# Quality Improvement of Water Hyacinth ( Eichornia Crassipes) Leaf Meal Fermented with Aspergillus Niger as Fish Feed Ingredient

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# Quality Improvement of Water Hyacinth (*Eichornia Crassipes*) Leaf Meal Fermented with *Aspergillus Niger* as Fish Feed Ingredient

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**Abstract**. An experiment was conducted to investigate the nutrient quality of water hyacinth leaf meal (WHLM) fermented with different doses of *Aspergillus niger* as fish feed ingredients. This study utilized a completely randomized design (CRD) with five treatments and three repetitions. The doses of *A. niger* supplemented in WHLM were 0; 6; 8; 10; and 12%. Results of this study showed that nutrient quality of WHLM with *A. niger* supplementation significantly affected the reduction of crude fiber and increase of crude protein ($P<0.05$). Addition of 12% *A. niger* is the best treatment for improving protein and fiber quality of water hyacinth leaf meal.

## 1. Introduction
Water hyacinth (*Eichhornia crassipes*) is native to South America and has spread to more than 50 countries including Indonesia. Water hyacinth is one of the many aquatic plants that grow in rivers, rice fields, lakes and reservoirs. These plants exhibit fast growth rate and have the ability to compete with other aquatic plants [1]. Water hyacinth can block irrigation flow [2]. Therefore, the presence of water hyacinth in the waters is more often considered as an aquatic weed which is very detrimental because it has a negative impact on aquatic ecosystems [3].

Recently, efforts to use water hyacinth leaves in fish feed have been widely given to Nile tilapia, African catfish, green catfish, river carp and Thai catfish [4,5,6,7,8]. Water hyacinth leaves can be used as fish feeds because these are good sources of nutrients. The leaves contain 6.31% to 11.20% crude protein, 12.60% to16.12% ash and 48.18% to 57.0% nitrogen free extract, while the fiber composition is 33.0% to 49.30% [9,10]. Even though the water hyacinth leaves have high nutritive value, the main obstacle in its use as fish feed ingredients is due to the relatively high content of crude fiber which makes it difficult for the fish to digest and can reduce feed quality.

One of the efforts that can be done to overcome the high crude fiber content in water hyacinth leaves is through fermentation technology. Fermentation process using *Aspergillus niger* could be applied on water hyacinth leaves to improve nutrient utilization for fish. *A. niger* can produce cellulase and hemicellulase enzymes that are able to degrade cellulose into simple sugars [11]. One of the factors affect fermentation process is the starter dosage. Therefore, the objective of this study was to evaluate the effects of different doses of *A. niger* supplementation during fermentation on the nutritive value of water hyacinth leaves as fish feed ingredients.

## 2. Materials and Methods

Water hyacinth plants were collected from bodies of water near the Siak River in Pekanbaru, Riau Province. The plant was gently washed in water to remove the mud, and the leaves were carefully removed. To ensure uniform drying, the leaves were cut into small pieces and sun dried to reduce the moisture content. The dried leaves were ground into a fine meal resulting in a product known as water hyacinth leaf meal (WHLM).

This study used a completely randomized design (CRD) with different doses of *Aspergillus niger* to ferment WHLM at doses of 0% (T0), 6% (T1), 8% (T2), 10% (T3), and 12% (T4). Each treatment was repeated thrice. Fermentation was carried out by weighing 10 g of WHLM for each treatment, placed in the aluminum foil, steamed in boiling water for 15 min and then allowed to cool at room temperature. After cooling, *A. niger* starter was mixed with WHLM according to the treatments, followed by the addition of distilled water at a ratio of 1:1 (1 g WHLM: 1 mL distilled water). The mixture of WHLM was placed into transparent plastic container with small holes and incubated for 72 hours at room temperature. After 72 hours, the mixture of WHLM was steamed in boiling water for 5-10 min to inactivate the *A. niger*. Furthermore, WHLM and fermented WHLM were analysed for proximate composition following the methods of AOAC [12] for moisture, crude protein, crude fiber, crude lipid and ash. Nitrogen free extract (NFE) in both samples were calculated using the method of Deng et al [13].

The data are presented as mean standard deviation (SD). When the overall differences were significant ($P < 0.05$), the data were subjected using one-way analysis of variance (ANOVA) followed by Duncan's multiple range test for comparison of means among groups. SPSS 21.0 for Windows was used for statistical analysis (SPSS, Michigan Avenue, Chicago, IL, USA).

## 3. Results and Discussion

The results of the proximate analysis of water hyacinth leaf meal (WHLM) fermented with different doses of *A. niger* is presented in Table 1. The crude protein (CP) content of fermented water hyacinth leaf meals increased with increasing dose of *A. niger* supplementation, while the crude fiber (CF) decreased.

Table 1. Proximate composition of WHLM with different doses of *A. niger* supplementation[1]

| **Dose of** *A. niger* | **Proximate composition (%)** | | | | | |
|---|---|---|---|---|---|---|
| | **Moisture** | **Crude protein** | **Crude fat** | **Crude fiber** | **Ash** | **NFE** |
| T0 (0%)/Control | 8.16±0.18$^a$ | 6.56±0.31$^a$ | 2.08±0.03$^a$ | 26.47±0.09$^a$ | 15.71±0.30$^a$ | 49.17±0.55$^a$ |
| T1 (6%) | 8.70 ±0.57$^b$ | 11.55 ±0.30$^b$ | 2.12±0.01$^a$ | 17.22±0.19$^b$ | 5.75 ±0.02$^b$ | 63.35±0.08$^b$ |
| T2 (8%) | 8,99 ±0.84$^c$ | 12.14±0.39$^c$ | 2.43 ±0.21$^b$ | 15.14±0.20$^c$ | 5.33 ±0.11$^c$ | 64.93±0.46$^c$ |
| T3 (10%) | 9.18 ±0.84$^c$ | 13.96 ±0.28$^d$ | 2.60±0.91$^c$ | 14.37±0.25$^d$ | 4.37 ±0.03$^d$ | 64.68±0.06$^c$ |
| T4 (12%) | 9.77 ±0.05$^d$ | 18.15 ±0.03$^e$ | 2.92 ±0.99$^d$ | 11.93±0.15$^e$ | 3.79 ±0.08$^e$ | 63.21±0.04$^b$ |
| Changes (%) | +19.73 | +176.67 | +40.38 | -54.93 | -75.87 | +28.54 |

[1]Values are means ± SD. Based on Duncan test, values within the column with different superscripts are significantly different (*P*<0.05)

Based on Table 1, it can be observed that the water hyacinth leaves fermented with *A. niger* increased the CP content by as much as 176.67% (from 6.56 to 18.15%), but lowered the CF content by as much as 54.93% (from 26.47 to 11.93%). The CP content in treatment T4 was significantly higher than the other treatments ($P < 0.05$). The increase in CP was due to the growth of *A. niger* cells which contain high protein as a result of the conversion of carbohydrates (fibre) into amino acids that make up proteins during the fermentation process. *A. niger* has cellulose enzymes that are able to break down complex long-chain cellulose molecules into proteins that make up their cells. The increase in protein content is in line with the growth of molds because the fungi body consists of nitrogen-containing elements [14]. In addition, the enzymes produced by fungi are also proteins [15]. Similarly, the increase in the crude protein content could also be caused by the increase in the population of mold colonies as indicated by the increase in *A. niger* biomass during the fermentation process [16]. Oboh et al [17] reported that cassava fermented with *A. niger* can increase the CP content from 4.4 to 12.2%. The increase of crude protein content could be attributed to the higher biomass of *A. niger* where most of the cells are proteins (single cell protein/SCP) [18]. Water hyacinth, which is a good substrate for fungi, can provide organic material in the form of carbon and nitrogen for the growth of *A. niger*.

The supplementation of different doses of *A. niger* starter in water hyacinth leaves showed a significant difference (P<0.05) in the CF content (from 26.47 to 11.93%) (Table 1). The CF content in fermented WHLM in inversely related to the dose of *A. niger* starter. The decrease in CF content of water hyacinth leaves was related to degradation of lignocellulose aerobically by the mold. This is in accordance with the findings of Winarno & Fardiaz [19] wherein they stated that the decrease of CF content in the treatments after fermentation was due to the enzymes produced by *A. niger*. These enzymes are capable of converting cellulose to simple glucose during the fermentation process.

The higher reduction in the CF content of fermented WHLM was obtained at a dose of 12% *A. niger* (T4). It might be due to the dose of *A. niger* starter in this treatment, which was higher than other treatments; thus, it had a lower CF content. This result is in accordance with Liyani [20] who conducted an experiment on sago pulp fermented with *A. niger*. The decrease in CF is brought about by the increase in the amount of *A. niger* concentration, so the ability to degrade fiber becomes higher. The decrease of CF content in fermented WHLM was due to the availability of *A. niger* that produces cellulose enzyme that is capable of degrading cellulose to simpler forms [21]. This result is in agreement with the findings of Mairizal [22], who reported that coconut meal fermented using *A. niger* can reduce the CF content from 15.15% to 10.24%. Similar results were also obtained by Suparjo et al [23] who reported that rice bran fermented with *A. niger* with incubation time of 72 h showed a decrease in CF content.

## 4. Conclusion

The present study indicated that the nutritive quality of water hyacinth leaves can be improved by fermentation using *A. niger* as starter. Supplementation of 12% *A. niger* in water hyacinth leaves is the best dose to increase protein content and to lower crude fiber levels.

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