OPTIMIZATION OF JELAWAT (*Leptobarbus hoevenii*) PRODUCTION BY USING INDIGOFERA LEAF MEAL (*Indigofera sp.)*

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Abstract. Food security can be improved by optimizing the production of local food sources like jelawat fish and lettuce. One way to reduce the use of soybeans in artificial feed is to incorporate local ingredients like Indigofera leaf meal. A study was conducted at the Fisheries Laboratory of Lampung State Polytechnic to examine the use of Indigofera leaf meal in artificial feed formulation and its effects on the growth and survival of jelawat fish. The study used Jelawat fish fry that measured 7.2 ± 1.2 cm/indv in total length with an average weight of 2.8 ± 0.02 g/indv, 600 in total, artificial feed containing Indigofera leaf meal hydrolyzed with cellulase enzyme, and a lettuce aquaponic installation. The treatments varied in concentrations of hydrolyzed Indigofera leaf meal (HILM) in artificial feed formulations, namely A (0%), B (15%), C (20%), D (25%), and E (30%). The results showed that the feed treatment had significant effects on production of Jelawat during increasing value of survival rate and also on absolute weight growth (AWG), daily weight growth (DWG), feed conversion ratio (FCR), feed efficiency (EP), protein retention (PR), and fat retention (FR). The best results were obtained from feed treatment B (15% of HILM) that showed an AWG of 4.47±0.22 g, DGR of 0.079±0.003 g/day, FCR of 1.5±0.02, EP of 66.4±0.92 and PR of 47.5±1.11%. Survival rate in the study was 95.8-100%, and the number of lettuce leaves ranged from 11 to 14 strands with a consumption weight of 8.7-16.1 g/plant. The study concluded that Indigofera leaf meal can replace soybean meal in an artificial diet of jelawat up to 15% while maintaining up to 100% survival in an aquaponic system.

Key words: Food Security, Jelawat, Indigofera, Aquaponic

Abbreviations (if any): -

Running title: Production Jelawat on Aquaponics Using Indigofera

INTRODUCTION

A key aspect of achieving national food security is maintaining the stability of staple food supply and prices, managing food reserves, and staple food distribution. One way to manage food reserves is through diversification and development of local food sources, such as diversifying farming and fisheries, and utilizing yard land. By strengthening community food security through local food sources, not only can the fulfillment of nutritional sources that supply carbohydrates be achieved, but also other nutrients, such as protein from the fisheries sector, can be achieved.

One of the local fish food sources owned by Indonesia is Jelawat or Jelabat fish (*Leptobarbus hoevenii*). Jelawat fish is a freshwater fish found in Indonesian regions such as Sumatra and Kalimantan. This fish is also spread in several Asian regions such as Malaysia and Brunei Darussalam, Rusliadi et.al. (2015). Jelawat fish has been widely studied and developed as a local food source that is favored by the community. To meet the needs of Jelawat, cultivation efforts are needed, as well as increasing productivity with the use of quality artificial feed. The high cost of feed fulfillment comes from the use of soybean meal as a raw material for artificial feed, which until now still depends on foreign production. Efforts can be made in the form of using raw materials that replace soybean meal in artificial fish feed. One of the local feed ingredients is expected to be able to act as a substitute for soybean meal, namely the Indigofera plant (*Indigofera sp*). It is known that the meal from Indigofera leaves has a high protein content of 26.09% Pangentasari. (2018); Jefry, et.al., (2021) so that it can be used in fish feed.

Indigofera leaf meal is classified as a source of vegetable protein with high crude fiber. Through the cellulase enzyme hydrolysis method by Jefry et. al (2021), the crude fiber can be converted into a carbohydrate source that can be utilized by fish. This change in form will increase the nutritional value and energy in artificial feed, which can be used by fish for growth. So that its utilization becomes more effective in fish feed. A way to introduce and increase the production of Jelawat fish in the community can be done by applying Jelawat fish farming using an aquaponic system. Rusliadi et.al

(2015), Jelawat can also be cultivated in a filtering system with plants like aquaponics. Aquaponics can be done by utilizing the rest of the community yard as a form of urban farming, which is currently popular as one of the household food sources. Related to this, research is needed to study the utilization of Indigofera leaf meal in artificial feed for jelawat fish and as an effort to strengthen community food security, and its effect on the growth and survival of jelawat fish reared in an aquaponic system.

MATERIALS AND METHODS

Study area

This study was conducted at the Fisheries Laboratory, Polytechnic of Lampung, for 56 days. Jelawat fish fry, measuring 7.2 ± 1.2 cm/ind in total length with an average weight of 2.8 ± 0.02 g /individual, as many as 40 fish for each experimental unit, Indigofera leaves, commercial cellulase enzyme (Novozymes®), feed mixture ingredients, and water quality measuring instruments. Treatment was carried out in 15 rectangular tarpaulin ponds with a size of 0.5 m x 1.4 m x 0.4 m. Lettuce plant media in the form of 2.5-inch PVC pipe perforated to place 20 aquaponic plant pots per treatment and equipped with a recirculation system using a submersible pump. The stocking rate used was 40 individuals/150 liters of water in every medium. The container was placed outdoors to ensure the plants received sunlight. Fish were kept in the aquaponic system by feeding 3% of their body weight twice a day, at 7 am and 5 pm.

Procedures

Fish fry were fed with indigofera leaf meal, which was hydrolyzed with cellulase enzyme. The cellulase enzyme hydrolysis process was carried out by mixing Indigofera leaf meal in a container with commercial cellulase enzyme as much as 10 ml/kg of material that had been dissolved using water as much as 30% of the weight of the raw material, Rakhmawati et.al. (2022). The fermentation container was closed using plastic that had been perforated. The container was placed at room temperature and with good air circulation for 1 week or until the smell of fermentation. The tested feed was fed with the following feed treatments (see Table 1).

Table 1. Composition Of Treatment Feed

NO	Composition	Treatment				
		A	B	C	D	E
1	Fish Meal	40 %	40 %	40 %	40 %	40 %
2	**Soybean meal**	**38 %**	**23 %**	**18 %**	**13 %**	**8 %**
3	**Hydrolyzed indigofera leaf meal**	**0 %**	**15 %**	**20 %**	**25 %**	**30 %**
4	Corn Meal	10 %	10 %	10 %	10 %	10 %
5	Bran meal	9 %	9 %	9 %	9 %	9 %
6	CMC	1 %	1 %	1 %	1 %	1 %
7	Fish Oil	1 %	1 %	1 %	1 %	1 %
8	Corn Oil	1 %	1 %	1 %	1 %	1 %
	Total	100 %	100 %	100 %	100 %	100 %

The process of measuring the weight and counting the number of live fish is carried out every 14 days. For lettuce plants, controlling pest attacks and cleaning the lettuce roots is important to remove any dirt. The care of lettuce plants was carried out until the end of the study. Data collection during the study includes the number of fish at the beginning and end of rearing, bodyweight of Jelawat, proximate artificial feed, protein content, and body fat. We also observed the water quality, such as DO, pH, temperature, and Ammonia content in water, three times during maintenance, specifically on days 7, 40, and 56. For plant observations, the number of lettuce leaves from 5 plant samples was recorded, along with their consumption weight at the end of the study. Lettuce was planted on aquaponic media after 2 weeks of fish rearing to ensure that the organic matter in the media was sufficient for lettuce growth. Maintenance was carried out until the study was completed, with a maintenance period of 42 days without harvesting or changing plants in the middle of the study. The data collected were used to test the following research parameters:

a. Absolute Weight Growth

Absolute weight growth can be calculated using the formula (Effendie, 1997).

$$\mathbf{Wm = Wt - Wo}$$

Description:
Wm: Absolute weight growth (grams)
Wt: Final average weight (grams)

Wo: Initial average weight (grams)

b. Daily Weight Growth
According to Effendie (1997), daily weight growth can be expressed by the formula :

$$\boxed{\mathbf{DGR} = \frac{\mathbf{Wt - Wo}}{\mathbf{t}}}$$

Description:
DGR: Daily Weight Growth (g/day)
Wt: Final average weight of fish (g)
Wo: Initial average weight of fish (g)
t: Length of rearing (days)

c. Survival Rate
According to Effendie (1997), the survival rate can be expressed by the formula:

$$\mathbf{SR} = \frac{\mathbf{Nt}}{\mathbf{No}} \times \mathbf{100}$$

Description:
SR: Survival Rate
Nt: Number of fish at the end of the study
N0: Number of fish at the beginning of the study

d. Feed Conversion Ratio
Feed Conversion Ratio According to Effendie (1997), the feed conversion ratio (FCR) is calculated based on the following formula:

$$\boxed{\mathbf{FCR} = \frac{\mathbf{F}}{(\boldsymbol{Wt} + \boldsymbol{D}) - \boldsymbol{Wo}}}$$

Description:
FCR: Feed conversion ratio/FCR
F: Weight of feed given (grams)
Wt: Biomass of test animals at the end of maintenance (grams)
D: Dead fish weight (grams)
Wo: Biomass of test animals at the beginning of maintenance (grams)

e. Feed Efficiency
To calculate feed efficiency, the formula (Zonneveld, 1991) was used in (Nurjannah et.al., 2018):

$$\boxed{\boldsymbol{EP} = \frac{[(\boldsymbol{Wt} + \boldsymbol{Wd}) - \boldsymbol{Wo}]}{\boldsymbol{F}} \times \mathbf{100}\%}$$

Description:
EP: Feed efficiency (%)
Wt: Final total weight (g)
Wd: Dead fish weight (g)
Wo: Initial total weight (g)
F: Amount of feed given (g)

f. Protein Retention
Protein retention (PR) formulated by Thung and Shiau (1991) in Yudiarto et.al. (2012) as follows:

$$\text{PR} = \frac{\text{(Final body protein weight- Initial body protein weight) (g)}}{\text{Total protein of feed fed (g)}}$$

g. Fat Retention
Fat retention (FR) was formulated by Viola and Rappaport (1979) in Yudiarto et.al. (2012) as follows:

$$\text{FR} = \frac{\text{(Final body fat weight - Initial body fat weight) g}}{\text{Total fat of feed fed (g)}} \times 100\%$$

h. Aquaponic Plant Growth

Plant growth was measured in the form of several leaves and wet weight at harvest. The number of leaves is calculated from the leaves that grow perfectly. The wet weight of lettuce consumption is taken and weighed from the base of the stem to the leaves of the plant at harvest time (Abeltino et.al., 2021).

i. Water Quality

Water quality parameters measured during the study were: DO, temperature, pH, TDS, and ammonia. Measurements were made on the 7th, 40th, and 56th day of observation during the study, except TDS on the 7th and 56th day.

Data analysis

The experiment was designed using a completely randomized design, with five different treatments and three replicates, making a total of 15 experimental units. First, the data were checked for homogeneity and normality and then analyzed using the analysis of variance at a 95% confidence interval. If the results obtained from the analysis show significant differences, further tests are conducted using the Least Significant Difference (LSD) test at a 95% confidence interval.

RESULTS AND DISCUSSION

Hydrolysis of Indigofera Leaf Meal

Indigofera leaf meal that has been hydrolyzed (HILM) with cellulase enzyme has a lower crude fiber content than Indigofera leaf meal without the hydrolysis process, as shown in Table 2. The total dietary insoluble fiber content (HILM) has shown a decrease from 12.69% to 10.51%, which represents a 17.19% reduction, while the carbohydrate content has increased from 53.9% to 56.4%, which is equal to a 4.6% increment. The use of cellulase enzymes can help convert the crude fiber present in TDIT into simpler molecules such as carbohydrates.

Table 2. Proximate Test Results of Indigofera Leaf Meal

Treatment	Water (%)	Ash (%)	Fat (%)	Protein (%)	Fiber (%)	Carbohidrate (%)
Indigofera Leaf Meal	5.37	11.26	4.13	25.26	**12.69**	**53.95**
Hydrolyzed indigofera leaf meal	6.66	9.44	3.67	23.80	**10.51**	**56.42**

Source: THP Polinela Lab, 2022.

According to Crueger & Crueger (1984) and Jefry et al. (2021), cellulase enzymes consist of endo-ß-1.4-gluconase enzymes that function to degrade cellulose polymers in the inner bonds of α-1.4-glycosides randomly into oligodextrin with varying chain lengths. Additionally, exo-ß-1.4-gluconase and ß-1.4-glucosidase enzymes will degrade cellulase from reductants and non-reductants into cellobiose or glucose (Co et al., 2021; Jefry et al., 2021). These carbohydrates are expected to be easily utilized by fish as a source of nutrition, particularly energy and protein.

Nutrient Analysis of Treatment Feed

The treatment feed in this study is a combination of soybean meal and hydrolyzed Indigofera leaf meal (HILM). The use of (HILM) is increasing successively in treatments B, C, D, and E. The value of nutrient content for each feed is as follows: Table 3. Each treatment feed has varying nutritional content. Treatment A has the highest protein content value of all feed types at 34.85%, followed by feed E, D, C, and B. The protein content of 34.85% is sufficient for the needs of the jelawat fish.

Table 3. Nutrient content of the feed treatment

Treatment	Water (%)	Ash (%)	Fat (%)	Protein (%)	Fiber (%)	Carbohydrates (%)
A	6.17	12.9	11.80	34.85	3.72	34.24
B	4.58	14.01	10.26	23.83	4.33	47.30
C	3.26	14.54	6.51	33.14	6.34	42.52
D	4.	1	6.2	33.	5.	40.64

	96	4.49	2	68	24	
E	5. 09	1 4.96	4.4 5	34. 16	5. 58	41.31

Source: THP Polinela Lab, 2022.

The combination of indigofera meal (15%) and soybean meal (23%) in treatment B provides a smaller protein value, but the carbohydrate content is the highest of the other feed treatments. it is expected that omnivorous fish can utilize carbohydrates as a source of energy. Warm water fish and omnivorous species such as tilapia and goldfish, whose food sources are at low tropical levels, can efficiently utilize higher carbohydrates (30-50%) than cold water fish species or carnivorous fish species (Wilson, 1994; Enes et al., 2011; Abro, 2014).

Observation of Research Parameters

Observations of research parameters, up to the 8th week of observation in the rearing period. Data on observation parameters were statistically tested, except for water quality observations. The mean data of observation parameters on treatment feed are presented in Table 4. The test results showed that 6 research parameters were significantly different (see Table 5).

Table 4. Recapitulation of Variety Analysis of Feed Treatment

Variable Observation	Feed Treatment	CC (%)
AWG	s	8,83
DWG	s	8,43
SR	ns*	1,63
FCR	s**	2,53
FE	s	6,81
PR	s	7,56
FR	s	21,12
Leaves	ns	10,14
Wet Weight	ns	43,34

Note: s (significant), ns (not significant), in the analysis of variance, confidence interval $p \leq 0.05$
* data transformed with the square root transformation
** data transformed with square root transformation (x + 0.5)

Table 5. Mean Value of Observation Parameters

Mean ± SD								
AWG (g)	DWG (g /day)	SR (%)	FCR	FE (%)	PR (%)	FR (%)	Leaves (Sheet)	Wet Weight (g)
4.43±0.39^{a}	0.0791±0.0069^{a}	97.5±4.3	1.6±0.14^{bc}	64.3±6.2 ^{ab}	31.6±3.93^{b}	53.4±4.85^{b}	14.0±2.00^{a}	16.1±9.3^{a}
4.47±0.22^{a}	0.0797±0.0039^{a}	99.2±1.4	1.5±0.02^{c}	66.4±0.92	47.5±1.17^{a}	35.1±3.41^{c}	13.7±0.58^{a}	13.7±1.4^{a}
3.79±0.56^{b}	0.0676±0.0101^{b}	99.2±1.4	1.8±0.19^{ab}	57.4±6.3 ^{bc}	29.0±2.52^{b}	45.5±7.37^{bc}	12.7±1.53^{a}	12.9±5.7^{a}
3.57±0.18^{b}	0.0638±0.0032^{b}	100.0±0.	1.7±0.06^{ab}	57.3±1.6 ^{bc}	28.1±0.80^{bc}	32.5±11.4^{c}	11.7±1.15^{a}	8.7±3.21^{a}
3.43±0.05^{b}	0.0612±0.0010^{b}	95.8±5.2	1.8±0.02^{a}	54.7±0.67	24.4±2.37^{c}	72.1±16.9^{a}	11.7±0.58^{a}	12.2±4.1^{a}

Description: 1.) Treatment A (38% SBM (Soy Bean Meal+0% HILM), B (23% SBM+15% HILM), C (18% TK+20% HILM), D (13% SBM+25% HILM), and E (8% SBM+30% HILM).
2.) The average value of treatments with the same letter indicates not significantly different at the 95% confidence interval.

Treatment Feed with (HILM) combination gave different results compared to feed without (HILM) addition (Treatment A), on absolute weight growth, daily growth, feed conversion ratio, feed efficiency, protein retention, and fat retention in Jelawat fish reared in an aquaponic culture system.

Discussion

a. Absolute Weight Growth and Daily Growth

The average weight of fish during the study increased, and the Absolute Weight Growth in the study (Figure 1) was successively from the highest to the lowest; namely feed B (4.47 g), A (4.43 g), C (3.79 g), D (3.57 g) and E (3.43 g).

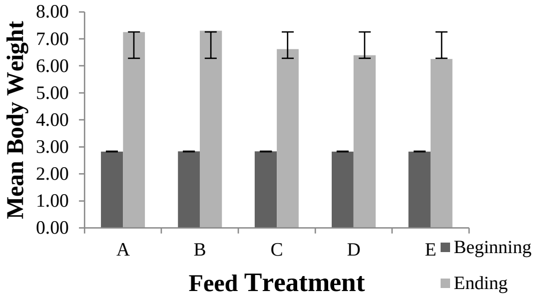
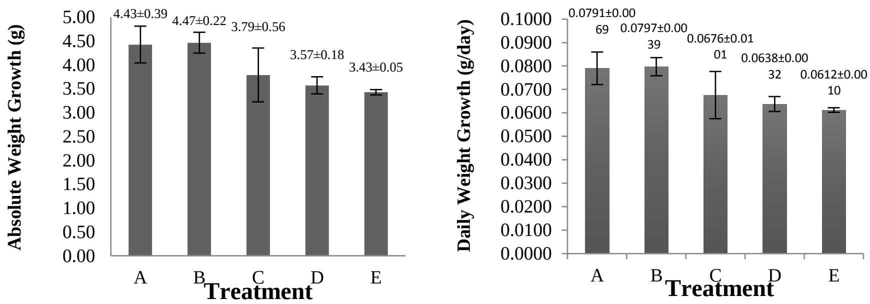


Figure 1. Histogram of Average Body Weight at the Beginning and Ending of the Study

This condition indicates an increase in fish body weight during the study. Absolute body weight and daily weight also showed the same value trend. This is quite good, when compared to previous studies, with treatment without aquaponic media, and the use of protein content in the feed of 39%-41% for 64 days of maintenance can give absolute weight growth of 1.04 ± 0.10 g (N.Sanovel et.al., 2020). The results of further tests on absolute weight growth and daily weight showed (Figure 2) that feed B with 15% (HILM) content in fish feed was significantly different from treatments C, D, and E, but not different from feed A (0% (HILM).



(**Figure 2**). Histogram of Absolute Weight Growth and Daily Weight Growth of Jelawat

Using 15% (HILM) in feed gives the same effect as feed without (HILM) or 100% using soybean meal. So (HILM) can reduce the role of soybean meal by 15% in Jelawat fish feed. The treatment feed contains nutrients from Indigofera plants that can be digested and meet the needs of Jelawat fish. Jelawat is an omnivore, enabling it to digest plant and animal proteins (Roberts, 1993); in (Au, H. et. al, 2020). The content of nutrients in feed treatment B provided a combination of nutrients that are good for the growth of Jelawat fish. Although it has a protein content of 23.8% suspected, there is the role of other nutrients such as carbohydrates at 47.3% and fat at 10.26% in feed B can replace the role of protein as a source of energy basal metabolism jelawat fish (protein sparring effect), so that more protein is used for growth or stored in the body of jelawat fish.

b. Feed Conversion Ratio and Feed Efficiency

The results of further tests on feed conversion ratios C and D were not different from treatment A. The best feed conversion ratio and feed efficiency were shown by treatment B of 1.5 ± 0.02 54.7 with an efficiency of 66.4%. The FCR value of the treatment (figure 3) ranged from 1.5 ± 0.02 to 1.8 ± 0.19, which was also supported by the efficiency value of feed utilization by fish, which reached 54.7%-66.4% of the feed given.

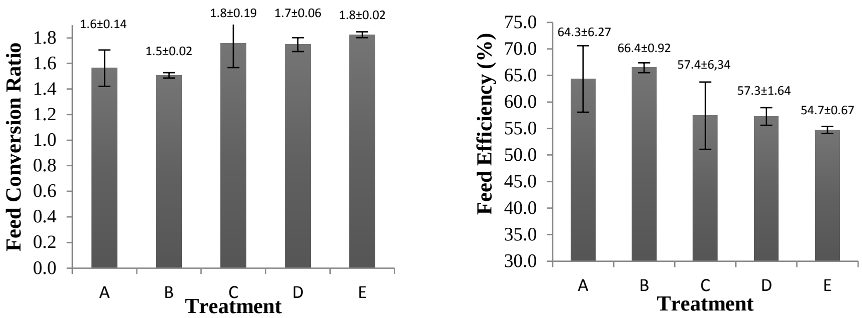


Figure 3. Histogram of Feed Conversion Ratio and Feed Efficiency of Jelawat Fish

The feed conversion ratio decreased with each increase in protein content in the treatment feed, whereas the FCR value decreased with increasing protein content.

c. Survival Rate

The test results showed that the Jelawat survival rate in the study was high, where for each feed treatment with (HILM), it reached 95-100%. The survival rate in each treatment is high. The HIML content in the feed can provide nutritional and energy needs for the fish, so that the fish can live and grow. The aquaponic media is thought to provide good environmental conditions for the jelawat fish, especially the need for dissolved oxygen or Dissolved Oxygen (DO) from the water flow provided. The absorption of organic matter and shade from the lettuce plants above the rearing media also provides good water quality. The recirculation system can increase the carrying capacity of media and increase the growth of cultured fish, Darmayanti et.al. (2018).

d. Protein Retention

Protein retention is the feed protein stored in body tissues during maintenance. Maulidin et.a.l, (2016) ; Syahailatua et.al., (2017). Protein retention from the study showed a significant difference between treatment B and treatments A, C, D, and E (Figure 4).

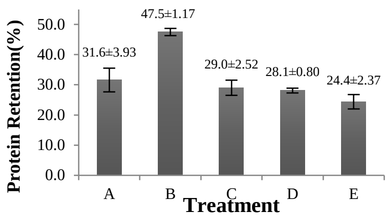


Figure 4. Histogram of Protein Retention

The best protein retention value (treatment B) reached 42% in the fish body. When viewed from the protein content in treatment B (Figure 5), which amounts to 23% and includes the smallest of all treatments, it provides the most significant protein retention. The combination of (HILM) at 15% with soybean meal in fish feed formulations provides appropriate nutrients to support the metabolism and activities of the Jelawat fish during the study. The protein in the feed can be absorbed well in the body of the Jelawat fish. The high carbohydrate content influences the energy use of the fish. With the use of energy from carbohydrates, the amount of protein in the fish's body can be used less for metabolism and can be maximized for growth. This condition shows that the protein-sparing effect occurs in Jelawat fish.

e. Fat Retention

Fat retention in all treatments was high, reaching 32.5% to 72% of the fat content in the feed (Figure 5). This fat retention value suggests that fat absorption from the feed occurs well in the fish. However, the fish did not use fat as the primary energy source, so that fat tends to be stored in the fish's body tissue. Feed treatment E has a protein content value of 34.16% and a low fat content of 4.45%. However, fat retention in the body of treatment E showed the highest value. It is suspected that feed treatment E causes the use of more protein as a source of energy for fish than the other feed treatments. While fat is not fully utilized as an energy source, it is stored optimally in the fish's body.

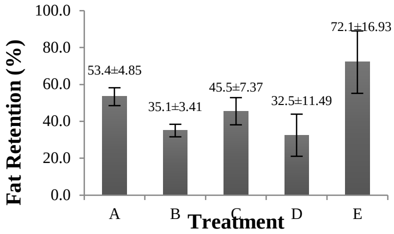


Figure 5. Histogram of Fat Retention

Another conjecture is the process of lipogenesis, which is the formation of fatty acids and triglyceride derivatives that occur in the liver and adipocyte tissue/body fat tissue, which can occur through the absorption of fat nutrients from feed or the process of de-novo lipogenesis (DNL). The most significant fat retention occurred in feed treatment E with a low fat content of 4.4% and a high carbohydrate content of 41%. This condition triggers the body to perform the DNL process optimally, producing higher body fat than other feed treatments.

f. Lettuce Productivity

The study assessed lettuce productivity based on the number of leaves and consumption weight at harvest. From the results of further tests, the number of leaves and wet weight were not significantly different for each treatment. The average number of leaves of lettuce plants ranged from 11 to 14 leaves per plant. This number is still relatively good for lettuce plants. The number of leaves in the research of different planting media and nutrients in the hydroponics Nutrient Film Technique (NFT) type, also gives an average number of leaves of as much as 11.28-12.38 strands (Ayu et.al., 2022).

The wet weight of lettuce plants varies quite a bit between plants. The wet weight at harvest in the study was an average of 8.7-16.1 g/g/ g/plant. When compared to other studies, rockwool media can provide an average wet weight of plants of 61.88 g, while the use of AB mix nutrients 5 ml / l can produce an average wet weight of 67.72 g, according to Ayu et.al. (2022). The nutrients recorded, such as TDS, were relatively small compared to the conditions in the hydroponic media (Table 6). The lettuce plants can still grow and be harvested under good conditions. The nutrients obtained by the lettuce are entirely derived from the Jelawat feces. This proves that Jelawat can grow on aquaponic media, and lettuce can utilize Jelawat farming waste even though it has not yet produced maximum productivity.

g. Water Quality

Water quality will affect the growth and survival of fish and provide the nutritional needs for aquaponic plants. The temperature parameters for all treatments are still based on the needs of Jelawat (Table 6). Aquaponic media allows the media to be exposed to sunlight well, so that the temperature is still in the optimal range for the growth of Jelawat fish. The optimum temperature range for Jelawat fish cultivation is 25-37ºC, Hardjamulia et.al. (1992) in Darmayanti et.al. (2018). This irradiation is also used for the photosynthesis process of lettuce plants so that lettuce can grow.

Table 6. Water Quality Observations

Parameter	Treatment					Reference
	A	B	C	D	E	
Temperature (º C)	26.9-28.4	26.9-29.3	27.0-29.5	26.9-29.5	27.1-29.6	25-37*
pH	6.72-8.7	7.0-8.7	7.0-8.5	6.9-8.8	6.9-8.8	7-8.5**
TDS (mg/l)	47-122.6	50.3-99	45.6-117.6	45.3-114.6	60.3-111.3	0-1.000***
DO (mg/l)	4.07-8.23	4.67-8.33	5.03-7.6	4.73-8.53	5.37-7.87	>5***
Ammonia (mg/l)	0.018-0.046	0.00-0.033	0.012-0.031	0.017-0.037	0.017-0.049	<0.2**

Description : * (Hardjamulia *et.al.*,.1992; Darmayanti, *et.al.*,. 2018)
** (Efendi, 2000)
*** (Boyd, 2015)

The pH content of the media measured during the study was in the neutral pH range. TDS value only reached 45.33 mg/l (D) to the largest (E) of 60 mg/l. This value is minimal. This condition is due to the water source used being a groundwater source, so the mineral and organic matter content is low. Boyd (2015) states that TDS in natural freshwater ranges from 20 to 1.000 mg/l, and solids consist of bicarbonate and carbonate with a pH above 8.3; besides that, it also consists of chloride, sulfate, calcium, potassium, magnesium, sodium, and silicate. This explains the pH value when measuring on day 7th, the water is still alkaline and tends to be close to neutral during maintenance due to organic matter from feces and the rest of the fish feed. Laying lettuce plants on day 14 of maintenance is helpful so that the media is filled with organic matter from jelawat feces and residual feed to support lettuce growth. Farida et al. (2017) state that the optimum TDS conditions for lettuce in aquaponic media range from 900 – 1.750 mg/l. This results in lettuce growth in the treatment not as good as growth in hydroponic media that uses additional fertilizer to increase the TDS value.

In general, DO concentration in the media during the study, for all treatments on average, ranged from 4.07 to 8.53 ppm and can be classified as good. For fish that live in warm areas, the desired Do concentration is five ppm - saturated concentration, Boyd (2015). The ammonia content in each treatment is still within the safe range for fish. Ammonia during the study changed according to the length of maintenance.

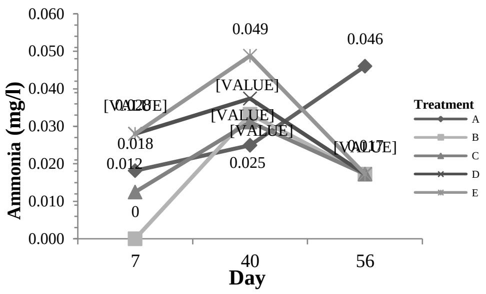


Figure 6. Average Ammonia Content During The Study

As shown in Figure 6, the average Ammonia value at the beginning of the study (day 7) ranged from 0-0.028 mg/l. At the middle (day 40), it became 0.025-0.037 mg/l. Ammonia in the media decreased until the 56th maintenance. This proves that lettuce plants can absorb ammonia from the media. Ammonia can be utilized by lettuce to grow, and ensure good water quality for Jelawat fish in the aquaponic media. Thus, all water quality parameters in the study showed that they were in good condition for Jelawat and could provide enough nutrients for lettuce, although not as good as in media with fertilizer application, such as hydroponic media.

This study illustrates that jelawat fish farming can be combined with lettuce vegetable farming through the utilization of indigofera leaf flour as an effort to support community food security. Using indigofera leaf meal in artificial feed can optimize the production of Jelawat fish by providing a survival value of Jelawat fish reaching 95-100% in the aquaponic cultivation system. Indigofera leaf meal can also be optimally utilized in artificial feeds for Jelawat fish reared in aquaponic media up to 15% in the Jelawat feed formulation, by providing the best absolute growth, daily growth, feed conversion ratio, efficiency, and protein retention.

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