JAZ INDIA

Journal of Advanced Zoology

ISSN: 0253-7214
Volume 44 Issue 04 Year 2023 Page 384:393

The Effect of Fermented *Black Soldier Fly* (BSF) Addition in Feed on Performance and Digestive Tract Characteristics of Native Chicken

Bainati Nurjannah, Sri Purwanti, Wempie Pakiding

Animal Science and Technology, Faculty of Animal Science, Hasanuddin University, Jl. Perintis Kemerdekaan No.KM.10, Tamalanrea Indah, Kec. Tamalanrea, Kota Makassar, Sulawesi Selatan, Indonesia

Corresponding Author: Sri Purwanti

**Corresponding author's E-mail: sripurwanti@unhas.ac.id*

Article History

Received: 26 June 2023
Revised: 12 Sept 2023
Accepted: 18 Nov 2023

Abstract

Enhancement amount population and level production native chicken superior need offset with enhancement availability feed for rapid growth and productivity tall needed enough feed contain substance food needed, good in a manner quality nor quantity. Black soldier fly (BSF) maggot flour is one of the feed ingredients that is quite good as a potential raw material for poultry feed, because it contains quite high maggot protein, namely 40-50%. The research design used was a completely randomized design (CRD) consisting of 5 treatments and 4 replications. The treatments applied were P0 (100% commercial feed); P1 (100% basal feed); P2 (85% basal feed + 15% BSF fermented); P3 (80% basal feed + 20% BSF fermented), and P4 (75% basal feed + 25% BSF fermented). The Research results show that treatment combination of basal feed with the addition of BSF fermentation influential real (P<0.05) to percentage combination treatment of basal feed with the addition of BSF fermentation, increase body weight, conversion feed and no influential real to drinking water consumption, small intestine morphometric and small intestine histology native chicken. This study concludes that the addition of BSF fermented in the feed up to 20% level able to improve the performance of native chickens in the starter phase.

Keywords: ***Native chicken, Fermentation, Black soldier fly, Small intestine morphometrics and Small intestine Histology***

1. Introduction

The increase in population has a big influence on increasing national food, especially animal protein sources. One animal protein that is widely consumed by Indonesian people is native chicken meat. Native chicken meat is one of the suppliers of animal protein. Based on data from the Central Statistics Agency for 2008-2020, consumption of native chicken meat has increased every year. In 2018 consumption of native chicken meat was 287156.48 kg/capita/year, in 2019 consumption of native chicken meat was 292329.20 kg/capita/year and in 2020 consumption of native chicken meat was 293139.53 kg/capita/year.

The increase in population size and production levels of superior native chickens needs to be balanced with an increase in feed availability. For fast growth and high productivity, feed is needed that contains enough of the required nutrients, both in quality and quantity. One of them is by providing feed that has a high protein content in the ration to maximize the performance of the digestive system in superior native chicken.

Feeding is the largest component of production costs in a poultry farming business, namely 60-70%, thus production costs must be reduced in terms of efficient use of feed. Efforts to overcome this are by using alternative feed ingredients as sources of protein. One of the feed ingredients that is available and has not been fully utilized in rations, especially poultry rations, is *Black Soldier Fly* (BSF).

There are several feed ingredients that are good enough to be used as potential raw materials for poultry feed, one of which is Black soldier fly (BSF) maggot flour. The protein content obtained by maggots is quite high, namely 40-50%. This data is the main consideration for making maggots a source of protein in feed (Muslim, 2019). The advantage of maggots as a feed ingredient is that the protein content is quite high, but the fat and fiber content exceeds the needs of native chickens. The high nutritional content contained in maggots is the crude protein potential of around 41-42% (Fauzi and Sari, 2018). However, the crude fiber content is quite high (exceeding the standard requirements for poultry livestock), namely 8.53% and crude fat around 27.30% (Wahyudi et al., 2020) so that a fermentation process can be carried out as an effort to improve the quality of BSF maggot flour. *Black Soldier Fly* (BSF) cannot be utilized optimally as a chicken feed ingredient due to the presence of the anti-nutrient chitin on the outside of its body (Marganov, 2003) so that a fermentation process can be carried out using the Trichoderma viride fungus as an effort to improve the quality of BSF maggot flour.

BSF fermentation technology is carried out to increase the nutritional value of local feed ingredients, for example using the Trichoderma viride fungus. Previous research on the use of BSF, Auza et al (2021) reported that up to 11.25% maggot flour in the diet could increase the relative length of the intestine, the histomorphology of the small intestine villi, and the percentage of carcass parts, with a significant effect on the weight percentage of the heart and small intestine. Veldkamp and Bosch (2015) stated that the amino acid profile contained in BSF flour is similar to soybean flour, in particular the alanine content is an essential amino acid for the resistance and growth system of native chickens. Based on the results of previous research, it was limited to providing flour, providing it with fermentation processing is very necessary to overcome chitin which reduces the level of digestibility. The specific aim of this research was to examine the effect of adding fermented BSF to feed on the performance and characteristics of the digestive tract of native chickens

2. Methods

Production Laboratory Experiment Cage, Faculty of Animal Husbandry, Hasanuddin University, Makassar. Histological and morphometric observations of the small intestine were carried out at the Maros Veterinary Center. The tools used in this research were scales, feed and drink containers, stationery, basins, shovels, feed stirrers, measuring cups, chicken feed grinding machines, knives, scissors, gloves, trays, measuring tape, analytical scales, hanging scales, thermometer, hydrometer, hand spray, stirrer, automatic syringe, measuring cup, Zeiss Primo Star microscope, and Optilab camera. The materials used in this research were native chicken, fermented maggot, drinking water, Aspergillus niger microbes, rice, vita stress, corn, bran, cassava, coconut meal, soybean meal, NaCl, Premix, DCP (Dicalium Phospate), CaCo3, L -Lysine, DL-Methionine, 70% alcohol, hanskun, cotton, anticoagulant EDTA (Ethylenediaminetetraacetic Acid), nutrient agar, tissue, disinfectant, label paper, vaccine, formalin, and water. This research used a Completely Randomized Design (CRD) (Steel and Torrie, 1991), consisting of 5 treatments and 4 replications to obtain 20 experimental units, where each experiment consisted of 6 native chickens so that the total number of chickens used was 120 chickens.

The stages in this research are Cage Preparation, Maggot Flour Making, Feed Fermentation Process, Ration Preparation. The composition of the feed used in this research is starter and grower phase feed in the form of conventional feed. starter feed is feed in the form of crumbles consisting of corn, bran, cassava, coconut meal, soybean meal, NaCl, premix, maggot, DCP (Dicalium Phosphate), CaCO3, L-Lysine, and DL-Methionine, while the grower phase feed is in the form of pellets. Rations and drinking water are provided ad libitum from one day of age until 126 days old.

Table 1. Composition of Nutrients in Rations

Feed Ingredients	EM (Kkal/Kg)	PK (%)	LK (%)	SK (%)	LY (%)	METH (%)	P (%)	Ca (%)
Corn	3291.27	9.88	1.79	5.70	0.06	0.18	0.60	0.02
Bran	2730.00	13.40	5.10	11.50	0.42	0.30	2.50	0.2
Onggok	3500.00	1.88	15.62	0.25	0.00	0.00	0.05	0.31
Coconut Meal	1525.00	16.00	15.00	16.00	0.00	0.00	0.75	0.3
Soybean Meal	2191.31	41.24	3.30	3.55	2.95	0.80	1.21	0.27
NaCl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Premix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maggot (*Black soldier fly* (BSF)	3596.4	46.14	21.88	13.1	0.00	0.00	0.934	1.285
CaCO3	0.00	0.00	0.00	0.00	0.00	0.00	0.04	39.00
L-Lysine	0.00	62.00	0.00	0.00	99.00	0.00	0.00	0.00
DL-Methionine	0.00	58.78	0.00	0.00	0.00	99.00	0.00	0.00

Source: Livestock Integrated Biotechnology Laboratory Test Results, 2020

Nutrient requirements for the ration are based on the needs of native chickens in the starter phase, namely 20 - 22% protein with a minimum metabolic energy of 2900 kcal/kg and growers 14 - 15% with a minimum metabolic energy of 2500 kcal/kg (SNI, 2013). The composition of the research ration can be seen in table 2.

Table 2. Composition of feed ingredients and nutritional content of starter phase rations

Feed Ingredients	P1	P2	P3	P4
Corn	49.00	42.00	44.00	40.40
Bran	28.40	11.50	7.00	7.00
Onggok	0.50	8.50	8.00	10.00
Coconut Meal	2.50	8.40	11.40	13.00
Soybean Meal	1.00	11.50	6.00	1.00
Fish flour	16.00	0.00	0.00	0.00
NaCl	0.50	0.50	0.50	0.50
Premix	0.50	1.00	1.50	1.50
Fermented Maggot	0.00	15.00	20.00	25.00
CaCO3	1.00	1.00	1.00	1.00
Lysine	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
Nutrient Composition				
ME (Kcal/Kg)	2924.19	2913.35	2943.87	2990.04
Crude protein (%)	19.22	19.22	19.32	19.51
Crude Fat (%)	3.79	7.59	8.68	10.10
Crude Fiber (%)	6.59	7.46	7.99	8.53
Lysine (%)	0.48	0.71	0.53	0.38
Methionine (%)	0.48	0.50	0.45	0.40
P (%)	1.63	0.89	0.79	0.77
Ca (%)	0.74	0.70	0.75	0.81

The next stages are Intestinal Sample Preparation, Histological Sample Preparation, and Villi Measurement Sample Preparation. The parameters observed were the performance of native chickens, small intestine morphometrics of native chickens. The data obtained was processed using data analysis of variance (ANOVA). Based on the treatment that has a real effect, it is followed by the Orthogonal Contrast Test (Steel and Torrie, 1991). The mathematical model used is Completely Randomized Design (CRD)

3. Results and Discussion

Performance of Native chickens

The results of research on the addition of fermented BSF on the performance of native chickens can be seen in Table 3 below.

Table 3. Effect of Adding Fermented BSF on the Performance of Native chickens

Treatment	Parameter			
	Feed Consumption (g/head/week)	Weight Gain (g/head/week)	*Feed Convertion Ratio*	Drinking Water Consumption (ml/head/week)
P0	174.59±19.36	46.68±4.80	3.75±0.25	353.55±80.57
P1	112.59±6.03	21.34±11.50	6.23±2.40	242.59±54.93
P2	168.29±37.09	49.26±7.68	3.41±0.44	416.57±188.47
P3	171.98±29.58	38.85±10.02	4.56±0.81	354.73±122.11
P4	148.33±42.63	34.81±7.61	4.23±0.74	377.70±340.71

Description: P0: 100% Commercial Feed, P1: 100% Basal Feed, P2: 85% Basal Feed + 15% BSF fermented feed, P3: 80% Basal Feed + 20% BSF fermented feed, and P4: 75% Basal Feed + 25% BSF Fermented Feed.

Feed Consumption

Based on the statistical analysis presented in Table 5, the addition of fermented BSF to feed on native chicken feed consumption showed no significant effect (P>0.05). Feed consumption obtained in this study ranged from 112.59-174.59 g/head/week and tended to be high at P0, namely 174.59 g/head/week.

According to the Ministry of Agriculture (2006) standard feed consumption for native chickens can reach an average of 178.63 g/head/week, while according to Aryanti, et al (2013) standard feed consumption for native chickens can reach an average of 147.42 g/head/week . The statistical analysis presented is based on table 5. Native chicken feed consumption is close to the average standard, namely P0 (174.59 g/head/week), P2 (168.29 g/head/week), P3 (171.98 g/head /week) and P4 (148.33 g/head/week). This research is in line with Marzuki and Rozi (2018) that this condition occurs because chickens are more interested in feed that is in the form of solid granules rather than in the form of flour or mash. So, chickens are more interested in pecking fermented BSF feed in pellet form rather than in flour or mash form.

Apart from being caused by external factors in the feed, consumption levels are also influenced by the protein content of the feed provided. The protein content, namely 47.14%, for each feed treatment in the starter phase is not much different so that there is no significant difference in chicken consumption in that phase. This is in line with Mudarsep et.al (2021) who reported that administering a BSF maggot-based amino acid solution into the feed did not have a significant effect on KUB chicken feed consumption, the main factor influencing the level of feed consumption was the energy content of the feed. The feed energy in this study was given the same for each treatment so that the results showed that the treatment had no real effect on feed consumption.

Weight Gain

The increase in body weight is influenced by the optimal quality and quantity of the ration, the differences in food substances contained in the ration influence the resulting increase in body weight. In line with the opinion of Rasyaf (2006) who states that body weight is influenced by the quality of the ration consumed because the content of food substances is balanced and sufficient to meet the needs required for optimal growth.

Based on the statistical analysis presented in Table 5, the addition of fermented BSF in the feed on the performance of native chickens has a significant effect (P<0.05) on the parameter of body weight gain (PBB) of native chickens, and continued with further orthogonal contrast tests in Table 4.

Table 4. Orthogonal Contrast Advanced Test Effect of adding Fermented BSF on body weight gain of native chickens

Treatment Combination	Significance Value
P0 vs P1	0.001*
P0 vs P2. P3. P4	0.021*
P1 vs P2. P3. P4	0.729
P2 vs P3. P4	0.033*

Note: *) Significant P<0.05

The addition of fermented BSF to the weight gain of native chickens based on statistical analysis ranged from 21.34 – 49.26 g/head/week, which is significant, at P0 vs P1 (100% commercial feed and 100% basal feed), P0 vs P2, P3 , P4 (100% commercial feed, 85% basal feed + 15% BSF fermented feed, 80% basal feed + 20% BSF fermented feed, and 75% basal feed + 25% BSF fermented feed), P2 vs P3, P4 (85 % basal feed + 15% BSF fermented feed, 80% basal feed + 20% BSF fermented feed, and 75% basal feed + 25% BSF fermented feed), while it was not significant P1 vs P2, P3, P4 (100% basal feed , 85% basal feed + 15% BSF fermented feed, 80% basal feed + 20% BSF fermented feed, and 75% basal feed + 25% BSF fermented feed), this is not in line with the opinion of Aryanti, et al (2013) and the Minister of Agriculture (2006) that the average weight gain for native chickens is 69 g/head/week. The weight gain of native chickens in treatments P0 (46.68 g/head/week), P1 (21.34 g/head/week), P2 (49.26 g/head/week), P3 (38.85 g/week). head/week), and P4 (34.81 g/head/week).

According to Rahayu et.al (2021) that the increase in average weight each day or each week depends on environmental conditions, if the temperature is optimal then livestock metabolism will run normally. Wahju (2004) added that apart from feed consumption, factors that also influence body weight gain are the type of chicken, the metabolic energy of the feed, the protein content of the feed and the environmental conditions around the cage. This shows that the feed ingredients used in this study have not been able to meet the daily needs of livestock and production requirements, while the average statistical analysis on feed consumption shows the normal category.

The results obtained are in line with research by Rahayu et.al (2021) which uses 25% BSF and 75% commercial feed for quail, Montesqrit et.al (2020) uses 6% BSF in broiler chicken rations, where each of these studies provides significant influence on the PBB of livestock used. Apart from using different levels, namely P0 (Commercial Feed), P1 (Basal Feed), P2 (85% Basal Feed + 15% BSF fermented feed), P3 (80% Basal Feed + 20% BSF fermented feed) and P4 (75% Basal Feed + 25% BSF Fermented Feed), also caused by different physiological responses from each animal and also environmental conditions that do not support animal metabolism.

Feed Conversion

Feed conversion (FCR) is a method to determine the comparison of the amount of feed consumed during the research with the body weight gain achieved during the research (Jaelani, 2011). Based on the results of the statistical analysis presented in Table 5, the addition of fermented BSF to the feed on the performance of native chickens shows a significant effect (P<0.05) on the feed conversion ratio parameter, so further tests are needed which are presented in Table 5.

Table 5. Further Orthogonal Contrast Test Effect of adding Fermented BSF on the feed conversion ratio (FCR) of native chickens

Treatment Combination	Significance Value
P0 vs P1	0.011*
P0 vs P2. P3. P4	0.195
P1 vs P2. P3. P4	0.492
P2 vs P3. P4	0.201

Note: *) Significant P<0.05

The addition of fermented BSF to the FCR of native chickens based on statistical analysis of P0 vs P1 ranged from 0.011, indicating significance with the FCR of native chickens P1, namely 6.23 g/head/week, at P0 vs P1 (100% commercial feed, and 100% basal feed) , while P0 vs P2, P3, P4 (100% commercial feed, 85% basal feed + 15% BSF fermented feed, 80% basal feed + 20% BSF fermented feed, 75% basal feed + 25% BSF fermented feed), P1 vs P2, P3, P4 (100% basal feed, 85% basal feed + 15% BSF fermented feed, 80% basal feed + 20% BSF fermented feed, 75% basal feed + 25% BSF fermented feed), and P2 vs P3 , P4 (85% basal feed + 15% BSF fermented feed, 80% basal feed + 20% BSF fermented feed, 75% basal feed + 25% BSF fermented feed), it can be seen that the FCR of native chickens reared in this study included in the unfavorable category. In line with Hidayat's (2012) research, the lower the feed conversion value, the more efficient the livestock's ability to digest feed, the less feed needed to achieve weight gain per kilogram.

This is because the composition of the feed ingredients in P0 Vs P1 has the highest corn at 49% of the total composition of the ration among all treatments so that it is very easily digested by livestock because it has a fairly low fiber content. This is supported by Despal (2000) that the digestibility of feed ingredients has a negative relationship with the crude fiber content of the feed ingredients. The lower the crude fiber, the higher the digestibility of the ration. Tillman (2005) states that the digestibility of crude fiber depends on the crude fiber content in the ration and the amount of crude fiber consumed. Crude fiber levels that are too high can interfere with the digestion of other substances. The digestibility of crude fiber is influenced by several factors, including the fiber content in the feed, the composition of crude fiber and the activity of microorganisms (Maynard et al., 2005).

The results obtained in this study are also not in line with the results reported by Wahid et al (2021) that substitution of fish meal and BSF larvae did not show significant results in feed conversion. The level of livestock consumption of the feed provided and the increase in body weight of native chickens which are not significantly different also influence the FCR value of each treatment.

Drinking Water Consumption

Table 5 shows that the addition of fermented BSF to feed had no significant effect (P>0.05) on drinking water consumption. Water consumption obtained in this study ranged from 242.59 – 416.57 ml/head/week. Observation of drinking water consumption showed that P2 with 85% basal feed + 15% BSF fermented feed and P4 with 75% basal feed + 25% BSF fermented feed that had been given consumed more water than treatment P1 with 100% commercial feed. Every organ and component of the body consists mostly of water, namely 83% blood, 75-80% muscle, 75% brain, even in bones the percentage of water content reaches 20% (Sierra, 2011). It is assumed that the amount of water provided is sufficient for the livestock's own needs. Iskandar et al. (1991) stated that if there is a water shortage of 20% of daily needs, it can reduce productivity and efficiency of feed use..

Morphometrics of Small Intestine of Native chickens

The results of research on the addition of fermented BSF on the morphometrics of the small intestine (Duodenum, Jejunum and Ileum) of native chickens can be seen in Table 6 below.

Table 6. Effect of Adding Fermented BSF on Morphometrics of Native chickens

Small Intestine Parts	Treatment	Parameter	
		Weight Percentage (%)	Length Percentage (%)
Duodenum	P0	28 ± 5	19 ± 2
	P1	29 ± 1	21 ± 3
	P2	27 ± 3	20 ± 2
	P3	28 ± 2	22 ± 3
	P4	29 ± 5	21 ± 3
Jejenum	P0	41 ± 5	42 ± 3
	P1	42 ± 2	40 ± 5
	P2	38 ± 4	41 ± 8
	P3	39 ± 5	40 ± 1
	P4	41 ± 3	38 ± 3
Ileum	P0	30 ± 1	38 ± 1
	P1	28 ± 2	38 ± 5
	P2	34 ± 4	38 ± 7
	P3	32 ± 6	36 ± 3
	P4	29 ± 4	40 ± 1

Description: P0: 100% Commercial Feed, P1: 100% Basal Feed, P2: 85% Basal Feed + 15% BSF fermented feed, P3: 80% Basal Feed + 20% BSF fermented feed, and P4: 75% Basal Feed + 25% BSF Fermented Feed.

Small Intestine Weight Percentage

Based on the statistical analysis presented in Table 8, the addition of fermented BSF to the feed on the characteristics of the digestive tract of native chickens showed no effect (P>0.05) on the weight percentage of the small intestine (Duodenum, Jejunum and Ileum). The results obtained in this study tended to be high, namely in the duodenum treated P1 and P4 it was 29%, the jejunum treated P1 was 42% and the ileum treated P2 was 34%. Meanwhile, the lowest results for the small intestine weight percentage parameter were obtained in the P2 treatment duodenum at 27%, P2 jejunum at 38% and P1 ileum at 28%.

This is different from the opinion of Sumiati and Aliyani (2003) who stated that the development of the small intestine of poultry is greatly influenced by the crude fiber content in the rations consumed by native chickens. The feed treatment is thought to cause the digestion rate to slow down because the high crude fiber in the feed requires more intensive feed digestion. Acceleration of digestion can be caused by increasing the capacity of the digestive organs and the presence of enzymes that hydrolyze food ingredients for longer so that nutrient absorption is more effective

Small Intestine Length Percentage

Based on the results of research using statistical analysis presented in Table 8, the addition of fermented BSF to the feed on the characteristics of the digestive tract of native chickens showed no effect (P>0.05) on the parameters of the length of the small intestine (Duodenum, Jejunum and Ileum). The results obtained tended to be 22% for the duodenum in the P3 treatment, 42% in the jejunum in the P0 treatment and 40% in the ileum in the P4 treatment. Meanwhile, the lowest results for the small intestine length percentage parameter were obtained in the P0 treatment duodenum at 19%, P4 jejunum at 38% and P3 ileum at 36%.

The results of this research show that the addition of fermented BSF maggot feed has a crude fiber content that exceeds the limit required for native chickens, namely 13.1%, based on the Indonesian National Standard (2013) in the starter phase, the crude fiber requirement for native chickens is a maximum of 7.01%, so that the results Statistical analysis showed no effect. This is supported by the opinion of Rukmana (2014) stating that the development of the small intestine is influenced by the crude fiber content in the ration consumed. The crude fiber content in the feed is the same, namely 5% and the normal crude fiber content given at 0-4 weeks of age is 4-7% (Rukmana, 2014).

Retnoadiati (2001) states that in rations that require intensive absorption, the intestine will expand its surface by thickening the intestinal wall or lengthening the intestine so that as many nutrients will be absorbed by the intestine. Hermana and Aliyani (2003) argue that feed that has high crude fiber makes it difficult for protein to be degraded, so that the length of the small intestine will be longer compared to when consuming feed with low crude fiber.

Histology of the Small Intestine of Native chickens

The results of research on the addition of fermented BSF on the histology of the small intestine (Duodenum, Jejunum and Ileum) of native chickens can be seen in Table 7 below.

Table 7. Effect of Adding Fermented BSF on the Histology of Native chickens

Small Intestine Parts	Parameter				
	Treatment	Villi height (μm)	Villi Width (μm)	Crypt Depth (μm)	Surface Area of villi (μm^2)
Duodenum	P0	5632.49±1116.74	1465.17±833.33	1999.73±404.38	28724.46±21845.92
	P1	3385.96±1334.37	1387.48±494.35	1648.76±1602.38	8669.93±4015.61
	P2	5457.59±1469.65	1423.92±753.87	1685.93±445.16	11869.68±4263.30
	P3	5454.04±522.69	1268.01±178.33	1274.35±148.23	12285.03±3439.58
	P4	4763.21±1439.75	1203.04±378.79	1338.37±620.92	20123.96±9514.33
Jejenum	P0	5087.92±565.13	1860.44±170.68	1726.03±638.11	13203.81±5331.14
	P1	3746.43±1165.17	1484.01±624.65	1479.86±348.29	8687.43±3946.34
	P2	4346.35±751.94	1573.81±416.51	1762.55±700.17	9056.67±3082.72
	P3	3224.67±954.49	1388.61±346.83	1802.24±577.39	8971.33±4544.99
	P4	4604.81±1130.64	1986.92±572.15	1406.62±123.86	9202.27±2752.66
Ileum	P0	3648.43±853.69	1252.86±225.77	1398.25±693.83	9924.77±1900.77
	P1	3670.70±238.91	1536.33±575.66	1260.46±374.78	8393.91±1377.78
	P2	4874.81±1289.56	1878.32±728.79	1392.74±133.88	18021.65±8389.81
	P3	3830.34±1320.89	1383.38±319.27	1600.39±891.49	12311.88±7564.30
	P4	3674.55±907.91	1314.96±301.47	1279.73±252.35	10234.68±4235.29

Description: P0: 100% Commercial Feed, P1: 100% Basal Feed, P2: 85% Basal Feed + 15% BSF fermented feed, P3: 80% Basal Feed + 20% BSF fermented feed, and P4: 75% Basal Feed + 25% BSF Fermented Feed.

Villi Height (μm)

Based on the results of the statistical analysis presented in Table 9, the addition of fermented BSF to the feed on the characteristics of the digestive tract of native chickens showed no effect (P>0.05) on the height parameters of the small intestine villi (Duodenum, Jejunum and Ileum). The results obtained in this study regarding the height parameters of the small intestine villi were 5632.49 μm in the duodenum in the P0 treatment, 5087.92 μm in the jejunum in the P0 treatment and 4874.81 μm in the P2 treatment in the ileum. Meanwhile, the results for small intestine height parameters were in the P1 treatment duodenum of 3385.96 μm, P3 jejunum of 3224.67 μm, P3 ileum of 3830.34 μm.

Fermentation of feed containing BSF larvae with basal feed in this study did not have a significant effect on the length of the villi of native chickens. These results are not in line with the results reported by Astuty et al (2021), who reported that the use of 11.25% maggot flour had a significant effect on the length of village chicken villi.

Villous growth that is not optimal in the native chickens used in this research is caused by external factors such as environmental conditions and weather that changes between rain and heat, thus affecting the temperature of the cage, causing the chickens to be exposed to heat and cold stress and disrupting the growth of the native chickens. Bell and Weaver (2002) state that the environmental temperature required by chickens is around 18-23oC. This is in line with the opinion of Sugito et al. (2007) explained that heat stress disrupts the growth of villi in chicken intestines. The addition of BSF fermented feed to the feed had no impact on the height and surface area of the villi.

Villi Width (μm)

Based on the results of the statistical analysis presented in Table 9, the addition of fermented BSF to the feed on the characteristics of the digestive tract of native chickens showed no influence (P>0.05) on the parameters of the width of the villi of the small intestine (Duodenum, Jejunum and Ileum). The results obtained in this study on the parameters of small intestinal villi width were 1465.17 μm in the duodenum in the P0 treatment, 1986.92 μm in the jejunum in the P4 treatment and 1878.32 μm in the P2 treatment in the ileum. Meanwhile, the results for the small intestine villi width parameters were obtained in the P4 treatment duodenum of 1203.04 µm, P3 jejunum of 1388.61 µm, P4 ileum of 1314.96 µm.

The cellulose compound contained in crude fiber shows 13.1% in BSF, based on the Indonesian National Standard (2013) in the starter phase the crude fiber requirement in native chickens is a maximum of 7.01%, this causes the rate of nutrient absorption to be slower. Sugito, et al (2007) stated that nutrient absorption is also influenced by the width of the villi (duodenum, jejunum and ileum).

Crypt Depth (µm)

Based on the results of the statistical analysis presented in Table 9, the addition of fermented BSF to the feed on the characteristics of the digestive tract of native chickens showed no effect (P>0.05) on the parameters of the depth of the small intestinal crypts (Duodenum, Jejunum and Ileum). The results obtained in this study regarding the depth parameters of the small intestine crypts were 1999.73 µm in the P0 treatment duodenum, 1802.24 µm in the P3 treatment jejunum and 1600.39 µm in the P3 treatment ileum. Meanwhile, the results regarding the depth parameters of the small intestine crypts were in the P3 treatment duodenum of 1274.35 µm, P4 jejunum of 1406.62 µm, P1 ileum of 1260.46 µm.

Based on the results obtained in this study, it shows that the addition of fermented BSF in feed shows an influence on the development of villi in the small intestine of livestock, and the depth of the intestinal crypts of livestock when adding fermented BSF feed tends to be higher although statistically it does not show a difference, this indicates an increase in area. the surface of the villi in the intestines of livestock which can increase digestibility and feed efficiency. Increasing the depth of the crypts will have an effect on increasing digestive ability. The higher the size of the villus and the depth of the crypts, the wider the area for nutrient absorption by the walls of the small intestine, which will trigger increased growth. As explained by Austic and Nesheim 1(990) that the ability to digest and absorb food substances can be influenced by the surface area of the intestinal epithelium, the number of folds, and the number of villi and micro villi which will expand the area of absorption and are also influenced by the height and area. surface of the villi of the duodenum, jejunum and ileum (Sugito et al., 2007; Ibrahim 2008).

This is caused by the protein that acts as plasma insulin not working properly as a growth factor. In accordance with the opinion of Kita et al. (2002) that the addition of high protein with arginine can increase plasma insulin growth factor (IGF). IGF works as proinsulin or insulin precursor which will act as a growth factor. Pro-insulin can trigger the growth of small intestinal crypt cells through IGF receptors and plays a physiological role in intestinal regulation of epithelial cell proliferation.

Surface Area of Intestinal Villi (μm^2)

Based on the results of the statistical analysis presented in Table 9, the addition of fermented BSF to the feed on the characteristics of the digestive tract of native chickens did not show a significant effect (P>0.05) on the surface area parameters of the villi of the small intestine (Duodenum, Jejunum and Ileum). The results obtained in this study on the surface area parameters of the small intestine villi were 28724.46 µm2 in the duodenum in the P0 treatment, 13203.81 µm2 in the jejunum in the P0 treatment and 18021.65 µm2 in the ileum in the P2 treatment. Meanwhile, the results regarding the surface area parameters of the small intestine villi were 8669.93 µm2 in the duodenum of the P1 treatment, 8687.43 µm2 in the jejunum P1, and 8393.91 µm2 in the P1 ileum.

The protein content of BSF maggot larvae (*H. illucens*) is known to optimize the growth of the small intestine of livestock thereby increasing the digestibility of the feed consumed. According to Kinasih et al., (2017) the use of Hermetia illucens maggot feed is known to have the potential to increase the surface area of the villi of the small intestine of the duodenum, jejunum and ileum. This is caused by the activity of essential amino acids contained in Hermetia illucens maggot flour which can improve the performance of the digestive organs. Miles et al, (2006) added that conditions of the small intestine such as high villi in the small intestine represent an area for wider nutrient absorption.

Increasing the area of the small intestinal villi in livestock, especially poultry such as native chickens, has a very large direct impact on the level of nutrient digestibility of feed. The greater the surface area of the small intestinal villi, the greater the level of feed digestibility. This is due to the increasing surface area of the tissue that can capture food that passes through the small intestine. According to Ensminger (1992), an increase in villi height and villi width is associated with greater surface area of the villi for absorption of nutrients into the bloodstream. The absorption capacity of nutrients in the small intestine is influenced by the surface area of the small intestine (folds, villi and microvilli).

The use of BSF maggot (*Hermetia illucens L*) in feed is known to have the potential to increase the surface area of the small intestine. This can be caused by the antimicrobial peptide (AMP) content as an active compound in maggots which can suppress the growth of pathogenic microorganisms such as E. coli and create ideal intestinal microecological conditions for beneficial intestinal microorganisms such as Lactobacillus, thereby improving the performance of the digestive organs (Auza et al. al, 2020).

4. Conclusion

Based on the results of this research, it can be concluded that the addition of fermented BSF in feed affects the parameters that have been tested, namely; (1) The addition of fermented BSF in feed on the histology of the small intestine of native chickens on the parameters of villi height, villi width, crypt depth and surface area of intestinal villi showed no effect (P>0.05) at the 15-25% level; (2) The addition of fermented BSF in feed up to a level of 15-25% showed no effect (P>0.05) on the small intestine morphometrics of native chickens on the parameters of weight percentage and small intestine length percentage; (3) The addition of fermented BSF in feed up to a level of 15-25% on starter phase performance showed an influence (P<0.05) on the weight gain (PBB) parameters of native chickens ranging from 21.34 – 49.26 g/head/ week but, at P2 with a level of 20% fermented BSF in the feed had the most influence on the weight gain parameters of native chickens.

References

Aryanti, F., Aji, M. B., & Budiono, N. (2013). Pengaruh pemberian air gula merah terhadap performans ayam kampung pedaging. *Jurnal Sain Veteriner, 31*(2), 156-165.

Astuty Auza, F., Purwanti, S., A Syamsu, J., & Natsir, A. (2021). The Effect of Substitution of Fish Meal by Maggot Meal (Hermetia illucens L) on the Relative Length of Digestive Tract, Histomorphology of Small Intestines and the Percentage of Carcass Parts in Native Chickens. *Journal of World's Poultry Research, 11*(1).

Austic, R. E., & Nesheim, M. C. (1990). *Poultry Production* (13th Ed.). Lea and Febiger.

Auza, F. A., Purwanti, S., Jasmal Syamsu, & Natsir, A. (2020). The relative weight of internal organs and digestive tract in native chickens age 12 weeks that are given various levels of BSF larvae meal (Hermetia illucens L) in the ration. *IOP Conf. Series: Earth and Environmental Science, 788*.

Bell, D., & Weaver, W. D., Jr. (2002). *Commercial Chicken Meat and Egg Production* (5th edition). Springer Science and Business Media Inc.

Despal. (2000). Kemampuan komposisi kimia dan kecernaan in vitro dalam mengestimasi kecernaan in vivo. *Media Peternakan, 23*(3), 84–88.

Ensminger, M. E. (1992). *Animal Science*. Interstate Publishing, Inc.

Fauzi, R. U. A., & Sari, E. R. N. (2018). Analisis Usaha Budidaya Maggot sebagai Alternatif Pakan Lele. *Industria. Jurnal Teknologi dan Manajemen Agroindustri, 7*(1), 39-46.

Hidayat, C. (2012). Pengembangan Produksi Ayam Lokal Berbasis Bahan Pakan Lokal. Balai Penelitian Ternak PO Box 221. Bogor 16002.

Ibrahim, S. (2008). Hubungan ukuran-ukuran usus halus dengan berat badan broiler. *Agripet, 8*(2), 42-46.

Iskandar, B. (2009). Kajian Perbedaan Aras dan Lama Pemeraman Ampas Tebu dengan Trichoderma Rzianum terhadap Kandungan Protein Kasar dan Serat Kasar. *Seminar Nasional Peternakan Universitas di Ponegoro*.

Iskandar, S. E., Juarini, E., Zainuddin, D., Resnawati, H., Wibowo, B., & Sumanto. (1991). *Teknologi Tepat Guna Ayam Buras*. BPT-Ciawi. Bogor.

Jaelani, A., Widaningsih, N., & Mindarto, E. (2011). Pengaruh Lama Penyimpanan Hasil Fermentasi Pelepah Sawit oleh Trichoderma sp Terhadap Derajat Keasaman (pH), Kandungan Protein Kasar, dan Serat Kasar. *Ziraa'ah, 40*(3), 2355-3545.

Kinasih, I., Suryani, Y., & Yuliawati, A. (2017). Konversi limbah organik oleh Larva Lalat Tentara Hitam (Hermetia illucens) menjadi sumber Protein terbarukan bagi produksi Pakan Ternak Organik. *UIN Sunan Gunung Djati Bandung*.

Marganov. (2003). Potensi Limbah Crustacea sebagai Penyerap Logam Berat (Timbal, Kadmium, dan Tembaga) di Perairan. *Dissertation. IPB*. Bogor.

Marzuki, A., & Rozi, B. (2018). Pemberian Pakan Bentuk Crumble dan Mash Terhadap Produksi Ayam Petelur. *Jurnal Ilmiah Inovasi, 18*(1).

Maynard, L. A., Loosil, J. K., Hintz, H. F., & Warner, R. G. (2005). *Animal Nutrition* (Seventh Edition). McGraw-Hill Book Company. New York, USA.

Miles, R. D., Butcher, G. D., Henry, P. R., & Littel, R. C. (2006). Effect of antibiotic growth promoters on broiler performance intestinal growth parameters, and quantitative morphology. *Poult. Sci., 85*, 476-485.

Montesqrit, M., Harnentis, H., & Rahmat, R. (2020). Optimasi Pemberian Tepung Maggot Dari Larva Black Soldier Fly (Hermetia illucens) Dalam Ransum Ayam Pedaging. In *Prosiding Seminar Teknologi Agribisnis Peternakan (Stap) Fakultas Peternakan Universitas Jenderal Soedirman* (Vol. 7, pp. 556-556).

Mudarsep, M. J., Muhammad, M. R., Fatwa, B., Dawanto, J., & Idrus, M. (2021). Pengaruh Pemberian Larutan Asam Amino Berbasis Maggot (BSF) Black Soldier Fly (Hermetia illucens) dengan Variasi Kon-sentrasi Ke dalam Pakan Terhadap Bobot Badan Akhir Ayam Kampung Unggul Balitnak (KUB).

Jurnal Ilmu dan Teknologi Peternakan Terpadu, *1*(1), 15-22.
Muslim, & Abdul, D. (2019). Budidaya Maggot Mengenai Morfologi dan Siklus Hidup BSF (lalat tentara hitam).
Peraturan Menteri Pertanian. (2006). Nomor: 49/Permentan/Ot.140/10/2006 Tentang Pedoman Pembibitan Ayam Lokal Yang Baik (Good Native Chicken Breeding Practice).
Rahayu, I., Sudaryani, T., & Santosa, H. (2011). *Panduan Lengkap Ayam*. Penebar Swadaya. Jakarta.
Rahayu, R. S., Putra, R. E., & Alfianny, R. (2021). Pengaruh Pemberian Tepung Larva Lalat Tentara Hitam (Hermetia illucens) Terhadap Kecepatan Tumbuh Burung Puyuh (Coturnix-coturnix japonica). In *Gunung Djati Conference Series* (Vol. 6, pp. 286-297).
Rasyaf, M. (2006). *Manajemen Peternakan Ayam Kampung*. Yogyakarta: Kanisius.
Retnoadiati, N. (2001). Persentase bobot karkas, organ dalam dan lemak abdominal ayam broiler yang diberi ransum berbahan baku tepung kadal (Mabouya multifaciata Kuhl). Skripsi. Fakultas Peternakan. Institut Pertanian Bogor, Bogor.
Rukmana, H. Rahmat. (2014). *Panduan Lengkap Ternak Itik Petelur dan Pedaging secara Intensif*. Lily Publisher. Yogyakarta.
Sierra. (2011). Pemberian Air Minum Sehat pada Ayam. http://www.fedcosierra.com/2011/12/pemberian-air-minum-sehat pada-ayam.html. (Diakses pada tanggal 15 November 2021). (online).
Steel, R.G.D., & Torrie, J. H. (1991). *Prinsip dan Prosedur Statistika*. Terjemahan B. Sumantri. Pt. Gramedia Pustaka Umum. Jakarta.
Sugito MW, Astuti DA, Handharyani E, Chairul. (2007). Histopatologi hati dan ginjal pada ayam broiler yang dipapar cekaman panas dan diberi ekstrak kulitbatang Jaloh (Salix tetrasperma roxb). *JITV*, *12*, 68-73.
Sumiati, W., Hermana, W., & Aliyani, A. (2003). Persentase Bobot Karkas dan Organ dalam Ayam Broiler yang diberi Tepung Daun Talas (Colocasia esculentas) dalam Ransum. *Media Peternakan, 26*, 1-10.
Tillman, D. (2005). *Living values: an educational program. Living values activities for children*. Terjemahan: Adi Respati dkk. Jakarta: PT. Grasindo.
Veldkamp, T., & Bosch, G. (2015). Insects: A protein-rich feed ingredient in pig and poultry diets. *Anim Front, 5*, 45-50.
Wahid, A. S., Purwanti, S., & Auza, F. A. (2021). Substitution of fishmeal with black soldier fly larvae (Hermetia illucens L) against the performance of native chickens grower phase. In *IOP Conference Series: Earth and Environmental Science* (Vol. 788, No. 1, p. 012182). IOP Publishing.
Wahju, J. (2004). *Ilmu Nutrisi Unggas* (Edisi ke-4). Gadjah Mada University Press, Yogyakarta.
Wahyudi, N. I. N., Resky, S. R. P., Daruslam, A. M., & Azhar, M. (2020). Palatabilitas Maggot Sebagai Pakan Sumber Protein Untuk Ternak Unggas. *Jurnal Agrisistem, 16*(1), 1858-4330.