THE COMBINATION OF FISH MEAL, SOYBEAN MEALS AND DEHULLED LUPIN IN FISH FEED AND THEIR EFFECTS ON THE GROWTH OF RED TILAPIA (*Oreochromis niloticus*)

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ABSTRACT

The aims of the study were to determine the combination of fish meal, soybean meals, and dehulled lupin meals in fish feed and their effects on the growth and survival rate of Oreochromis niloticus. Three treatments at different substitution levels of lupin dehulled meals to the soybean meals as main sources of plant protein i.e 50% of soybean meals + 50% fish meals (A), 50% FM + 25% SB + 25% LM (B) and 25% FM + 25% SB + 25% LM (C) were adopted in this study.

The Red tilapia (Oreochromis niloticus) with initial weight ranging from 238,67-239,65 g/fish with stocking density of 150 fish per cage were used as experimental fish. The study was conducted in Rawa pening Lake, Ambarawa - Central Java, from Desember 1998 to March 1999. The result indicated that different combination of dehulled lupin and soybean as plant protein sources in fish feed had significantly affected (P<0,05) the absolute growth and NPU, and had not significantly affected the daily growth rate , FCR, SR, and PER. The best absolute growth (292,05g), daily growth rate (1,34%/day), FCR (2,31), PER (1,68) and NPU(8,37), were achieved by treatment B, followed by C and A. Meanwhile, the best SR was achieved by treatment C and followed by A, and B.

Therefore, treatment B appeared to be the best fish feed formulation for Red tilapia production.

Keys words : Lupin dehulled, Red Tilapia, Growth (W), SGR, FCR, PER, NPU.

I. INTRODUCTION

Red tilapia (*Oreochromis niloticus*) is one of the commercial freshwater fish which are widely cultivated in the cage culture located in open waters in Central Java. This is due to the increase of its demand either for local consumption or export commodity. This fish have several advantages, i.e. :

- faster growth;
- responsiveness to artificial feed;
- efficiency in feed conversion;
- high adaptability to a change environment; and
- resistence to diseases.

(Jangkaru *et al*, 1991).

The succeess of culturing red tilapia in cage culture mostly depends on the availability of good quality regular supply of feed. Meanwhile good quality feed can be produced depending on the quality level of raw material used in feed formulation. So far the protein sources normally used by the feed industry in Central Java are : fish meal and soybean meal. These protein sources are expensive and their availability is only seasonal. Further-more, they have also been used for human consumption in food industries. Dehulled lupin, therefore appeared to be an alternative plant protein source for fish feed industries.

Lupin (*Lupinus angustifolius*) is a leguminoceae seed which contains high protein levels, 25 - 45% CP and low alkaloid levels (Petterson and Mackintosh, 1994). It is internationally recognised as a value stock for feed ingredient. Nutrient properties content in lupin such as protein quality, fibre digesbility , fatty acid composition and mineral balance make it available as an alternative plant protein source.

Lupin seed grown in Western Australia has two seed forms of production. There are two kinds of lupin available in the market, namely whole seed and dehulled seed. It is believed that whole lupin seed contains lower nutrious value than the dehulled lupin, since it has smooth fibre, lower total amino acid and production energy. Meanwhile dehulled lupin contains increased amino acid content and total energy compared to whole seed. This study was initiated due to the fact that it contained a low alkaloid level (0,02%) and its chemical composition is similar to soybean. Although the content of lysin is marginally less than soybean and rape seed meals, lupin seed does not contain trypsin inhibitors, which can reduce its digestibility. It is hypothesized that dehulled lupin can be succesfully substituted for fish meal and soybean meal as alternative plant protein source for Red tilapia feed.

II. METHODOLOGY

The fish used in the experiment, Red tilapia *(Oreochromis niloticus,* Stirling strain) which are arigmated from Singapore with initial weight ranging from 230,66 to 248,68 grams/fish were obtained from Aquafarm Fish culture Ltd in Wunut Janti Klaten, Central Java. Stocking density of 150 fishes/ cage were adopted in this study.

The experimental systems of 12 cages were located in the Rawa pening Lake - Ambarawa, Central Java. The size of each cage was 4 m x 1,6 m x 2 m and the mesh size of nets is 1 cm. Formulation of experimental diets were made according to the substitution level of dehulled lupin to replace fish meals and soybean meals. The three experimental diets with protein level approximately of 26 % were formulated in different combinations of substitution level of fish meals, soybean meals, and dehulled lupin meals in the diet.

Meanwhile other raw materials i. e., lechitin, CMC, Ascorbic Acid, Premix, DL-Methionin, Lysin, were maintained relatively constant for all experimental diets. Composition of ingredient in the experimental diets is presented in Table 1 and the chemical composition of experimental diet is presented in Table 2.

Table 1. Composition of ingredient in the experimental diets

Ingredient (%)	Experimental diets		
	A	B	C
Fih meals	15.00	15.00	8.50
Soybean meals	15.00	7.50	8.50
Dehulled lupin meals	0.00	7,50	17,00
Rice bran	28.00	28.00	28.00
Corn meals	0.50	0.50	0,50
L-Lysin 98 %	0.50	0.50	0.50
DL- Methionin 98 %	0.15	0.15	0.15
Premix	1.00	1.00	1.00
Di Calcium Phospat	0,70	0.70	0.70
Vitamin C	0.01	0.01	0.01
Lechitin	1.00	1.00	1.00
CMC	2.00	2.00	2.00

Table 2. Chemical composition of the experimental diets

Chemical composition (%)	Experimental diets		
	A	B	C
Moisture	9,24	9,20	9,01
Crude Lipid	9,59	11,74	10,33
Crude Protein	24,36	24,19	'25,27
Crude Fibre	2,52	3,16	3,23
Ash	7,98	7,67	6,56

The experimental design adopted in this study was Completely Randomized Design with three treatments, and each treatment was replicated three times.

The treatments are as follows :

A. 50 % Fish meals + 50 % Soy bean meals + 0 % Lupin dehulled meals
B. 50 % Fish meals + 25 % Soy bean meals + 25 % Lupin dehulled meals
C. 25 % Fish meals + 25 % Soy bean meals + 50 % Lupin dehulled meals

A feeding rate of 3 % per total body weight per day was adopted during the course of study (Techner, 1995). Diets were given three times per day. Water quality i.e. DO mg/l, CO_2 mg/l, NH_3-N mg/l, NO_2 mg/l, T° C, TOM mg/l, PH and H_2S mg/l were observed once a week.
Biological and Nutritional parameters measured were : Absolute Growth, SR (Effendie, 1979), SGR (Jauncey and Ross, 1982), PER (Steffens, 1989), FCR (Jauncey and Ross, 1982), NPU (Tacon, 1987). Fish growth (Absolute and SGR),PER, FCR, NPU, and SR were analysed by Anova and followed by Duncan's test, whereas water quality were analysed descriptively

III. RESULTS

3.1. Growth Performance

The absolute growth (biomass) of experimental fish (*Oreochromis niloticus*) fed different experimental diet during growth trial is presented in Table 3.

Table 3. Absolute growth (biomass) of experimental fish as a function of different experimental growth (gram) during the course of study.

Diet	Replication			Total	Mean Value	± SD
	1	2	3			
A	287,58	287,80	289,36	864,78	288,26[a]	0,94
B	290,22	291,84	294,10	876,16	292,05[b]	1,95
C	287,28	288,78	289,93	865,99	288,66[a]	1,33

*) Figures having the same superscript are not significantly different (P>0,05, Duncan'sTest).

Table 4. Anova of the absolute fish growth

SV	Df	JK	KT	F count	F table	
					0,05	0,01
Treatment	2	28,28	14,14	7,602*	4,76	9,78
Error	6	11,20	1,86			
Total	8	39,48				

From Table 3 and 4, it can be noted that absolute fish growth was significantly (P<0,05) affected by different experimental diet during the growth trial. The best absolute fish growth was achieved by B (292,05 gram) followed by C, and A.

3.2. Daily Growth Rate (SGR)

SGR of fish during the course of study can be seen on Table 5.

Table 5. SGR of fish as function of different experimental diet (%/day) during the course of study.

Diet	Replication			Total	Mean Value	± SD
	1	2	3			
A	1,27	1,35	1,32	3,94	1,31[a]	0,04
B	1,29	1,39	1,35	4,03	1,34[a]	0,05
C	1,32	1,32	1,32	3,96	1,32[a]	0,00

Table 6 Analysis of Variance of SGR

SV	DF	JK	KT	F count	Ftable	
					0,05	0,01
Treatment	2	0.0014	0.0007	0.5	4.76	9.78
Error	6	0.0083	0.0014			
Total	8	0.0097				

Table 5 and 6 indicated that the SGR was not significantly (P>0,05) affected by different experiments during the growth trial. The best SGR was achieved by B (1,34 %/ day) and followed by C, and A.

3.3. Survival Rate

Survival rate of fish during the course of study can be seen on Table 7.

Table 7. Survival Rate of fish as function of different experimental diet (%) during the course of study

Diet	Replication			Total	Mean value	± SD
	1	2	3			
A	96,92	95,38	95,38	287,68[a]	95,89	0,89
B	90,77	92,31	96,92	280,00[a]	93,33	3,20
C	95,38	95,38	96,92	287,68[a]	96,41	1,09

*) Figures having the same superscript are not significantly different (P>0,05, Duncan's T-test)

Tabel 8. Anova on Survival Rate of Experimental fish

SV	df	JK	KT	F count	F tabel	
					0,05	0,01
Treatment	2	13,11	6,55	1,33	4,76	9,78
Error	6	29,64	4,94			
Total	8	42,75				

From table 8, it can be noted that the SR was not significantly (P>0,05) affected by different experimental diets during the growth trial.

3.4. Food Conversion Ratio

FCR of fish during the course of study can be seen in Table 9.

Table 9. FCR of fish as function of different experimental diets during the course of study.

Diet	Replication			Total	Mean value	± SD
	1	2	3			
A	2,33	2,26	2,32	6,91[a]	2,303	0,038
B	2,32	2,26	2,31	6,89[a]	2,296	0,032
C	2,26	2,31	2,33	6,90[a]	2,300	0,036

*) Figures having the same superscript was notr significantly different (P>0,05, Duncan's Test)

Table 10. Anova on FCR

SV	Df	JK	KT	F count	F table	
					0,05	0,01
Treatment Error Total	2 6 8	0,00007 0,00753 0,00760	0,000035 0,001255	0,028	4,76	9,78

Table 9 and 10 indicated that the FCR was not significantly (P>0,05) affected by different experimental during the growth trial. The best FCR was achieved by A (2,296) and followed by B, and C.

3.5. Protein Efficiency Ratio

PER of fish during the source of study can be seen in the Table 11 and Figure 5.

Table 11. PER as function of different experimental diets during the course of study.

Diet	Replications			Total	Mean Value	± SD
	1	2	3			
A	1,61	1,69	1,65	4,95[a]	1,65	0,04
B	1,63	1,71	1,69	5,03[a]	1,68	0,03
C	1,64	1,60	1,54	4,78[a]	1,59	0,05

*) Figures having the same superscript is are not significantly different (P>0,05, Duncan's Test)

Table 12. Anova on PER of fish

SV	Df	JK	KT	F count	F table	
					0,05	0,01
Treatment Error Total	2 6 8	0,010 0,009 0,019	0,0050 0,0015	3,33	4,76	9,78

Table 11 and 12 indicated that the PER was not significantly different (P>0,05) affected by different experimental diets during the growth trial

3.6. Net Protein Utilization

NPU during the course of study can be seen in Table 13.

Table 13. NPU (%) as function of different experimental diets.

Diets	Replications			Total	Mean Value	± SD
	1	2	3			
A	4,59	5,22	5,06	15,23	5,08[a]	0,14
B	8,18	8,58	8,36	25,12	8,37[b]	0,21
C	5,96	5,78	5,54	17,28	5,76[c]	0,2

*) Figures having the same superscript was not significantly different(P>0,05, Duncan's test).

Table 14. Anova of NPU

S.Var	df	JK	KT	F count	F table	
					0,05	0,01
Treatment	2	18,16	9,079	259,4**	4,76	9,78
Error	6	0,21	0,0035			
Total	8	18,37				

Table 13 and 14 indicated that NPU was significantly (P<0,01) affected by different experimental diets during the growth trial. The best NPU was achieved by B (8,37%) and followed by C , and A.

Water quality parameters during the course of study are presented in Table 15.

Table 15. Water quality parameter of media during the course of study.

Water quality Par.	Value	References
Temperature C	26 -28	25 -32° C
pH	6,20– 6,80	6 –9
DO (mg/l)	2,70 – 6,65	≥ 1
Amoniak (mg/l)	0,00 – 0,0038	≤ 0,02
Nitrit (mg/l)	0,00– 0,01	≤ 0,2
Tot Sulfide (mg/l)	0 ,00	0,02
CO_2 (mg/l)	7,92 – 11,99	≤ 15

Table 16. Index of variance of planktonic distribution in Rawa Pening Lake

Genus	pi	-ln pi	-pi ln pi
Sceletonema sp	0,26	1,34	0,34
Coscinodiscus sp	0,12	2,12	0,25
Nitzhia sp	0,28	1,27	0,35
Schroederia sp	0,01	4,66	0,04
Chaetoceros sp	0,22	1,51	0,33
Scenedesmus sp	0,01	4,66	0,04
Microcystis sp	0,03	1,51	0,1
Gomphosphaeria sp	0,001	4,66	0,03
Apharotheca sp	0,01	4,66	0,04
Gonyaulax sp.	0,001	4,96	0,03
Total		H	1,55

Index of Variance : H' = 1,55
Index of Homogeneity : E = H'/ln 10 = 1,55/ln 10 = 0.6

3.7. Hedonic's Test

In order to determine the degree of acceptance of consumers for the colour, sensor, flavour, texture and total quality of Red Tilapia produced during the feeding trial, H edonic's Test i.e Colour test, Sensory test, Flavour test , Texture test and Total Quality Test were performed and the results can be seen in Table 17 to 26

Table 17. Colour Test Data on Red Tilapia After Fed on Experimental Diets

Experiment Diets	No. of Fish	Total value	Mean Value
A	10	33,65	3,365[a]
B	10	32,30	3,230[a]
C	10	25,63	2,563[a]

(*) Figures having the same superscript are not significantly different (P>0,05, T test)

Table 18. Comparison of colour test data among the experimental diets (by T-test)

Comparison of Exp.diet	Mean Diff.	Standard error	T count	T table	
				0.05	0.01
(A-B)	0.135	0.56	0.24	2,101	2.878
(A-C)	0.802	0.54	1.49		
(B-C)	0.67	0.35	1.91		

Table 17 and 18 indicated that Colour of fish was not significantly (P>0,05) affected by different experimental diets. The best Colour of Red Tilapia was achieved by A (3,365) and followed by C and A.

Table 19. Sensory Test Data on Red Tilapia After Fed on Experimental Diets

Experiment Diets	No. of Fish	Total value	Mean Value
A	10	30,30	3,030[a]
B	10	30,64	3,064[a]
C	10	24,98	2,498[b]

(*) Figures having the same superscript are not significantly different (P>0.05, T test)

Table 20. Comparison of sensory test data among the experimental diets (by T-test)

Comparison of Exp.diet	Mean Diff.	Standard error	T count	T table	
				0.05	0.01
(A-B)	0.034	0.35	0.097	2,101	2.878
(A-C)	0.532	0.33	2.67*		
(B-C)	0.566	0.26	2.18*		

Table 19 and 20 indicated that fish sensory was significantly different (P<0,05) affected by different experimental diets. The best Sensory of Red Tilapia was achieved by B (3,064) followed by A and C.

Table 21. Flavour Test Data on Red Tilapia After Fed on Experimental Diets

Experiment Diets	No. of Fish	Total value	Mean Value
A	10	36,62	3,662[a]
B	10	33,97	3,397[ab]
C	10	22,97	2,297[c]

(*) Figures having same superscript are not significantly different (P>0,05, T test)

Table 22. Comparison of flavour data among the experimental diets (by T-test)

Comparison of Exp.diet	Mean Diff.	Standard error	T count	T table	
				0.05	0.01
(A-B)	0.265	0.44	0.602	2,101	2.878
(A-C)	1.365	0.46	2.967*		
(B-C)	1.100	0.47	2.340*		

Table 21 and 22 indicated that the Flavour of fish was significantly different (P>0,05) affected by different experimental diets. The best Flavour of Red Tilapia produced in this trial was achieved by A (3,662) followed by B and C.

Table 23. Texture Test Data on Red Tilapia After Fed on Experimental Diets

Experiment Diets	No. of Fish	Total value	Mean Value
A	10	33,31	3,331[a]
B	10	32,97	3,297[a]
C	10	23,32	2,332[b]

(*) Figures having same superscript are not significantly different (P>0,05, T test).

Table 24. Comparison of texture data among the experimental diets (by T-test)

Comparison of Exp.diet	Mean Diff.	Standard error	T count	T table	
				0.05	0.01
(A-B)	0.034	0.47	0.072	2,101	2.878
(A-C)	0.999	0.467	2.139*		
(B-C)	0.965	0.397	2.431*		

From Table 23 and 24 it can be noted that texture of the fish was significantly different (P>0,05) affected by different experimental diets. The best texture of red tilapia was achieved by A(3,331) followed by B and C.

Table 25. Total Quality Test Data on Red Tilapia After Fed on Experimental Diets

Experiment Diets	No. of Fish	Total value	Mean Value
A	10	34,65	3,465[a]
B	10	32,30	3,23[ab]
C	10	22,00	2,20[c]

(*) Figures having superscript are not significantly different (P>0,05, T test)

Table 26. Comparison of total quality data among the experimental diets (by T-test)

Comparison of Exp.diet	Mean Diff.	Standard error	T count	T table	
				0.05	0.01
(A-B)	0.235	0.45	0.52	2,101	2.878
(A-C)	1.030	0.41	3.05**		
(B-C)	1.265	0.49	2.102*		

Table 25 and 26 indicated that total quality of fish was significantly (P<0,05) affected by experimental diets given during the trial. The best quality of Red Tilapia was achieved by A (3,465) followed by B and C.

IV. DISCUSSION

The result of this study indicated that the growth performance (absolute growth=W) of Red tilapia (*Oreochromis niloticus)* are significantly affected (P<0,05) by the experimental diets (Table 3 and 4). This shows that the formulation of diets using lupin as a substitute for fish meal and soybean meals significantly affected fish growth.

From table 3. it can be noted that diet B appeared to be the best diet for Red tilapia and followed by C, A. Although the SGR are not significantly different (P>0,05), treatment B proved to be the best diet for Red tilapia compared the others. This also indicates that 25 % dehulled lupin as a plant protein alternate in diets can improve the growth performance of red tilapia as a substitute for soybean meal in diets. It is assumed that nutrient properties such as protein quality, fibre digestibility, fatty acid composition and mineral balance contained in dehulled lupin would be utilised efficiently by Red tilapia.

It may be due to the fact that dehulled lupin does not contain tripsin inhibitor and low alkoloid, whereas soybean contained lectin which is tripsin inhibitor (Brenes *et al,* 1983 in Hugh and Van Berneveld, 1994), Therefore the performance of dehulled lupin as plant protein source appeared to be superior to soybean. Further more, the present of Phytic acid in soybean would also reduce protein digestibility as demonstrated in rainbow trout (Spinelli *et al*, 1983), salmon (Richardson *et al*, 1985) and Channel fish (Satoh *et al*, 1989).

Although FCR and PER of Red Tilapia in responding to the experimental diets given were not significant, it can be noted that the substitution level of dehulled lupin to soybean up to 25 % (treatment B) has improved the growth performance as exhibited by diet B. It is believed that protein digestibility and energy contents in the dehulled lupin are higher compared to soybean as mentioned by Evàns (1994), which might be the case in diet B.

Furthermore, during the feeding trials the FCR, PER and NPU of diet B appeared to be the best, thus the combination of 50 % fish meal + 25 % soybean + 25 % dehulled lupin has significantly improved food conversion and protein efficiency by Red tilapia.

According to Petterson and Mackintosh (1994) alkaloid level in dehulled lupin are relative low and Ω tokoferol content as natural anti-oxidant is higher than in soybean. Therefore the loss of vitamins, essensial amino acids and essential fatty acids are very limited in dehulled lupin (diet B).

HEDONIC'S TEST

The results of hedonic's test i.e. colour test, sensory test, flavor test, texture test and total quality test indicated that the colour of Red Tilapia produced during the feeding trial was not significantly affected by experimental diets given. Meanwhile the taste, sensory, consistency and quality of Red Tilapia were significantly affected by experimental diets.

This finding proved that substitution of dehulled lupin (*Lupinus angustifolius*) in the diets to replace the soybean and fish meal had significantly improved the texture the flavor, and quality of "Fillet' Red Tilapia. Most of the respondents had accepted the flavor and texture of the fillet. Therefore, dehulled lupin has a promising prospect in the future to improve the quality of fillet Red Tilapia in floating cage culture in Central Java.

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