Nutritive Value of Fermented Water Hyacinth (*Eichornia crassipes)* Leaf with *Aspergillus niger* in Tegal Duck

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Abstract. Two steps of experiment were conducted to evaluate the proximate composition and nutritive value of fermented water hyacinth leaf (WHL) with *Aspergillus niger* in Tegal duck. Twenty two heads of eight-week Tegal ducks with an average body weight of 1202.55 ± 111.14 g were used in this experiment. There were two treatments namely: non-fermented (NFWH) and fermented with *Aspergillus niger* (FWHAN). Each treatment was replicated 10 times. Data gathered were analyzed using t-student test. The proximate composition between NFWH and FWHAN showed an increase in crude protein/CP (11.44 vs 16.09%) and ash (12.76 vs 22.37%) but a decrease in crude fiber/CF (21.51 vs 16.62%) and nitrogen free extract/NFE (53.20 vs 43.59%). The nutritive value of diet for eight-week Tegal ducks showed that fermentation of WHL with *Aspergillus niger* significantly increased CP digestibility, true metabolizable energy (TME) and nitrogen retention (NR), but not for CF digestibility. It could be concluded that fermentation of WHL with *Aspergillus niger* increases the nutrient quality and the nutritive value of diet for eight-week Tegal ducks in term of CP digestibility, TME and NR.

Key Words: water hyacinth leaf, fermentation, *Aspergillus niger*, biological value, Tegal ducks

Introduction

Duck farmers generally face some problems on the availability of the cheaper price, high-quality feedstuffs. Farmers were forced to feed low-quality ration to the ducks that would results in lower productions as well as slower farm development. To solve the problem, water hyacinth might be used as an alternative of a cheap and highly available feedstuff. Weeds like water hyacinth would cause several problems in the rivers, lakes or swamps. Water hyacinth usually grows easily in these places, since such kinds of places are very favorable for the weeds to grow and breed, that can cause the worst situation at which time the weed covers the entire water surfaces of these places. This situation is very unfavorable and dangerous for the surrounding people. Some people who live close to the places on where the weed grows has been producing handicrafts made from the stalks of water hyacinth, therefore, the leaf could be used as an alternative feedstuff for ducks. However, high crude fiber (CF) content is one of the constraints on utilizing water hyacinth leaf (WHL) as feedstuff.

According to Rahmawati et al. (2000) and Mangisah et al. (2006), CF content of WHL is as high as 36.59%. The results of proximate analysis of WHL conducted by Mahmilia (2005) in dry matter (DM) basis are as follows: 6.31% crude protein (CP), 26.61% CF, 2.83% extract ether (EE), 16.12% ash and 48.18% nitrogen free extract (NFE); while the fiber composition are 49.30% neutral detergent fiber (NDF), 28.16% acid detergent fiber (ADF), 21.14% hemicellulose, 24.61% cellulose and 3.35% lignin.

Duck is one among the water fowls that effectively utilizes CF from the ration (Wizna et al., 1995 and Yuwanta et al., 2002). According to the research of Sumiati and Nurhaya (2002), duck digests higher proportion of CF of kayambang (*Salvinia molesta*) leaf (54.33%) compared to male local chicken which is only 46.57%. On the other hand the amount and composition of the CF in the ration would also influence nutrient digestibility (McDonald et al*.,* 1982). Even though duck can utilize dietary CF better than that of chiken, but still WHL should be managed in such a way to increase its nutrient utilization. Fermentation using *Aspergillus niger* can be applied on WHL to increase its nutrient utilization for the duck.

Fermentation with *Aspergillus niger* on WHL had been conducted by Mangisah et al. (2006).

The research showed that 6-week fermentation was the best time to increase the nutrient content of WHL. Crude protein concentration of 6-week fermented WHL with *Aspergillus niger* (FWHAN) increased 65.41% and decreased the CF as high as 57% as compared to those of non-fermented (NFWH). The changes of the nutrient concentrations of FWHAN especially its CP and CF, would affect the nutritive value of this feedstuff when fed to ducks. This was the reason of conducting this research. In addition, this research would also provide information of WHL nutrient composition on the basis of proximate analysis and nutritive value of FWHL that can be used in feed formulation which utilizes the feedstuff for duck's ration.

Materials and Methods

The first step of the experiment was gathering the leaves of water hyacinth from Rawapening swamp at Ambarawa District, Semarang Regency. Half of the ready WHL was than fermented with *Aspergillus niger*. Fermentation procedure was the following: withering the WHL so that the water content decreased up to 50%, than addition of 5% of molasses; Preparation and mixing of diluted *Aspergillus niger* as much as 2.5% (DM basis) with WHL; filling perforated plastic bags with the mixture of WHL and *Aspergillus niger*, 1 kg of mixture/bag; placing all of the mixture in the plastics in fermentor; harvesting, drying, and grinding NFWH and FWHAN after 6 weeks of storage. These 2 kinds of feedstuffs were sampled for proximate analysis based on AOAC (1990).

To measure the nutritive value of NFWH and FWHAN in ducks, 22 heads of 8-week old male ducks with an average body weight of 1202.55 ± 111.14 g were used in this experiment. Ten ducks were used for NFWH treatment and the other ten for FWHAN. Two ducks were used for the WHL-unfed animals to measure the endogenous nutrient voided in the excreta. All ducks were placed in individual battery cages prior to force feeding according to Sibald (1983) method. Variables observed for measuring the nutritive value was TME which was computed based on Sibbald (1983), while CP and CF digestibilities as well as NR were computed according to Pond et al. (2005). Data gathered were analyzed using *t-student* test (Steel and Torie, 1980).

Results and Discussion

Proximate Composition

Nutrients content of NFWH and FWHAN is presented in Table 1. Six-week fermentation of the water hyacinth leaves with *Aspergillus niger* increased CP, EE and ash concentrations as much as 40.65, 22.02 and 75.30%, respectively, but decreased CF content as much as 22.73%.

Table 1. Proximate compositions

Nutrients	Water Hyacinth Leaf		Changes
	NF (%)	F *(%)*	(%)
Crude Protein	11.44	16.09	+ 40.65
Crude Fiber	21.51	16.62	- 22.73
Extract Ether	1.09	1.33	+ 22.02
Nitrogen Free Extract	53.20	43.59	- 18.06
Ash	12.76	22.37	+ 75.30

NF : non fermented; F : fermented

The increase of CP of FWHAN was due to the destruction of the protein in WHL in the presence of protease enzyme produced by *Aspergillus niger* that convert CP into amino acids. It was then utilized for the growth of the fungi. On the other hand, the increased protein content could also be due to the increase of sporulation resulting from the increase of *Aspergillus niger* biomass. The organic matter of the substrate provided as C and N sources for the growth of *Aspergillus niger*, since there was a decrease of organic matter of the substrate and an increase of protein and ash. The decrease of organic matter was due to the utilization of carbohydrate as an energy source for growth and formation of fungi's cell biomass as well as citric acid production. All these processes were easily noticed by the decreased NFE of the FWHAN, while the increase of CP was due to the decrease of carbohydrate that was used for the growth of the fungi which contained around 5-8% of N. *Aspergillus niger* produces enzyme along the fermentation process, which is protein in nature. This results is supported by the research of Sjofjan et al. (2001) and Nurhayati et al. (2006).

Aspergillus niger is capable of producing cellulolytic enzyme. Cellulase and hemicellulase

enzymes produced by *Aspergillus niger* would degrade cellulose and hemicellulose producing simple carbohydrates like monosaccharide, disaccharide and sellobiose that are more soluble. Judoamidjojo et al. (1989) and Christiyanto (1998) state that *Aspergillus niger* produces selulase and hemicellulase enzymes that hydrolyze cellulose into simple sugars.

Nutritive Value for Duck

Nutritive value of NFWH and FWHAN in 8-week male ducks is presented in Table 2. Fermentation did not significantly increase CF digestibility of WHL, but there were some increases in CP digestibility, TME and NR as compared to those of NFWH.

Fermentation of WHL with *Aspergillus niger* did not influence CF digestibility. The most abundance fiber components in WHL were lignocellulose and lignohemicelluloses. The presence of lignin attached to cellulose and hemicelluloses was very difficult to hydrolyze or was almost completely un-hydrolyzed by the fungi, since *Aspergillus niger* did not produce lignocellulose and lignohemicellulose enzymes. Enzymes produced by *Aspergillus niger*.

Tabel 2. Nutritive value

Paramenters	NFWH	FWHAN
Digestibility of Crude Fiber (%)	25.80	27.51
Digestibility of Crude Protein (%)	54.50[b]	60.82[a]
Nitrogen Retention (g)	0.21[b]	0.30[a]
True Metabolizable Energy (kal/g)	973.06[b]	1310.09[a]

Values bearing different superscript at the same row differ significantly (P<0.05).
NFWH: Non Fermented; FWHAN: Fermented Water Hyacinth with *Aspergillus niger*

Value with different superscript in each parameter significantly different (P<0,01) are amylase, cellulase and amiloglukosidase (Darwis et al., 1989). *Aspergillus niger* is also capable of producing extra cellular enzymes like catalase, glucoamilase, α-amylase, protease and lactase (Judoamidjojo et al., 1989). Lignocelluloses and lignohemicelluloses components of both fermented and non-fermented WHL became limiting during fiber digestion in the duck's digestive tract. Poultry has no lignocellulase and lignohemicellulase enzymes in its digestive tract, so that these two components cannot be digested. Therefore, fermentation with *Aspergillus niger* in WHL for 6 weeks did not improve dietary CF digestibility in the 8-week old ducks.

Even though fermentation with *Aspergillus niger* for 6 weeks in WHL did not enhance CF digestibility, but the treatment definitely improved the quality of its fiber's components. These could be seen from the data observed after the 2 feedstuffs were analyzed for its fibers components using Van Soest procedures. There were a decrease in NDF and ADF contents in FWHAN as high as 8.88% and 18.23%, respectively. This decrease would certainly increase the neutral detergent solubles (NDS) and acid detergent solubles (ADS) of FWHAN. Fermentation applied in this experiment really affected the concentration of fiber's component that appeared in the NDS or ADS compartment. The change of fiber's components of the cell content that was found in the NDS compartment is shown at Table 1 and was already been discussed previously. Among those of the ADS constituents were hemicelluloses and N of the cell wall. Fiber's quality of WHL was persistently improved upon 6 weeks of fermentation with *Aspergillus niger*, so that it would influence the nutrient availability to the ducks as it was observed in the digestibility of CP, as well as NR and TME content.

Using *Aspergillus niger* in the process of fermentation in WHL significantly increased CP digestibility, from 54.50% into 60.82%. This increase was due to the increase of CP content of FWHAN (Table 1). All enzymes produced by *Aspergillus niger* (Judoamidjojo et al., 1989) would also contribute on the improvement of CP digestibility. According to Suliantari and Rahayu (1990), fermentation would increase the CP digestion value. The decrease of CF content (Table 1) and quality improvement of fiber's components of FWHAN would increase the availability of N from the cell wall, hence increased the CP to be digested. Researches by Mangisah et al. (2006) showed a good protein digestion that is 78.67% when 7.5% FWHAN was included in broiler ration, while the CF digestibility was around 27.17–31.94%. On the

other hand, fermentation with fungi restructured the protein substrate (Winarno, 1991), which later affected the work of protease enzymes in the duck's digestive tract. The enzymes would hydrolyze the protein substrate of FWHAN, easily and effectively.

Nitrogen retention of ducks fed FWHAN increased 42.86% (Table 2). This increase was due to the increase of CP content as well as the digestibility of the feedstuff. As CP content of FWHAN increases, nitrogen consumption would also increase. In concomitant to the increase of CP digestibility, of course, these 2 factors enhanced the NR. Siri et al. (1992) mention that the different levels and components of CF in the ration influence N and energy retentions; Fiber with high lignin and cellulose decreases N and energy retentions. As it was discussed previously that fermentation applied in this research improved the quality of fiber's components of WHL, resulting in the increase of the availability of cell wall N and reducing the control of fiber on nutrient digestion and absorption. Therefore it was obvious if there was an improvement of NR of FWHAN when fed to the ducks.

There was an increase of TME as much as 34.64% of FWHAN (Table 2). This increase was due to the increase of EE and CP content as well as the decrease of CF in WHL after 6-week fermentation with *Aspergillus niger* as presented in Table 1. Even, there was a decrease of NFE but FWHAN still provided a good TME for the ducks, since energy value not only comes from the NFE but from all nutrients in the feedstuff include CP, CF and EE.

The quality improvement of the fiber components upon fermentation processes of WHL would again explain the increase in TME. It was recognized that there was no enzyme to hydrolyze lignocelluloses and lignohemicelluloses but fermentation processes by *Aspergillus niger* might widen the chemical bond of these 2 components, which might lead to enhancement of nutrients digestion processes of FWHAN. Besides, it has been clarified previously that the decrease of CF in FWHAN, affected the decrease of NDF and ADF, which in turn, provided an increase of NDS and ADS components. Increasing the NDS and ADS components of WHL after 6-week fermentation with *Aspergillus niger* significantly contributed the availability of hemicelluloses and cell wall N as energy sources for the duck, measured as TME.

Conclusions

Fermentation of water hyacinth with *Aspergillus niger* for 6 weeks increases CP concentration as much as 40.65% and decreases CF concentration as much as 22.73%, which in turn, improves the nutritive value of CP and TME as well as NR, but not the CF.

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