# Nutrient digestibility and digestive track development of the kampong-crossbreed chicken fed *Salvinia molesta* leaf meal

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# Nutrient digestibility and digestive tract development of the Kampong-crossbreed chicken fed *Salvinia molesta* leaf meal

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## Abstract

The objective of the present study was to investigate the effect of dietary inclusion of *Salvinia molesta* on the nutrient digestibility and digestive tract development of the Kampong-crossbreed chicken. Four experimental diets with different levels of *Salvinia molesta* leaf meal i.e., 0, 6, 12 and 18% were formulated. The diets were offered to 100 of the 3-weeks-old Kampong-crossbreed chickens with the average body weight of 218 ± 0.54 g. The birds were slaughtered at 10 weeks of age. Results showed that dietary inclusion of *Salvinia molesta* increased the feed and protein digestibility of chickens. The relative weights of proventriculus, gizzard, intestine, duodenum and cecum were lower in the treated birds than in control. The same condition was observed for the relative lengths of proventriculus, intestine, duodenum, ileum and cecum. The duodenal villi was higher in the birds fed *Salvinia molesta* than in control. Dietary inclusion of *Salvinia molesta* improved growth performance and feed conversion ratio of chickens. The treatments also lowered feed cost per gain of Kampong-crossbreed chickens. In conclusion, *Salvinia molesta* as a feed ingredient improved nutrient digestibility, duodenal villi and growth performance of the Kampong-crossbreed chickens.

***Keywords:*** *crossbreed chicken, gastrointestinal tract, performance*

## Introduction

Kampong-crossbreed chicken has recently attracted huge interest from the consumers due to its unique taste and low cholesterol content in meat as compared to broiler meat (Nugraha et al 2016). To response the continuously increasing demand, farmers are now endeavoring to maximize the growth performance while reducing the cost of feed. The development and morphology of the intestine are the key factors for the growth and wellbeing of chickens (Yamauchi and Tarachai 2000; Sugiharto 2016). In general, the digestive tract of chickens begins to grow shortly after hatching and continue thereafter. A number of factors have been reported to affect the development of the chicken's digestive tract, one of which is the feed (Röhe 2013). Protein is generally considered as a vital nutrient for the normal growth and development of the gastrointestinal tract of chickens (Laudadio et al 2012). To meet the protein requirement, soybean meal has commonly been included in the chicken ration. Due to its high price, it is therefore necessary to find alternative other than soybean meal as a source of protein for chickens. One of the local cheap stuff that may be exploited as an alternative to soybean meal for the chicken is *Salvinia molesta*.

### *Salvinia molesta*

Is a free-floating aquatic plant that is abundantly grown in swamp, rivers and rice fields. According to McFarland et al (2004), the yearly production of *Salvinia molesta* can reach 45.6

to 109.5 t/ha. *Salvinia molesta* may be used as a feed ingredient for chickens as it contains of 12.9% crude protein (Leterme et al 2009). *Salvinia molesta* is also rich in essential minerals and amino acids needed for the growth of chickens. Nonetheless, *Salvinia molesta* has a high content of crude fiber (around 16.8%) (Adrizal 2002), which may limit the use of such stuff in the chicken rations. Apart from the latter concern, dietary fiber has been suggested to stimulate the growth and development of the digestive tract (Yu and Chiou 1996; Sumiati and Sumirat 2003) as well as improve the structure and morphology of the intestine of chickens (Oliveiera et al 2008). For these reasons, feeding *Salvinia molesta* was expected not only to substitute the protein-rich feedstuffs such as soybean meal, but also to improve the development of digestive tract of chickens and thus performances of the chickens. The objective of the present study was to investigate the effect of dietary inclusion of *Salvinia molesta* on the nutrient digestibility and digestive tract development of the Kampong-crossbreed chicken.

## Material and methods

A hundred of Kampong-crossbreed chickens (two weeks of age; 218.76±0.54 g [body weight ± standard deviation) were used in the current trial. The experiment was arranged based on a completely randomized design with four treatments and five replicates consisting of five chickens in each. The treatments included four diets containing different levels of *Salvinia molesta* leaf meal, i.e., 0, 6, 12 and 18%. The diets were offered at week-3 onward. The experimental diets were divided into starter and finisher diets, and were prepared to be isoprotein and isoenergy. The compositions and chemical contents of the diets are presented in Tables 1 and 2. *Salvinia molesta* leaf meal used in the present study (containing crude protein, crude fat and crude fiber of 10.15%, 3.15% and 33.03%, respectively) was collected from Rawapening swamp, Banyubiru, Central Java, Indonesia. It was sundried (for 2 days) and milled before being included in the rations. Feed and water were provided *ad libitum* for the entire experimental period. Chickens were vaccinated with ND (Newcastle disease) vaccine at day 4 and Gumboro vaccine at day 13.

**Table 1.** Ingredients and composition (as-dry basis) of the starter diet

| Ingredients | *Salvinia molesta* level | | | |
|---|---|---|---|---|
| | 0% | 6% | 12% | 18% |
| Maize | 52.1 | 52.3 | 51.0 | 51.8 |
| Soybean meal | 21.3 | 17.0 | 14.0 | 10.8 |
| Vegetable oil | 1.20 | 1.20 | 1.30 | 1.30 |
| Rice bran | 16.8 | 15.9 | 15.1 | 11.8 |
| Fish meal | 5.00 | 5.00 | 5.00 | 5.00 |
| $CaCO_3$ | 0.80 | 0.70 | 0.40 | 0.40 |
| Premix | 0.80 | 0.70 | 0.40 | 0.30 |
| Methionine | 1.00 | 0.60 | 0.40 | 0.30 |
| Lysine | 1.00 | 0.60 | 0.40 | 0.30 |
| *Salvinia molesta* meal | 0.00 | 6.00 | 12.0 | 18.0 |
| Total | 100 | 100 | 100 | 100 |
| **Chemical composition** | | | | |
| Metabolic (kkal/kg) | 2,901 | 2,901 | 2,900 | 2,901 |
| Crude | 20.3 | 20.0 | 20.3 | 20.3 |
| Crude | 5.04 | 4.94 | 4.91 | 4.68 |
| Crude | 6.22 | 8.36 | 10.6 | 12.1 |
| | 1.26 | 0.97 | 0.87 | 0.85 |
| Lysine (%) | 1.55 | 1.42 | 1.47 | 1.61 |
| Calsium (%) | 1.24 | 1.77 | 2.10 | 2.73 |
| Phospor (%) | 0.72 | 1.05 | 1.39 | 1.70 |

**Diets were formulated according to Ma'rifah et al (2013)*

At week 10, one chicks was randomly obtained from each replicate and then placed in the individual battery cage for the nutrient digestibility trial. To measure the nutrient digestibility, the total collection method was conducted after the chicken was fasted (from feed but not from water) for 24 hours. The chickens were provided with the treatment diets for three days and the

excreta was collected during the period of the trial. The excreta was collected in the plastic tray and sprayed with 0.2 N HCl to avoid the evaporation of nitrogen. The data on the endogenous nitrogen loss were obtained by fasting the 10 chickens for 48 h, and in the hour-48 excreta was collected. After being cleaned from feathers, debris and feed, the excreta was weighed to find out the wet weight, and then air-dried and weighed again to find out the air-dry weight. Dried excreta was stored at room temperature until analysis. Proximate analysis was conducted thereafter following the standard methods of AOAC (2007).

**Table 2.** Ingredients and composition (as-dry basis) of the finisher diet

| Ingredients | *Salvinia molesta* level | | | |
|---|---|---|---|---|
| | 0% | 6% | 12% | 18% |
| Maize | 54.0 | 52.9 | 52.6 | 52.5 |
| Soybean meal | 19.3 | 16.5 | 12.7 | 9.40 |
| Vegetable oil | 1.20 | 1.10 | 1.20 | 1.20 |
| Rice bran | 17.7 | 11.3 | | 14.6 |
| Fish meal | 4.00 | 3.50 | | 3.50 |
| $CaCO_3$ | | 0.70 | | |
| Premix | | 0.50 | | |
| Methionine | | 0.60 | | |
| Lysine | | 0.60 | | |
| *Salvinia molesta* meal | 0.00 | 6.00 | 12.0 | 18.0 |
| Total | 100 | 100 | 100 | 100 |
| **Chemical composition** | | | | |
| Metabolic energy (kkal/kg) | 2,903 | 2,902 | 2,902 | 2,902 |
| Crude protein (%) | 19.0 | 19.1 | 19.0 | 19.1 |
| Crude fat (%) | 5.09 | 4.91 | 4.87 | 4.71 |
| Crude fiber (%) | 6.31 | 8.68 | 10.8 | 12.7 |
| Methionine (%) | 1.14 | 0.94 | 0.84 | 0.73 |
| Lysine (%) | 1.42 | 1.39 | 1.44 | 1.49 |
| Calsium (%) | 1.36 | 1.65 | 1.98 | 2.41 |
| Phospor (%) | 0.68 | 1.02 | 1.35 | 1.68 |

** Diets were formulated according to Ma'rifah et al (2013).*

The chickens were slaughtered at 10 weeks of age, and the digestive tracts were immediately obtained. The weight and length of each digestive tract including proventriculus, gizzard, duodenum, jejunum, ileum, pancreas, cecum and large intestine were then measured. The relative weight or length of these digestive organs was expressed as wet organ weight or length to live body weight (Sugiharto et al 2016). A piece of duodenum (1 cm) was obtained from each chicken and then soaked in a solution of 90% Bouin for histological analysis (Samson and Unity 2014). Histological analysis was carried out on 5 µm duodenal slice stained using hematoxylin and eosin. The optical microscope installed with the digital camera was used to determine the villus height and crypt depth.

Data collected from this present study were statistically analyzed based on analysis of variance (Steel and Torrie 1960). Duncan's multiple-range test was conducted when remarkable differences ($p<0.05$ or $p<0.01$) were found among the treatment groups. The data are shown as means and standard deviation.

## Results and discussion

Data on the nutrient digestibility of the Kampong-crossbreed chicken fed *Salvinia molesta* leaf meal are presented in Table 3. Our present finding showed that dietary inclusion of *Salvinia molesta* increased the feed and protein digestibility of chickens. It has commonly been known that well-balanced essential amino acids is coupled with the improved nutrient digestibility in poultry. Previously, Beski et al (2015) pointed out that vegetable (plant)-based protein contain unbalanced essential amino acids. Conversely, aquatic ferns such as *Salvinia molesta* contain well-balanced essential amino acids (Leterme et al 2009). For this reason, the dietary incorporation of *Salvinia molesta* may therefore improve the balanced amino acids and thereby

increased the feed and protein digestibility in the Kampong-crossbreed chickens. In addition to the amino acid balance, the increased content of fiber in the *Salvinia molesta* treated groups may also increase the digestibility of chicks due to the improvement in intestinal morphology, i.e., increased duodenal villi height, of chicks in the present study. The latter inference was supported by de Vries (2015) suggesting that moderate levels of fiber may improve the gastrointestinal development and function and thus nutrient digestibility and growth performance of chickens.

**Table 3.** Nutrient digestibility of Kampong-crossbreed chickens

| Items | *Salvinia molesta* | | | |
|---|---|---|---|---|
| | 0% | 6% | 12% | 18% |
| Feed digestibility (%) | $14.11^{c}$ | $34.65^{b}$ | $37.56^{b}$ | $52.99^{a}$ |
| Protein digestibility (%) | $82.06^{c}$ | $83.73^{b}$ | $83.95^{b}$ | $86.01^{a}$ |

$^{a,b}$ *Means in a row with different superscripts are significantly different ($p < 0.05$)*

Data on the relative weights of digestive tract and the height of duodenal villi are presented in Table 4. The relative weights of proventriculus, gizzard, intestine, duodenum and cecum were lower in the birds fed *Salvinia molesta* meal than in control. The same condition was observed for the relative lengths of proventriculus, intestine, duodenum, ileum and cecum. Since the data of the gastrointestinal size were presented as relative to the final body weight, the lower measurements of the gastrointestinal tract of the treated chickens seemed to be associated with the much greater final body weight of the treated chickens than that of the control (Table 5). Note that feeding *Salvinia molesta* meal increased the absolute weight of the small intestine of birds in the present study (the absolute weights of small intestine of the chickens fed *Salvinia molesta* meal of 0, 6, 12 and 18% were 18.51, 24.53, 27.10 and 25.51 g, respectively).

In this present study, the duodenal villi was higher in the birds fed *Salvinia molesta* than in control. The improved morphology of villi was most likely attributed to the higher fiber content of *Salvinia molesta* than of control, as de Vries (2015) and Alvarez et al (2007) reported that villi tended to increase with the increased content of fiber in the diets. The improved morphology of villi eventually results in expanded surface area for the nutrient absorption which is beneficial for the chickens (Lenhardt and Mozes 2003; Sarikhan et al 2010).

**Table 4.** Relative measurement of the gastrointestinal tract of Kampong-crossbreed chickens

| Items | *Salvinia molesta* | | | |
|---|---|---|---|---|
| | 0% | 6% | 12% | 18% |
| **Relative weights** | | | | |
| Proventriculus (%) | $3.63^{a}$ | $2.80^{a}$ | $2.83^{bc}$ | $2.68^{c}$ |
| Intestine (%) | $3.63^{a}$ | $2.80^{b}$ | $2.83^{b}$ | $2.68^{b}$ |
| Gizzard (%) | $4.04^{a}$ | $3.22^{a}$ | $3.06^{b}$ | $3.13^{ab}$ |
| Duodenum (%) | $1.15^{A}$ | $0.69^{B}$ | $0.73^{B}$ | $0.70^{B}$ |
| Jejunum (%) | 1.27 | 1.14 | 1.16 | 1.18 |
| Ileum (%) | 1.21 | 0.97 | 0.95 | 0.80 |
| Cecum (%) | $1.01^{A}$ | $0.66^{B}$ | $0.58^{B}$ | $0.55^{B}$ |
| Large intestine (%) | 0.38 | 0.30 | 0.30 | 0.31 |
| Pancreas (%) | 0.38 | 0.40 | 0.37 | 0.37 |
| **Relative lengths** | | | | |
| Proventriculus (cm/100gBW) | $0.89^{A}$ | $0.60^{B}$ | $0.50^{B}$ | $0.56^{B}$ |
| Intestine (cm/100 g BW) | $25.3^{A}$ | $17.5^{B}$ | $13.4^{B}$ | $15.2^{B}$ |
| Duodenum (cm/100 g BW) | 6.17 | 7.38 | 9.64 | 6.17 |
| Jejunum (cm/100 g BW) | $9.62^{A}$ | $6.76^{B}$ | $5.10^{B}$ | $6.17^{B}$ |
| Ileum (cm/100 g BW) | $5.16^{A}$ | $3.78^{B}$ | $3.04^{B}$ | $3.30^{B}$ |
| Cecum (cm/100 g BW) | 1.70 | 3.17 | 0.96 | 1.09 |
| **Duodenal villi** | | | | |
| Diameter (µm) | 259 | 248 | 287 | 272 |
| Height (µm) | $52.4^{B}$ | $47.9^{B}$ | $57.1^{B}$ | $78.4^{A}$ |

$^{A,B}$ *Means in a row with different superscripts are significantly different ($p<0.01$)*

$^{a,b,c}$ *Means in a row with different superscripts are significantly different ($p<0.05$)*

Taken together, the increased height of intestinal villi and the reduced relative size of gastrointestinal tract (which may reduce the energy need for maintenances and thus save the energy for growth) eventually result in improved growth performance of the chickens. Indeed, the growth performance and FCR were better in the chickens fed *Salvinia molesta* meal than in control. Moreover, feeding *Salvinia molesta* meal resulted in lower feed cost per gain (Table 5). In the present study, dietary inclusion of *Salvinia molesta* reduced the use of soybean meal, which had much higher price compared to *Salvinia molesta*, in the rations of Kampong-crossbreed chicken. This consequently lowered the price of feed per kilogramme. Overall, the improved growth performance of chickens (with feeding *Salvinia molesta*) and the lowered feed price per kilogramme may simultaneously lowered the feed cost per gain of Kampong-crossbreed chickens in the current study.

**Table 5.** Final body weight and feed cost of Kampong-crossbreed chickens

| Items | *Salvinia molesta* | | | |
|---|---|---|---|---|
| | **0%** | **6%** | **12%** | **18%** |
| Final body weight (g/bird) | $511^{B}$ | $876^{A}$ | $960^{A}$ | $952^{A}$ |
| Feed cost (IDR/kg feed) | 17,977 | 16,261 | 15,520 | 14,816 |
| Feed cost/gain (IDR/kg body weight) | $35{,}152^{a}$ | $18{,}565^{b}$ | $16{,}171^{b}$ | $15{,}569^{b}$ |

*$^{A,B}$ Means in a row with different superscripts are significantly different ($p<0.01$)*

*$^{a,b}$ Means in a row with different superscripts are significantly different ($p<0.05$)*

*IDR: Indonesian rupiah (Indonesian currency)*

## Conclusion

- The use of *Salvinia molesta* as a feed ingredient improved nutrient digestibility, the duodenal villi and growth performance of the chickens.

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