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Research Article
Carcass Characteristics and Organ Development of Broilers Fed Fermented Pineapple Peel [*Ananas comosus* (L.) Merr] Waste Using a Local Microorganism Solution Derived from Bamboo Sprouts

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Abstract

Background and Objective: The utilization of pineapple peel waste as poultry feed is limited due to the high crude fiber content. The poultry digestive tract does not produce cellulase, a cellulose digesting enzyme, however, cellulolytic microorganisms produce cellulase that could be used in hydrolyzing high-cellulose feed content through a fermentation method. The previous experiment showed that crude fiber content in pineapple peel waste was reduced from 24-17.16% after fermenting for 1 week with a local microorganism solution derived from bamboo sprouts. Thus, this study aims to evaluate the amount of fermented pineapple peel waste, using a local microorganism solution derived from bamboo sprouts, that could be used in a broiler diet, as well as how it effects the carcass performance and organ development of broilers. **Materials and Methods:** This experiment was performed with a completely randomized design using five different amounts of fermented pineapple peel waste (0, 3, 6, 9 and 12%) in the broiler diet and each treatment was repeated four times. Body weight, abdominal fat pad percentage, carcass weight and percentage and organ development in relation to the liver, gizzard, spleen and duodenum weight were measured. **Results:** The inclusion of different amounts of fermented pineapple peel waste in the broiler diet did not significantly affect ($p>0.05$) the body weight, abdominal fat pad percentage, carcass weight and percentage, organ development, such as weight of the liver, gizzard, spleen and duodenum. **Conclusion:** Fermented pineapple peel waste using a cellulolytic local microorganism solution derived from bamboo sprouts could be used up to 12% in a broiler diet without negative effects on carcass performance and organ development.

Key words: Pineapple peel waste, local microorganism, bamboo sprouts, carcass, organ development

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pineapple peel is a waste from processing pineapple into canned or sliced fruit. Pineapple peel waste contains the following nutrients: 93.79% dry matter, 5.76% crude protein, 0.93% fat, 24% crude fiber, 6.08% ash, 0.528% Ca, 0.47% P and 3699.8 kcal kg^{-1} gross energy[1]. In addition to containing nutrients, pineapple peel waste is also known as a bromelain enzyme producer[2]. Based on analysis from the Feed Technology Laboratory of Andalas University, Faculty of Animal Science, bromelain activity in fresh pineapple peel waste is 0.0029 U mL^{-1} [3]. Bromelain enzymes belong to proteolytic enzymes, which can lower cholesterol[4]. Previous research has shown that bromelain can lower LDL, VLDL and cholesterol in the blood serum of Leghorn chickens at 75 weeks[4]. Mice fed with pineapple juice had decreased cholesterol concentrations, triglycerides and chylomicron blood plasma[5]. The cholesterol-lowering mechanism of bromelain enzymes has not been widely disclosed, but reports show bromelain breaks down plaque caused by cholesterol in blood vessel walls, resulting in smooth blood circulation[6]. Furthermore, Lien *et al.*[4] explained that the bromelain enzyme structure is resistant to stomach acid and can be absorbed up to 40% in the digestive tract of chickens. Based on its ability to lower cholesterol, it is predicted that bromelain found in pineapple peel waste can also affect the formation of abdominal fat in broilers and indirectly affect broiler carcass performance. The utilization of pineapple peel waste is limited in broiler diet due to high crude fiber content and it is suspected that it could inhibit organ development. Some researchers reported that crude fiber content in pineapple peel waste varied from 19.69-27.09%[1,7,8]. The high crude fiber content in pineapple peel waste can be overcome by a fermentation method using cellulolytic microorganisms that can produce the cellulase enzyme. Adrizal *et al.*[9] reported that the local microorganism solution derived from bamboo sprouts is the best microorganism solution in reducing crude fiber in pineapple peel waste in comparison to the local microorganism solutions derived from vegetable waste, fruit waste, banana gnats and rice waste. Pineapple peel waste fermented for 1 week with a local microorganism solution derived from bamboo sprouts can lower the crude fiber from 24-17.16%[9]. According to Lindung[10], the microorganisms present in the bamboo sprout solution are *Rhizobium* sp., *Azospirillum* sp., *Azotobacter* sp., *Pseudomonas* sp. and *Bacillus* sp. Since there is a lack of literature regarding the effect of pineapple peel waste fermented by using a local microorganism solution derived from bamboo sprouts in broiler diet. The present study was designed to evaluate the amount that could be used in a broiler diet and how it effects the carcass performance and organ development of broilers.

MATERIALS AND METHOD

Pineapple peel waste: Fresh pineapple waste was obtained from a local market in Padang city, West Sumatra province, Indonesia and was brought to laboratory for the experiment.

Preparation of the local microorganism solution derived from bamboo sprouts: Bamboo sprouts (1000 g) were chopped into cubes and placed in a plastic bowl with 3 L of water from washing the rice and 200 g of brown sugar and this was fermented for 15 days. Fermentation was stopped by centrifugal separation of the solution. The resulting solution was used for pineapple waste fermentation (method from http://www.gerbangpertanian.com/2012/05/membuatmol-rebung-bambu.html).

Pineapple waste fermentation: Pineapple waste was fermented by mixing 500 g of fresh pineapple waste with 325 mL of a local microorganism solution derived from fermenting bamboo sprouts for a duration of 1 week.

Birds: The experiment used 18 one week old unsexed broiler birds of the broiler strain Arbor Acres for 5 weeks.

All the experimental diets were prepared by following NRC 1994 as shown in Table 1.

Variables: Body weight, abdominal fat pad percentage, carcass weight and percentage and organ development in relation to the weight of the liver, gizzard, spleen and duodenum were measured.

Data analysis: The experiment was performed in a completely randomized design with different amounts of fermented pineapple waste (0, 3, 6, 9 and 12%) in the broiler diet. Each treatment was replicated 4 times. Data were statistically analyzed by one-way ANOVA. Differences among treatments were determined using Duncan's multiple range test[11].

RESULTS

Body weight: The body weight of broilers was not significantly ($p>0.05$) affected by different amounts of fermented pineapple waste in the diet (Table 2).

Abdominal fat pad percentage: The abdominal fat pad percentage of the broilers was not significantly ($p>0.05$) affected by any amount of fermented pineapple waste in the diet (Table 2).

Table 1: Composition of experimental diet according to NRC (1994) (kcal kg^{-1}) as feed basis

	Experimental diet				
Feed	A	B	C	D	E
Commercial bravo 311	45.50	45.50	45.50	45.50	45.50
Corn mash	22.50	22.25	22.00	21.75	21.50
Rice bran	12.00	9.00	6.00	3.00	0.00
Soybean meal	17.50	17.50	17.50	17.50	17.50
Fermented pineapple peel waste	0.00	3.00	6.00	9.00	12.00
Bone meal	1.25	1.25	1.25	1.25	1.25
Coconut oil	1.25	1.50	1.75	2.00	2.25
Total	100.00	100.00	100.00	100.00	100.00
Crude protein	21.47	21.35	21.19	21.05	21.00
Fat	7.38	7.29	7.21	7.12	7.12
Crude fiber	6.48	6.49	6.50	6.51	6.53
Ca	0.90	0.90	0.90	0.90	0.90
P available	0.50	0.60	0.60	0.60	0.60
ME (kcal kg^{-1})	2903.80	2909.46	2903.13	2902.79	2902.46

Table 2: Effect of fermented pineapple peel waste in broiler diet on carcass performance at 5 weeks old

Fermented pineapple peel waste in broiler diet (%)	Average body weight (g)	Average carcass weight (g)	Average abdominal fat pad percentage	Average carcass percentage
0	1211.88	811.18	1.13	60.44
3	1151.00	810.30	1.53	59.85
6	1308.13	757.10	1.34	56.01
9	1233.88	777.33	1.33	58.06
12	1289.25	777.40	1.17	57.40
Standard Error	50.54	44.37	0.16	1.22

Table 3: Effect of fermented pineapple peel waste in broiler diet on organ development at 5 weeks old

Fermented pineapple peel waste in broiler diet (%)	Average liver weight (g)	Average gizzard weight (g)	Average spleen weight (g)	Average duodenum weight (g)
0	1.95	2.66	0.09	4.46
3	2.09	2.56	0.14	4.13
6	1.99	2.72	0.12	4.32
9	2.03	2.65	0.14	4.67
12	2.04	2.22	0.13	4.65
Standard error	0.11	0.20	0.04	0.48

Carcass weight and carcass percentage: Table 2 shows that carcass weight and carcass percentage were not significantly ($p>0.05$) affected by different amounts of fermented pineapple waste in the diet.

Liver weight: The broilers' liver weight was not affected by different amounts of fermented pineapple waste in the diet ($p>0.05$) (Table 3).

Gizzard weight: Different amounts of fermented pineapple waste in the diet of broilers did not affect the gizzard weight significantly ($p>0.05$) (Table 3).

Spleen weight: Table 3 shows that spleen weight was not significantly ($p>0.05$) affected by different amounts of pineapple waste in the diet.

Duodenum weight: Duodenum weight of broiler was not affected by different amounts of fermented pineapple waste in the diet ($p>0.05$) (Table 3).

DISCUSSION

The inclusion of fermented pineapple peel waste up to 12% in the diet did not affect the body weight of the broilers. The body weight was unaffected because the quality of added nutrients in the treatment diets with different amounts of fermented pineapple peel waste (3, 6, 9 and 12%) was equal to the quality of nutrients in diets without fermented pineapple peel waste (0%), thus, the formation of broiler meat would be the same for all treatments of fermented pineapple peel waste. According to Karmini[12] the fermentation process will improve the nutritional quality of the feed and it will

become easier to digest. In addition to that, the body weight did not differ between treatments in this study due to the bromelain proteolytic activity found in the fermented pineapple peel waste being low. As a result, its effect in helping to hydrolyze proteins into simple peptides or amino acids in the broilers' digestive tract, which is needed for formation of broiler meat, was not different for any of the amounts of fermented pineapple peel waste in the diet. The activity of bromelain in each level of pineapple peel waste (0, 3, 6, 9 and 12%) in the diet was 0.01, 0.19, 0.023 and 0.039 U mL^{-1}, respectively based on Analysis of Feed Industry Technology Laboratory, Faculty of Animal Husbandry andalas University, 2017[3]. According to Plumstead and Cowieson[13], protease supplements in the diet prevent the loss of endogenous amino acids, so that more nutrients are absorbed by the body and will improve the performance because nutrition will be more effectively used in body weight formation. The effect of bromelain enzyme activity at different amounts of fermented pineapple peel waste in the diet has not demonstrated any effect on broiler abdominal fat pad formation, but its effect is seen in the decreasing of fat content in the liver, cholesterol and triglycerides in broiler blood serum (Data Unpublished). The average abdominal fat percentage of broilers in this study ranged from 1.13-1.53%, which are lower than the 2.22% reported by Daud *et al.*[14] The average carcass weight and broiler carcass percentage in this study also did not show any differences between the treatments. This was due to body weight, feed consumption and daily weight gain (data unpublished), as well as weight of some organs (liver, lymph, gizzard and small intestine) (Table 3) also not differing for any level of fermented pineapple peel waste in the diet. The broiler carcass weight is closely related to the body weight. According to Haroen[15], the achievement of carcass weight is closely related to the body weight and weight gain. Resnawati[16] stated that the carcass weight produced is influenced by the quality and quantity of the ration. One of the elements of nutrition that is very influential in the formation of the carcass is protein. In this study, it was found that the development of the liver, gizzard, spleen and duodenum organs were also not affected by increasing the amount of fermented pineapple peel waste in the diet. This was related to the availability of the same quality of nutrients among the diet treatments, because the nutrients needed for the development of these organs were available. This study showed that pineapple peel waste, as a product of fermentation with local microorganism from bamboo sprouts, could be used as an alternative broiler feed without affecting carcass quality and organ development.

SIGNIFICANCE STATEMENT

This study discovered that pineapple peel waste, fermented by using a local microorganism solution derived from bamboo sprouts, can be beneficial for farmers to utilize as an alternative poultry feed in broiler diet for performance and organ development. This study will help researchers to uncover the critical areas of agricultural waste processing utilization, especially pineapple peel waste for poultry feed, using local microorganisms that many researchers have not yet explored. Thus, a new theory about processing agricultural waste as an alternative poultry feed may result.

CONCLUSION

Fermented pineapple waste could be used up to 12% in broiler diets without negative effects on carcass performance and organ development of broilers.

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