TÜBİTAK

Turkish Journal of Veterinary and Animal Sciences

http://journals.tubitak.gov.tr/veterinary/

Research Article

Turk J Vet Anim Sci
(2015) 39: 668-675

doi:10.3906/vet-1411-52

Effects of duck feed supplemented with invasive giant salvinia (*Salvinia molesta*) on duck meat characteristics

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Received: 26.11.2014 • **Accepted/Published Online:** 03.08.2015 • **Printed:** 31.12.2015

Abstract: The present work was designed to study the potency of *Salvinia molesta* (SM) as feedstuff influencing meat characteristics in ducks for the first time. Therefore, the study aimed to evaluate the effects of fermented (FSM) and nonfermented (NFSM) SM powder as a duck feed supplement on the lipid composition (fat, total cholesterol, LDL, and HDL levels) and fatty acid profile of duck meat, as well as its protein and water content. This study included eighty 4-week-old ducks, which were assigned at random to 2 groups based on treatment: basal diets (control) and supplementation with SM (15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM). The results indicated that SM significantly decreased the levels of total cholesterol and LDL of the duck meat while the HDL level significantly increased ($P < 0.05$). On the other hand, there was no change in the protein and water content of the duck meat because of SM supplementation. Furthermore, the levels of all fatty acids' composition except linolenic acid were significantly different between the control (basal diet) and treatment (SM diets) groups. Thus, SM, an invasive plant, can be used as a new dietary source of fatty acids for the production of healthy duck meat.

Key words: *Salvinia molesta*, fat, fatty acid, protein, duck, meat

1. Introduction

An increasing population combined with rising per capita incomes has drawn attention toward nutritional adequacy. A potential fulfilment of nutritional needs stems from poultry products. Demand for poultry products continues to increase, as the meat is an indispensable protein source (1). Furthermore, the demand for duck meat as a protein source has recently shown an upward trend (2). According to the USDA Nutritional Database, the protein and cholesterol contents of duck meat are higher than those of chicken meat (3). This has led people to avoid duck meat consumption based on the belief that it raises blood cholesterol levels, which may cause some chronic diseases.

Moreover, concern over excessive calorie and fat intake is a very legitimate one, and making intelligent food choices is essential to everyone's good health. These findings have encouraged investigations into reducing the cholesterol level of duck meat and improving its fat composition and overall appearance, so that its quality can provide more benefits for human health.

One approach to improving the fat composition of meat is feed supplementation. However, the problems associated with feed often become obstacles in duck cultivation in local poultry industry. Furthermore, on an intensive farm, feed costs can reach up to 60%–70% of the total production cost (1,4). Therefore, an alternative feedstuff that does not compete with resources for human needs is required, and it must also be cheap. In addition, the material must also be abundant, so that its existence and production continuity are maintained.

Based on these requirements, one species of water fern, namely invasive giant salvinia or *Salvinia molesta* (SM), is a suitable feed alternative. A previous study demonstrated that SM is a good source of minerals and essential amino acids in feedstuff for pigs (5). However, its digestible energy and protein content are low due to the crude fiber content of SM being high. Consequently, such conditions can restrict pig production. Fermentation using *Aspergillus niger* (AN) is required to decrease the crude fiber content and optimize application of SM as a feedstuff (6).

Thus, the present work was designed to study the potency of fermented and nonfermented *Salvinia molesta* (FSM and NFSM) as feedstuff that influences meat characteristics in ducks for the first time. The study aimed to evaluate the effects of FSM and NFSM powder at various percentages as a duck feed supplement on the lipid composition (fat, total cholesterol, LDL, and HDL levels) and fatty acid profile of duck meat as well as its

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protein and water content. Through this study, we have the great expectation to utilize invasive or waste plants, thus indirectly contributing to overcoming health problems associated with certain meat products.

2. Materials and methods

2.1. Preparation of animals and diet

The study was carried out at the Faculty of Animal and Agricultural Sciences, Diponegoro University, according to the guidelines for applied nutrition experiments in poultry (7). Starter and finisher periods of eighty 4-week-old Indian Runner ducks with an average body weight of 734.25 ± 0.52 g were chosen for this study. They were fed with FSM and NFSM, which were used as isocaloric and isonitrogenous supplements (Tables 1 and 2). SM was collected from Rawa Pening Lake, Central Java, Indonesia (Table 3). After removal of its roots, SM was dried under sunlight and powdered. Fermentation was performed aerobically by using AN with a SM:AN ratio of 1000:8, which was mixed with 584.4 g warm mineral water. The mixed formula was spread on a tray, covered with thin paper, and incubated for 1 week.

The animals were housed in groups under standard conditions in a 20-unit postal cage with 4 individuals per unit. At 4–5 weeks of age, the ducks were fed 3 times per day ad libitum with 2900 kcal of metabolic energy and 22% crude protein. At 5–12 weeks of age, the ducks were fed with 52,900 kcal metabolic energy and 20% crude protein; their fattening duration was 49 days. Body weight was measured once a week. Individuals were chosen for the experiment by a completely randomized design with 5 treatment groups and 4 replicates: T_0 (basal diet), T_1 (15% NFSM), T_2 (15% FSM), T_3 (17.5% FSM), T_4 (20% FSM).

Table 1. Ingredients and composition of the experimental diets during the starter period.

Feed stuff	*Salvinia molesta* (% of diet)				
	T_0	T_1	T_2	T_3	T_4
Corn	53.60	48.10	47.50	45.60	44.90
Salvinia	0.00	15.00	0.00	0.00	0.00
Fermented salvinia	0.00	0.00	15.00	17.50	20.00
Soybean meal	22.80	20.40	19.60	19.10	18.60
Oil	0.60	1.00	0.70	1.00	1.00
Bran	13.90	7.00	9.10	8.60	7.50
Fish meal	7.00	7.00	6.80	6.80	6.80
Lime	0.60	0.40	0.30	0.30	0.20
Premix	0.60	0.30	0.30	0.30	0.30
Methionine	0.40	0.30	0.30	0.30	0.30
Lysine	0.50	0.50	0.40	0.50	0.40
Total	100.00	100.00	100.00	100.00	100.00
Nutrition content					
Energy metabolism	2922.96	2904.27	2900.42	2900.139	2900.6
Crude protein	22.09	22.02	22.03	22.01	22.03
Crude fat	4.40	4.15	4.18	4.41	4.35
Crude fiber	5.67	8.70	8.55	9.11	9.11
Methionine	0.76	0.66	0.65	0.65	0.64
Lysine	1.43	1.39	1.28	1.36	1.26
Arginine	0.54	1.28	1.27	1.25	1.23
Ca (%)	1.20	1.15	1.27	1.34	1.34
P (%)	0.76	0.72	0.70	0.70	0.68

T_0–T_4: Treatment with FSM/NFSM.
T_0: basal diet.
T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively.
Energy metabolism (EM) was measured based on the Balton formula.
Nitrogen free extract = 100 – (% water + % ash + % crude protein + % crude fat + % crude fiber).
Energy metabolism (EM) = 40.81 {0.87 (crude protein + 2.25 crude fat + nitrogen free extract + 4.9}.

Table 2. Ingredients and composition of the experimental diets during the finisher period.

Feed stuff	*Salvinia molesta* (% of diet)				
	T_0	T_1	T_2	T_3	T_4
Corn	54.70	51.10	52.20	50.00	49.00
Salvinia	0.00	15.00	0.00	0.00	0.00
Fermented salvinia	0.00	0.00	15.00	17.50	20.00
Soybean meal	20.00	18.50	17.50	16.80	16.40
Oil	1.00	0.70	0.50	0.50	0.60
Bran	15.00	8.50	8.50	9.30	8.10
Fish meal	5.50	4.50	4.50	4.50	4.50
Lime	1.00	0.50	0.50	0.30	0.30
Premix	1.50	0.30	0.40	0.30	0.30
Methionine	0.40	0.30	0.30	0.30	0.30
Lysine	0.90	0.60	0.60	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Nutrition content					
Energy metabolism	2903.25	2900.00	2914.10	2900.17	2900.16
Crude protein	20.03	20.04	20.02	20.00	20.04
Crude fat	4.80	3.92	3.96	3.98	4.00
Crude fiber	5.73	8.84	8.13	9.04	9.41
Methionine	0.72	0.61	0.60	0.60	0.60
Lysine	1.69	1.39	1.36	1.27	1.26
Arginine	1.28	1.18	1.16	1.14	1.13
Ca (%)	1.48	1.06	1.29	1.16	1.22
P (%)	0.70	0.65	0.61	0.62	0.61

T_0–T_4: Treatment with FSM/NFSM.
T_0: basal diet.
T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively.
Energy metabolism (EM) was measured based on the Balton formula.
Nitrogen free extract = 100 – (% water + % ash + % crude protein + % crude fat + % crude fiber).
Energy metabolism (EM) = 40.81 {0.87 (crude protein + 2.25 crude fat + nitrogen free extract + 4.9}.

Table 3. Fatty acid composition of *Salvinia molesta*.

Fatty acid	Level content (%)
Lauric	0.71
Myristic	0.92
Palmitic	33.75
Palmitoleic	2.13
Stearic	4.42
Oleic	10.54
Linoleic	1.96
Linolenic	3.69

2.2. Measured traits

Duck mortality was zero during the test. At day 49, prior to slaughtering, the ducks were weighed, deprived of feed for 6 h, and then slaughtered in a commercial slaughterhouse. The carcasses were prepared by removing the skin, feet, reproductive organs, and digestive tract (8). Leg meat was collected 24 h postmortem from the carcass and immediately frozen at –20 °C until analyzed.

2.3. Analytical determination

Duck meat protein content was analyzed by the Kjeldahl method (9). Briefly, a meat sample (5 g) was suspended in distilled water. The sample suspension was poured into a Kjeldahl flask, then augmented by 3 g of CuSO4/K2SO4 mixture (1:9; w/w) and 20 mL of concentrated H_2SO_4. The

Kjeldahl flask was heated until the solution color became white, and then it was cooled. Before the distillation step, 3 drops of indicator phenolphthalein were added to the sample solution. Distillate was created by adding 50 mL of 2% boric acid solution, 5 drops of Tashiro indicator, and NaOH until the solution became alkaline. The sample was titrated by 0.1 N HCl until the sample solution became pink.

Water content was analyzed by thermogravimetric methods. Porcelain cups that were coded according to the sample were prepared and then oven-dried at 100–105 °C for approximately 1 h. They were then moved into a desiccator for 15 min and then weighed. A duck meat sample of 1–2 g was weighed in a porcelain cup of known weight, then oven-dried at 100–105 °C for 4–6 h. Subsequently, if a constant weight was not reached after one additional hour, the sample was reinserted into the oven for an additional hour and weighed again. This was repeated until a constant weight was reached. Weight was considered constant if the difference did not exceed 0.2 mg. After constant weight was reached, water content was calculated.

Fat content was determined by the Soxhlet method (9). Filter paper (11.7 × 14.5 cm) was oven-dried at 100–105 °C for 1 h and then cooled in a desiccator for 15 min, after which the filter paper was weighed. A sample was weighed and placed in the middle of the filter paper, which was then folded. The samples in filter paper were oven-dried at 100–105 °C for 4–6 h, weighed, and then repeatedly dried until a constant weight was found, as described above. After a constant weight was found, the sample was placed in the desiccator for 15 min and then weighed. The sample was then inserted into the Soxhlet apparatus with fat solvents of as much as approximately 2.5–3 times the volume of the extraction flask. This process was carried out for approximately 6 h. After 6 h, the samples were removed from the apparatus and aerated for approximately 30 min in the open air, reinserted into the oven for approximately 1 h, placed in a desiccator for 15 min, and then weighed again. The weight was considered constant when the difference did not exceed 0.2 mg.

Cholesterol content was measured by a modified saponification process (10). Approximately 2 g of each sample was saponified with 4 mL of 50% potassium hydroxide and 6 mL of 95% ethanol. Saponified samples were heated at 40 °C until complete solubilization, and then heated for 10 min at 60 °C. After 5 mL of water was added, the samples were cooled. The nonsaponifiable fraction was extracted 3 times using 10 mL of hexane. Aliquots of hexane extracts (3 mL) were dried under a nitrogen flow. After saponification, samples were analyzed using enzymatic methods (11). The extract was diluted in 0.2 mL of isopropyl alcohol and analyzed with an enzymatic kit (Merck Diagnostica, Darmstadt, Germany).

Concentrations of LDL and HDL were analyzed by enzymatic methods (11). For sample precipitation, a 25-µL meat extract was added to 250 µL of 500 LDL or 250 HDL precipitating solution until homogeneous. After incubation at room temperature for 15 min, the precipitating solution was centrifuged (12,000 rpm for 2 min). One hundred microliters of the formed supernatant, blank, and standard solution was added into 1000 µL of cholesterol reagent until homogeneous. Absorbance was measured by using a spectrophotometer at 540 nm (Microlab 300, Merck, Germany) after incubation at room temperature for 10 min. Concentration of cholesterol in the supernatant was determined by dividing sample absorbent by standard absorbent; the result was then multiplied with the concentration of the standard solution (200 mg/dL). Concentration of LDL or HDL was determined by total cholesterol concentration minus supernatant cholesterol concentration resulting from the precipitation process.

Fatty acid composition analysis consisted of 3 steps: lipid extraction, total lipid determination, and fatty acid identification. The lipids were extracted with a chloroform:methanol mixture (2:1, by 200 mL) (12). Four 10-mL aliquots were stored for the next steps. The total lipid content was determined gravimetrically on an analytical scale (Marte, at a precision of 0.001 g). Aliquots of the lipid extract were esterified with BF3-methanol (13). The fatty acid composition of each aliquot was determined by gas chromatography in a 60-mL fused capillary column with an internal diameter of 0.20 mm (CP Sil 88). The analysis was performed on a Hewlett-Packard 6890 gas chromatograph equipped with a flame ionization detector. Helium was used as the carrier gas and nitrogen as the make-up gas. The injection port temperature was 200 °C and the detector temperature was 250 °C. Oven temperature was ramped up to 150 °C for 3 min and increased to 160 °C at 1.5 °C/min; it was then held at 160 °C for 3 min, increased to 190 °C at 1.5 °C/min, and held at 190 °C for 1 min. Finally, temperature was increased to 220 °C at 1 °C/min. A Hewlett-Packard computing integrator calculated retention times and peak area percentages. Fatty acids were identified by comparing sample retention times with standard retention times (36 saturated, monounsaturated, and polyunsaturated fatty acid standards; Sigma and PolyScience, USA). Quantification was carried out by normalization and transformation of the area percentage to milligrams per 100 g of edible portion, using a lipid conversion factor (14).

2.4. Statistical analysis

One-way ANOVA was used to identify the difference levels of SM for some indicated parameters. For group differences,

post hoc multiple comparison Duncan multiple range tests were used. Statistical analyses were performed using SPSS for Windows. $P < 0.05$ was considered statically significant (15).

3. Results

3.1. Water and protein content

Feed supplementation by NFSM (T_1) and different levels of FSM (T_2, T_3, and T_4), in comparison with the control (T_0 basal diet), showed no significant differences in water and protein content of the duck meat (Figure 1).

3.2. Fat profile

The SM-supplemented feed group showed variations in the meat fat profile (Figure 2). NFSM (T_1)-supplemented feed significantly increased meat fat levels compared with control-basal diet (T_0); with FSM-supplementation, there was only 17.5% (T_3) significantly elevated meat fat content compared with the control (T_1). In contrast, NFSM (T_1) and FSM (T_2, T_3, and T_4) supplementation significantly decreased meat cholesterol and LDL levels compared with control-basal diet (T_0). Furthermore, there were no significant differences in meat HDL levels between NFSM

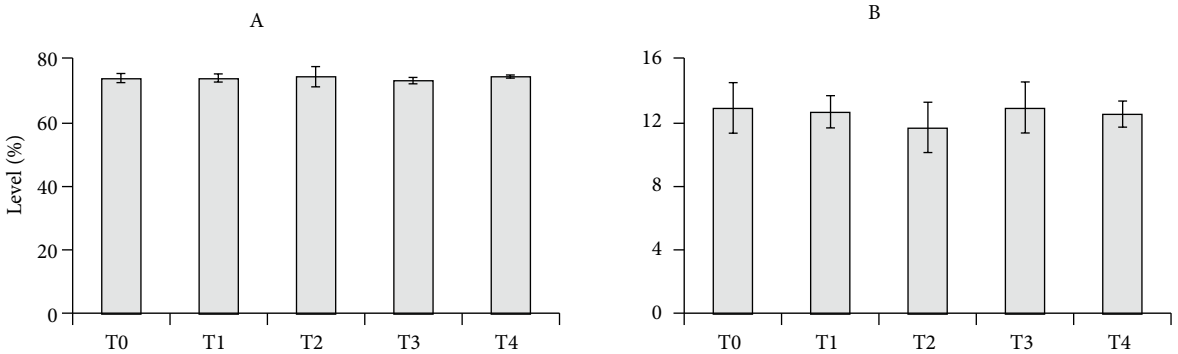

Figure 1. Level of water (A) and protein (B) content in the meat of ducks with experimental diets. T_0: basal diet; T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively.
Water and protein content were expressed as %. Data are mean ± SD of 4 replicate analyses. *: $P < 0.05$ versus the control group (T_0).

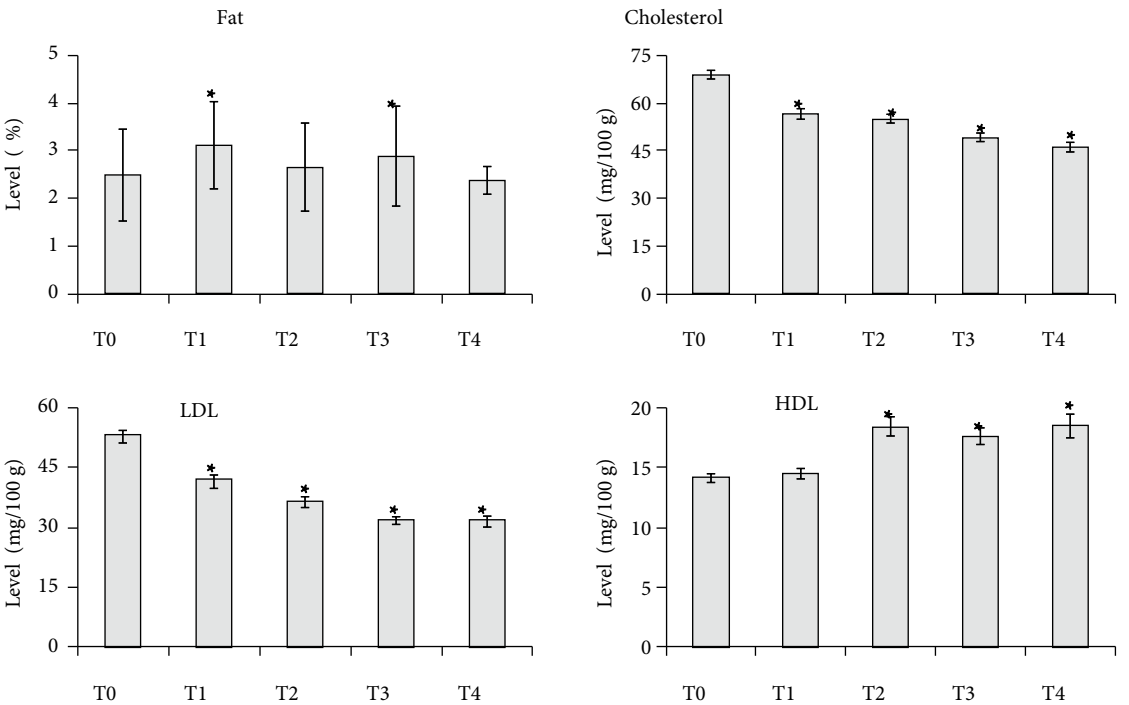

Figure 2. Meat fat profile of ducks with experimental diets. T_0: basal diet; T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively. Fat content was expressed as % while cholesterol, LDL, and HDL content were expressed as mg/100 g. Data are mean ± SD of 4 replicate analyses. *: $P < 0.05$ versus the control group (T_0).

(T_1) supplementation and basal diet (T_0), while FSM (T_2, T_3, and T_4) supplementation significantly increased meat HDL levels.

3.3. Fatty acids profile

The effect of SM-supplemented feed at the indicated concentrations showed variation in the fatty acid profile of duck meat (Figure 3). Among the 7 fatty acids, only linolenic acid was not affected by SM supplementation (T_1 to T_4) compared with the basal diet (T_0). Palmitic, stearic, palmitoleic, and oleic acid contents were significantly increased by NFSM or FSM supplementation. Myristic acid content was also significantly increased in 15% SM supplementation (T_1 and T_2), while linoleic acid content was significantly increased in 17.5% and 20% FSM (T_3 and T_4).

4. Discussion

This study reveals for the first time the potency of SM as feedstuff in influencing meat characteristics in ducks by demonstrating the effects of different percentages of FSM and NFSM as feed supplement in duck diet on the fat profile (fat, total cholesterol, LDL, and HDL levels) and fatty-acid profile of duck meat, as well as its protein and water content. Supplementation of SM in duck feed showed no effect on water and protein content of duck meat, nor on body weight and feed/gain ratio of the growing ducks (Figure 1; Tables 4 and 5), indicating that SM powder is a potential natural source for supplementation or substitution in duck feed. Some reports have mentioned that duck meat is more delicious than chicken meat due to its higher protein content (16).

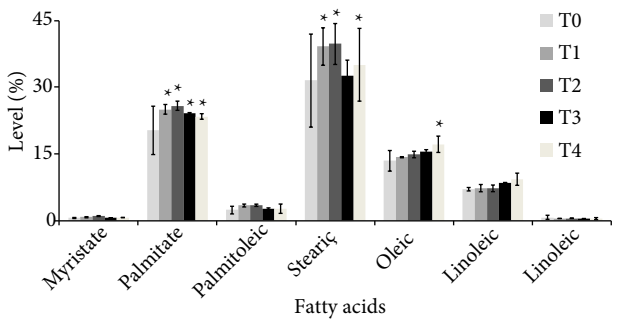

Figure 3. Meat fatty acid profile of ducks with experimental diets. T_0: basal diet; T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively. Fatty acid contents were expressed as %. Data are mean ± SD of 4 replicate analyses. *: $P < 0.05$ versus the control group (T_0).

The tenderness of duck meat, which is due to its fat content, has been prized by consumers. However, this also raises concern for consumers to avoid duck meat based on the belief that it can increase blood cholesterol, leading to several chronic diseases. Here, we have demonstrated that SM supplementation, compared with a basal diet (control group), can significantly reduce the cholesterol levels in duck meat, although it has no effect on the fat levels (Figure 2). Furthermore, LDL levels significantly decreased while HDL levels increased through SM treatment (Figure 2). These data suggest that an increase in fat content of the meat was not an adverse effect of SM supplementation because it has been proven to suppress the cholesterol level of meat to the ideal ratio between LDL and HDL levels. LDL-cholesterol is considered detrimental because it contributes to several degenerative diseases such as hypercholesterolemia, heart attack, and atherosclerosis (17). In contrast, HDL cholesterol is considered beneficial cholesterol because it helps remove LDL cholesterol from the arteries. Experts believe that HDL acts as a scavenger, carrying LDL cholesterol away from the arteries and back to the liver, where it is broken down and passed from the body (18). One-fourth to one-third of the total blood cholesterol is carried by HDL. A healthy level of HDL cholesterol may also protect against heart attack and stroke, while low levels of HDL cholesterol have been shown to increase the risk of heart disease.

In addition, this study also delineated the fatty acid profile of meat that resulted from SM supplementation in

Table 4. Performance (means ± SD) of growing ducks fed experimental diets.

Parameter	FSM and NFSM (% of diet)				
	T_0	T_1	T_2	T_3	T_4
Total weight gain (g)	779.19 ± 59.20	864.50 ± 57.55	868.88 ± 71.36	811.88 ± 65.89	862.27 ± 64.38
Feed/gain ratio (g/g)	7.03 ± 0.52	6.33 ± 0.40	6.30 ± 0.53	6.74 ± 0.52	6.35 ± 0.50

FSM: Fermented *Salvinia molesta.*
NFSM: Nonfermented *Salvinia molesta.*
T_0–T_4: Treatment with FSM/NFSM.
T_0: basal diet.
T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively.

Table 5. Meat chemical characteristics (means ± SD) of ducks fed experimental diets.

Parameter	FSM and NFSM (% of diet)				
	T_0	T_1	T_2	T_3	T_4
Water (%)	73.93 ± 1.43	73.95 ± 1.27	74.35 ± 3.17	73.13 ± 1.00	74.40 ± 0.48
Protein (%)	12.92 ± 1.58	12.67 ± 1.00	11.70 ± 1.57	12.94 ± 1.59	12.53 ± 0.81
Fat (%)	02.49 ± 0.96	03.12 ± 0.91	02.66 ± 0.92	02.89 ± 1.04	02.38 ± 0.28
Cholesterol (mg/100 g)	68.9 ± 1.35^a	56.59 ± 1.66^b	55.10 ± 1.36^b	49.26 ± 1.34^c	46.16 ± 1.50^c
LDL (mg/100 g)	53.30 ± 2.15^a	42.11 ± 2.36^b	36.66 ± 1.72^c	31.64 ± 0.94^d	31.78 ± 1.74^d
HDL (mg/100 g)	14.11 ± 0.36^b	14.48 ± 0.43^b	18.44 ± 0.80^a	17.62 ± 0.69^a	18.47 ± 0.98^a

$^{a, b, c, d}$: Means in the same row with different superscripts differ significantly ($P < 0.05$) according to Duncan's multiple range test.
FSM: Fermented *Salvinia molesta;* NFSM: Nonfermented *Salvinia molesta.*
T_0–T_4: Treatment with FSM/NFSM; T_0: basal diet.
T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively.

the diet (Figure 3). Palmitic, stearic, palmitoleic, and oleic acids significantly increased in all treatment levels of SM compared with control. Myristic acid also was significantly enhanced by SM treatment at 15% of SM tested (T_1 and T_2). Only with the high treatment levels of FSM (T_3 and T_4) was linoleic acid significantly increased. Myristic acid is a common fatty acid that is found in animal fats. As a saturated fatty acid, this has been considered a negative dietary factor, known to raise cholesterol levels. Although in this study myristic acid was significantly increased, at the higher level of SM (T_3 and T_4), supplementation showed no significant effect on this fatty acid. Palmitic acid is also one of many saturated fatty acids that occur naturally in various animal derivatives. Supplementation of SM showed significant effect on this fatty acid as well as on stearic acid, another saturated fatty acid, in this study (Figure 3; Table 6). In biology, palmitic acid plays a role in some modified proteins by the addition of a palmitoyl group in a process known as palmitoylation, which is important for membrane localization of many proteins (19). Meanwhile, based on clinical studies, stearic acid has been found to be associated with lowered LDL in comparison with other saturated fatty acids (20). This may indicate that this fatty acid is healthier than other saturated fatty acids. An increase of unsaturated fatty acids such as palmitoleic, oleic, and linoleic acids in this study (Figure 3; Table 6) was thought to lower LDL and raise HDL (20,21). In this study, the increased levels of fat in the meat of ducks supplemented with SM

Table 6. Meat fatty acid profiles (means ± SD) of ducks fed experimental diets.

Fatty acid	FSM and NFSM (% of diet)				
	T_0	T_1	T_2	T_3	T_4
Saturated fatty acid					
Myristic (%)	00.62 ± 0.09^c	00.81 ± 0.11^b	01.07 ± 0.10^a	00.61 ± 0.03^c	00.73 ± 0.06^{bc}
Palmitic (%)	16.09 ± 0.82^d	25.29 ± 0.88^{ab}	26.15 ± 0.91^a	24.30 ± 0.34^{bc}	23.33 ± 0.48^c
Stearic (%)	24.22 ± 0.84^c	40.88 ± 1.09^a	42.19 ± 1.82^a	33.04 ± 2.65^b	40.41 ± 0.99^a
Unsaturated fatty acid					
Palmitoleic (%)	01.77 ± 0.21^c	03.45 ± 0.24^a	03.42 ± 0.20^a	02.55 ± 0.21^b	02.72 ± 0.75^{ab}
Oleic (%)	10.97 ± 0.80^c	14.58 ± 0.55^b	15.26 ± 0.83^b	15.75 ± 0.53^b	17.42 ± 1.36^a
Linoleic (%)	06.66 ± 0.31^b	07.18 ± 0.63^b	07.37 ± 0.56^b	08.73 ± 0.33^a	09.51 ± 1.02^a
Linolenic (%)	00.56 ± 0.19	00.56 ± 0.10	00.55 ± 0.03	00.46 ± 0.06	00.74 ± 0.10

$^{a, b, c, d}$: Means in the same row with different superscripts differ significantly ($P < 0.05$) according to Duncan's multiple range test.
FSM: Fermented *Salvinia molesta;* NFSM: Nonfermented *Salvinia molesta.*
T_0–T_4: Treatment with FSM/NFSM; T_0: basal diet.
T_1, T_2, T_3, and T_4: 15% NFSM, 15% FSM, 17.5% FSM, and 20% FSM, respectively.

powder are associated predominantly with higher levels of myristic, palmitic, and stearic acids (saturated fatty acid) and palmitoleic, oleic, and linoleic acids (unsaturated fatty acid) compared to the other fatty acid profiles analyzed, indicating its ability to reduce levels of total cholesterol in duck meat (Figure 2; Table 5).

The invasive SM plant effectively improved the quality of duck meat by increasing the levels of oleic acid and HDL, while concurrently suppressing the levels of total cholesterol and LDL. Thus, SM can become a prospective feedstuff for livestock in order to yield good quality of animal products, and especially healthy duck meat.

Acknowledgment

This project was supported by the Indonesian General Directorate of High Education through the Master Plan of the Acceleration and Extension of Indonesian Economic Development research grant program.

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