unit	Control (J)	5JPKM	0PKM	5PKM
Ash Content	%	9,56	9,64	9,77	10,03
Total Fat	%	6,54	6,62	6,58	6,59
Moisture Content	%	11,55	11,43	11,12	11,17
Protein Content	%	33,35	34,11	33,93	33,22
Crude Fiber	%	1,56	1,93	1,62	2,22
L-serine	%	2,17	2,09	2,11	1,98
L-Glutamic Acid	%	4,29	4,27	4,24	4,19
L-Phenylalanine	%	2,91	2,92	2,77	2,64
L-Isoleucine	%	1,73	1,72	1,72	1,64
L-Valine	%	2,08	2,07	2,08	1,99
L-Alanine	%	1,71	1,72	1,73	1,62
L-Arginine	%	2,01	2,02	2,94	2,85
Glycine	%	2,25	2,28	2,34	2,24
L-Lysine	%	1,41	1,42	1,44	1,31
L-Aspartic Acid	%	1,71	1,72	1,73	1,66
L-Leucine	%	2,88	2,82	2,95	2,97
L-Tyrosine	%	0,26	0,25	0,31	0,23
L-Proline	%	2,02	2,03	2,08	1,97
L-Threonine	%	1,84	1,83	1,86	1,72
L-Histidine	%	1,25	1,13	1,22	1,11
L-Tryptophan	%	0,32	0,29	0,32	0,28
L-Cystine	%	1,19	1,18	1,22	1,23
L-Methionine	%	0,36	0,34	0,32	0,29



GROWTH PERFORMANCE OF SHRIMP

Diet code	Final Biomass (g)	Final Mean Weight (g)	Survival (%)	PWG[1] (%)	FCR[2]	TGC[3]	ADG[4]
Control (J)	2872,00	13,86[a]	74,06	1493,36[a]	1,49[a]	0,5618[a]	0,1444[a]
5 JPKM	2866,00	13,71[a]	73,90	1476,14[a]	1,51[b]	0,5584[ab]	0,1427[a]
0 PKM	2774,00	13,44[b]	71,53	1445,06[b]	1,54[bc]	0,5523[c]	0,1397[b]
5 PKM	2724,00	13,14[c]	70,24	1410,34[c]	1,58[c]	0,5453[d]	0,1363[b]
P-value	0,8450	<0,0001	0,8950	<0,0001	<0,0001	<0,0001	<0,0001
PSE	95,9961	0,0435	2,2986	4,9984	0,0053	0,0001	0,0011

Note: [1] PWG = Percentage weight gain; [2] FCR= Feed conversion ratio; [3] TGC = Thermal growth coefficient; [4] ADG=Average daily growth in gram per day, [5] PSE = Pooled standard error

NUTRITIONAL COMPOSITION OF SHRIMP

Composition	Unit	**Control (J)**	**5JPKM**	**0PKM**	**5PKM**
Ash Content	%	1,68	1,61	1,76	1,71
Total Fat	%	<0,02	<0,02	<0,02	<0,02
Moisture Content	%	72,51	73,57	72,68	72,48
Total Calories	Kcal/100 g	103,28	99,30	102,26	104,31
Carbohydrate (By Difference)	%	2,47	2,59	1,64	1,31
Protein Content	%	24,35	24,24	23,93	23,31
Crude Fiber	%	0,61	0,67	0,57	0,20
L-Glutamic Acid	%	3,87	3,85	3,60	3,72
L-Phenylalanine	%	0,99	1,00	1,51	1,36
L-Isoleucine	%	0,95	0,99	1,01	0,98
L-Valine	%	0,97	0,91	1,04	0,99
L-Alanine	%	1,55	1,51	1,51	1,61
L-Arginine	%	1,85	1,84	1,88	1,60
Glycine	%	1,78	1,64	1,89	2,00
L-Lysine	%	1,71	1,74	1,26	1,35
L-Aspartic Acid	%	2,21	2,21	1,86	2,03
L-Leucine	%	1,57	1,57	1,67	1,63
L-Tyrosine	%	0,68	0,63	1,05	0,97
L-Proline	%	1,41	1,39	1,41	1,30
L-Threonine	%	0,91	0,98	1,14	1,05
L-Histidine	%	0,59	0,59	0,85	0,77
L-Tryptophan	%	0,16	0,16	0,17	0,16
L-Cystine	%	0,78	0,79	0,78	0,64
L-Methionine	%	0,39	0,37	0,26	0,35

TOTAL HAEMOCYTE COUNT OF SHRIMP

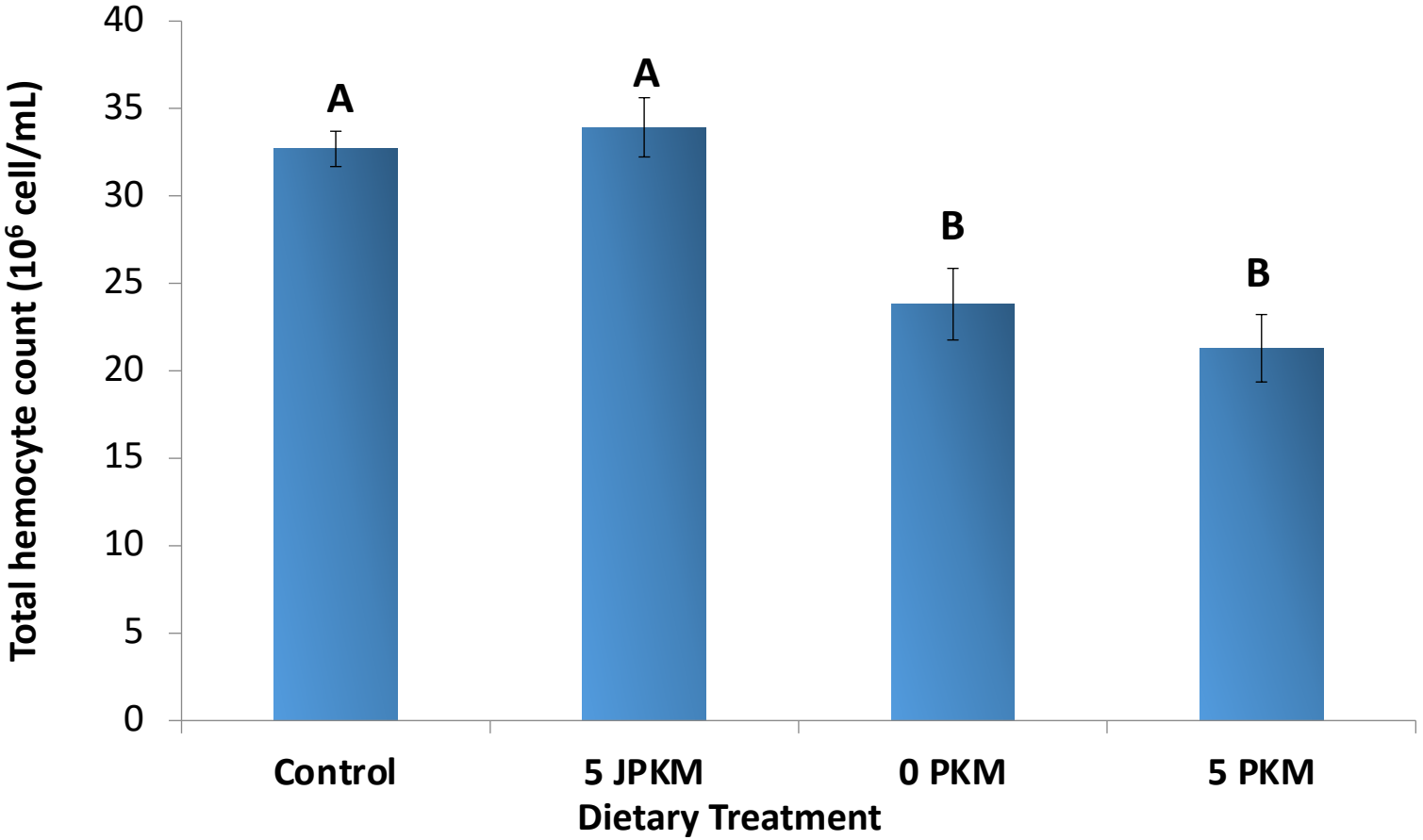


Figure 1. Relationship between inclusion of protease in the diet and total hemocyte count (THC) of Pacific white shrimp *Litopenaeus Vannamei* (10^6 cell/mL) at the end of the growth trial. Values represent the mean of five replicates.

LYSOZYME ACTIVITY OF SHRIMP

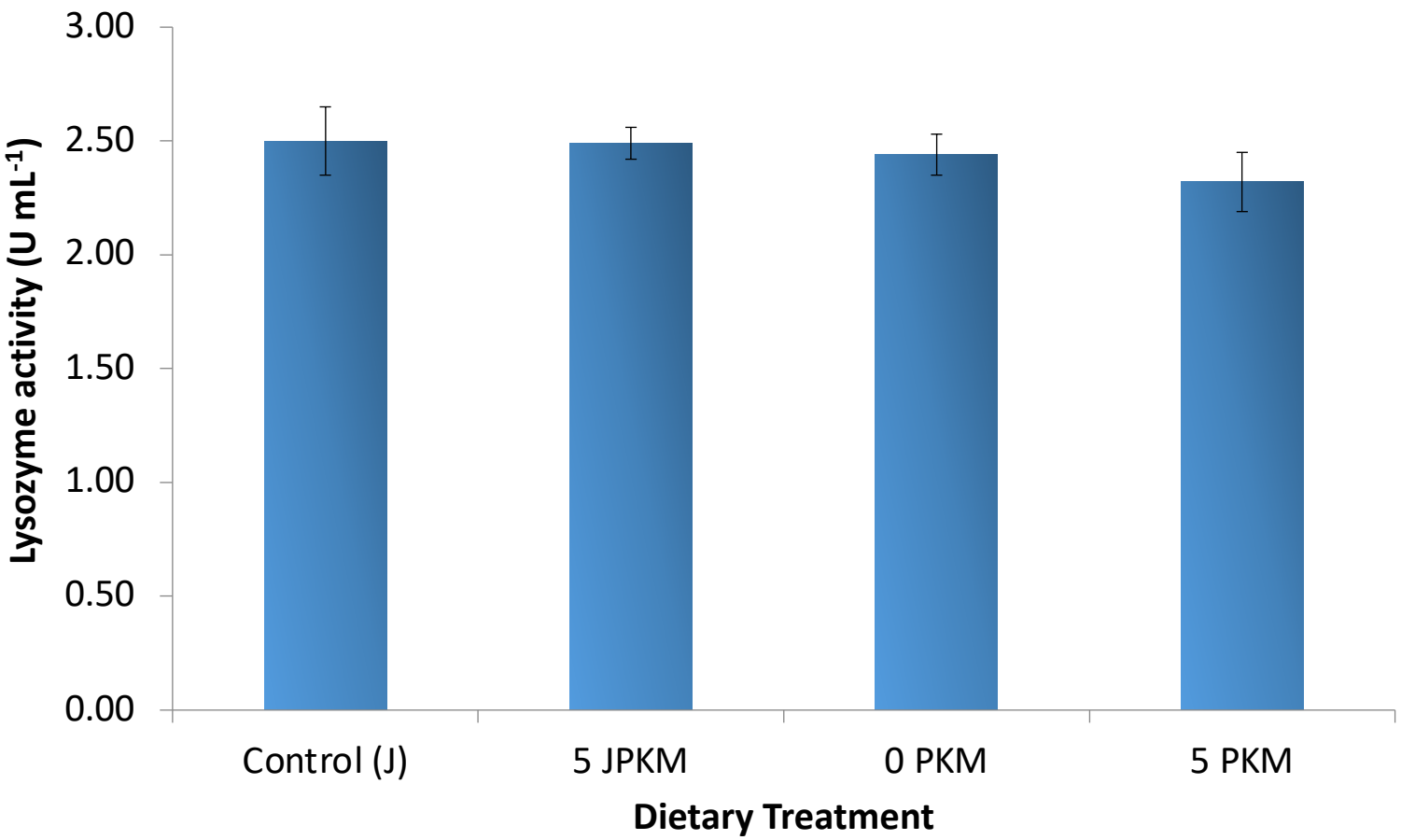
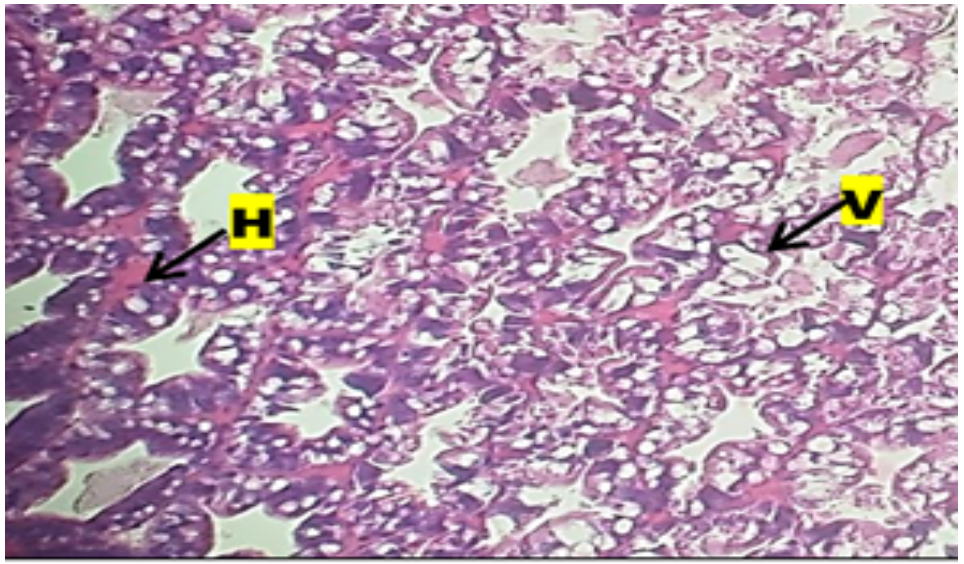
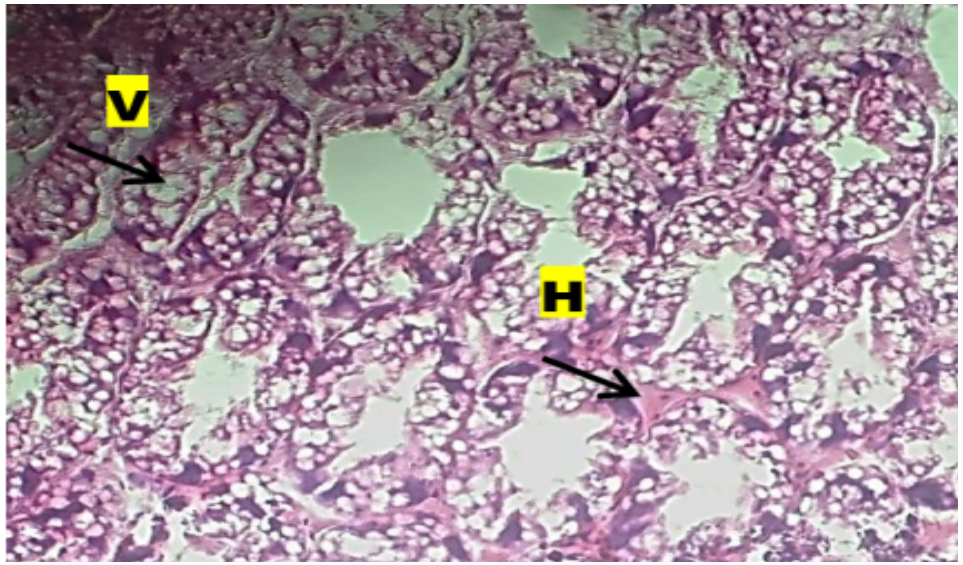


Figure 2. Relationship between inclusion of protease in the diet and lysozyme activity of Pacific white shrimp *Litopenaeus Vannamei* (U mL^{-1}) at the end of the growth trial. Values represent the mean of five replicates.

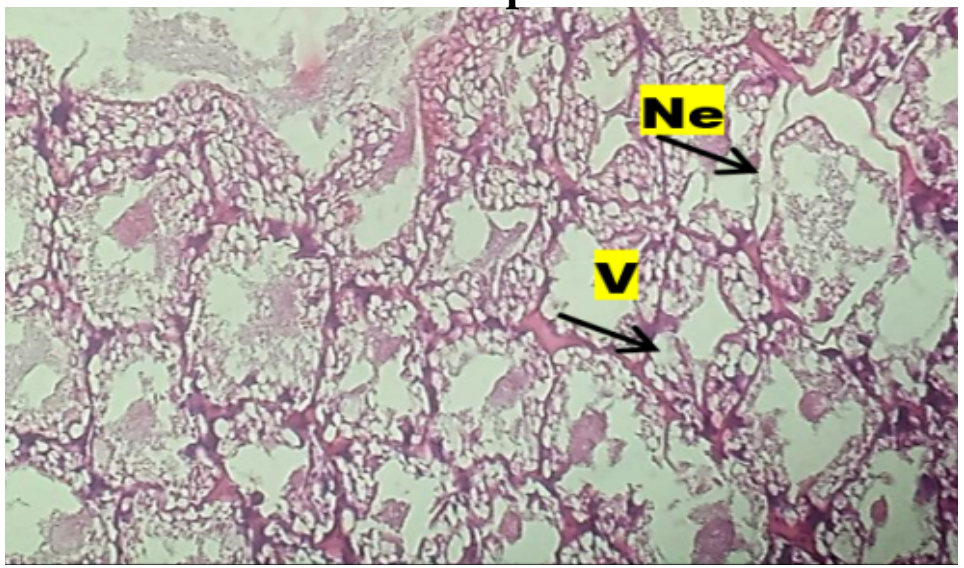
HISTOMORPHOLOGICAL CONDITION OF HEPATOPANCREAS



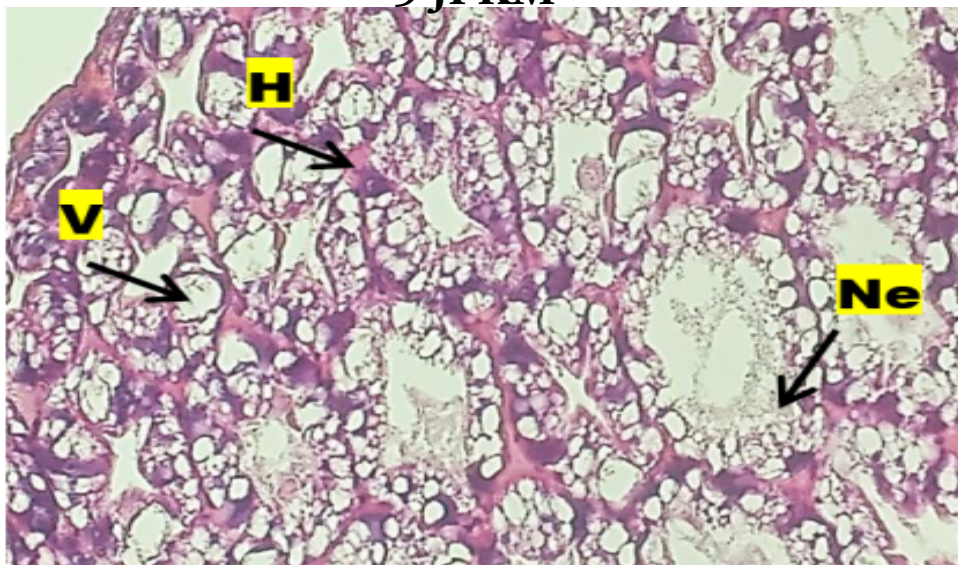
Control + protease



5 JPKM



Control



5 PKM

WAY FORWARD FOR INDONESIAN AQUAFEED

CONCLUDED ACTIVITIES

1. Production of **ECONOMICAL FEED** – replacing the use of expensive ingredients with economically sound practical ingredients – reducing total feed costs
2. Production of **FUNCTIONAL FEED** – to enhance the nutritional profile and health condition of aquatic organisms – improves intestinal health and digestibility of feedstuff proteins
3. Increase the production capacity of feed mil run by government

ON-GOING PROCESS

1. Degradation of anti-nutrients in several plant-protein sources
2. Development of locally sources of ingredients – reliable and cost-effective solutions in formulations
3. Effort to provide flexibility in choosing protein sources – Insect meal dan local protein ingredients

Thank You

novriadiromi@yahoo.com

Jefo

Life, made easier