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The Improvement of Nutrient Quality of Cassava Peel Waste Through Fermentation with Natura as Quail Feed

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ABSTRACT

This research aims to improve the quality of cassava peel waste through fermentation processing with *Natura* used as alternative feed which reduces the use of corn and concentrate in feed of laying quail in the grower period. This research consisted of two phases. Phase 1 improvement the quality of cassava peel waste using fermentation technology with *Natura*, organic decomposer containing multi enzyme, *xylanase, beta-glucanase, pectinase, amylase, lipase, protease* and *phytase* and also contain probiotics, *Acetobater* sp, *Bacillus* sp, *Lactobacillus* sp, *Streptomyces* sp, *Aspergillus* sp, *Sacaromyces* sp, and *Trichoderma* sp. Phase 2: the best fermented cassava peel waste experiment at phase 1 (using completely randomized factorial design consisted of 3x3 with 3 replications: 3 levels of Natura dose; 1, 2, and 3% and 3 levels of fermentation length; 7, 11, and 15 days) to the performance of laying quail in the grower period. The research methods at phase 2 used experimental method with completely randomized design (4 treatments and 5 replications): 0%, 4%, 8%, 12% and 16% of fermented cassava peel waste in the feed of laying quail in grower period (1-4 weeks). The best result in phase 1 was treatment with dose of 3% and 11 days of fermentation length with crude protein content: 14.14%, nitrogen retention: 62.90), crude fiber digestibility (47.58%) and crude fiber content (11.34%). The result of phase 2 was that the addition of fermented cassava peel waste 16% in the feed of laying quail in grower period gave a significantly higher effect on feed consumption, weight gain, and significantly had the lowest feed conversion compared to other treatments. Conclusion, that 3% Natura inoculum dose with 11 days of fermentation was the best treatment to increase the content and quality of cassava peel waste nutrient. The addition of fermented cassava waste with Natura up to 16% in feed could maintain the performance of laying quail in grower period, also reduced the use of corn 10% and concentrate 12% in feed.

Keywords: Cassava peel waste, Fermentation, Natura, Quality nutrition, Quail performance

Introduction

Cassava peel waste is a waste from cassava in the making of "Sanjai/Balado Chips" which is a typical food of West Sumatera. Cassava production in West Sumatera in 2013 was 250,000 tons, with an estimated potential of cassava peel which was produced approximately 16% of cassava production (Central Bureau of Statistics, 2014). It was estimated that the amount of cassava peel available was 40,000 tons in 2013. Cassava peel waste is potential enough to be used as poultry feed in terms of potential availability and nutrient content.

In the terms of nutrient content, cassava peel waste contains crude protein 4.08% but has high crude fiber 27.23% and there is antinutrient of HCN 225 ppm (Nuraini et al., 2009). Cassava peel waste which contains high crude fiber when consumed by poultry will limit its use. This is because the digestive tract of poultry contains only little microbes which produce enzymes that hydrolyze crude fiber. Efforts to reduce crude fiber in cassava peel waste so that its utilization in poultry feed is optimal, is needed processing technology. One of them is by fermentation with Natura.

Natura is a revolutionary combination of environmentally friendly biotechnology products produced using the latest biotechnology with a combination of active decomposer microbes and native Indonesian enzymes to overcome waste and organic waste produced by Indonesian Natura BioResearch. In the market, Natura is sold in flour form in a sachet 250 g. The benefits of Natura include reducing the smell of ammonia under broiler house, eliminating the smell of waste, being able to break down household waste,

industrial waste and factories. The ability to break down waste is because Natura contains various kinds of microbes (bacteria and mold) and multi enzymes. Microbes in the form of probiotics such as bacteria: *Acetobacter sp*: 5.9 x 10^8 colony form unit (cfu); *Bacillus sp*: 5.5 x 10^8 cfu; *Lactobacillus sp*: 4.7 x 10^8 cfu, and *Streptomyces*: 4.4 x 10^8, moreover, Natura contains molds such as: *Aspergillus sp*: 3.9 x 10^8 propagaul/g; *Saccharomyces sp*: 5.3 x 10^8 propagaul; and *Trichoderma sp*: 3.6 x 10^8 propagaul, and also contains enzymes such as protease, amylase, xylanase, beta-glucanase, lipase, pectinase, phytase, and cellulase (Natura Product, 2013).

Cellulase enzymes can degrade cellulose into simpler carbohydrates which is glucose. The amylase enzyme is able to break down the bonds in the starch to form maltose. Another enzyme, a protease belonging to the hydrolase enzyme, is an enzyme that hydrolyze a substance with the help of water, this protease hydrolyzes groups of proteins such as peptides into amino acids (Beequinn, 2014). Probiotics from Natura affect crude fiber digestibility and crude protein digestibility. Kurnia (2014) reported that a dose of 0.1% multi enzyme in Natura with a 7-15 day fermentation length could degrade crude fiber from palm oil waste. The results of the study by Nuraini *et al*. (2016) 3% Natura dose with 15 days incubation time could reduce crude fiber from pineapple waste by 35%, increase crude protein 30%, provide protein quality, crude fiber digestibility and increased metabolic energy as indicated by 50% nitrogen retention and crude fiber digestibility 49% and metabolic energy 2,500 kcal/kg.

The dose of Natura (containing multi enzymes and probiotics) given and incubation length can affect the alteration of the nutrient content by the enzyme. An increase in enzyme concentration in general will give greater influence on the time of hydrolysis process. The length of hydrolysis process causes more substrate to be degraded and the quality of the products produced will increase (Kurnia, 2014).

Multi enzymes and probiotics contained in Natura given to cassava peel waste with a dose of 3% and incubation time of 15 days has been shown to reduce crude fiber by 42.65% and increase crude protein by 47.97% (Nuraini et al., 2016). The Increasing of crude protein content of an ingredient is not certain to improve protein quality. The quality test of feed ingredients for livestock needs to measure nitrogen retention, and digestibility of crude fiber. The improvement of digestibility will have a positive effect on growth and production. The nutrient quality of cassava peel waste which is fermented with Natura and limitation on its use and its effect on quail performance is unknown. this research is to improve the quality of cassava peel waste through fermentation process with Natura to be used as alternative feed ingredients which reduces the use of corn and concentrates in laying quail feed in the grower period.

Materials and Methods

Phase I. The nutrient quality test of processed cassava peel waste products with Natura

The materials used at this stage was cassava peel waste, Natura organic decomposer, rice bran, and 6 weeks old male broiler as many as 33 heads which was placed in a metabolic cage (size 50 x 50 cm as many as 33 pieces) and chemicals for analysis of crude protein content, crude fiber, nitrogen retention and crude fiber digestibility.

The production process of fermented cassava peel waste was as follows: Firstly, the air dried cassava peel waste was chopped and then finely ground. The flour was taken 80 grams mixed with 20 grams of rice bran and added with distilled water until the water content reached 70%. The mixture was put into an autoclave with a temperature of 121^{o}C for 15 minutes. The next stage, the heated mixture was taken out from the autoclave, let stand for 30 minutes until warm. The next step, The warm mixture were inoculated with Natura with doses (1,2 and 3%) and incubated for 7, 11, and 16 days. After incubation according to each time, the mixture was put into an oven with a temperature of 60^{o}C, then finely ground, the last step was analysis.

The method used in this study was experimental method with completely randomized design (CRD) factorial pattern 3x3 with 3 replications. Factor A was Natura dosage: 1%, 2% and 3% of substrate. Factor B was the duration of fermentation: 7 days, 11 days and 15 days. Parameters observed: the content and quality of nutrient ingredients: crude protein (%), crude fiber (%), nitrogen retention (%), crude fiber digestibility (%) and amino acid content (%) from the best treatment.

Determination of protein quality, crude fiber digestibility and nitrogen retention of fermentation products

Fermentation products were determined by protein quality, and crude fiber digestibility. The quality of protein could be measured by determining the amino acid content of fermentation products that were carried out in the Biochemistry laboratory, Faculty of Animal Science, Bogor Agricultural University. The measurement of nitrogen retention and digestibility of crude fiber from fermentation products was done by giving treatment to broilers in the technical implementation unit of Faculty of Animal Science, Andalas University, Padang. Livestock used for determination of nitrogen retention, and crude fiber digestibility were 33 male broiler age 6 weeks, 27 heads as treatment, 3 heads as correction factors, and 3 heads as control for each feed, which were placed on individual metabolic cages.

Firstly, The chicken was fasted for 24 hours, then the treated chicken was fed 20 g of fermented and unfermented (control) products, after which excreta was collected for 48 hours,

while chicken for correction was fasted for 72 hours. Nitrogen content of excreta was analyzed based on the Kjehdahl method and crude fiber content

Nitrogen retention (%): calculated using the formula:

$$\frac{\text{N consumption (g/head) - \{N excreta (g/head) - N endogenous (g/head)\}}}{\text{N consumption (g/head)}} \times 100\%$$

$$\text{Crude fiber digestibility (\%)} = \frac{\text{consumption CF - CF Feses}}{\text{CF consumption}} \times 100\%$$

Phase II. The feed test contained the best fermented cassava peel waste products in phase 1 with Natura to quail in grower period

This research was experiment (biological evaluation) from the best fermentation cassava peel waste products in phase 1 with Natura in feed of grower quail. This experiment was conducted on poultry house of the Technical Implementation Unit of Faculty of Animal Science, Andalas University, Padang.

The research materials for this phase were 200 quails *Coturnix coturnix japonica* aged 1 week which were placed in a battery cage sized 100 cm x 60 cm as many as 20 pieces, each of which contained 10 quails. The feed was selfmixing compossed from ingredients such as corn, soybean meal, fish meal, rice bran, fermentation product of cassava peel waste with Natura, coconut oil, premix and Ca2CO3 flour. The composition and nutrient content of feed were listed in Table 1. The experimental design used was a completely randomized design with 5 treatments using fermentation products and 4 replications. The treatments used were 0% (RA); 4% (RB); 8% (RC), 12% (RD) and 16% (RE) fermentation products of cassava peel waste with Natura which each feed treatment will reduce the use of corn and concentrate. Each treatment unit contained 10 quails. The feed was composed of iso protein 20% and iso metabolic energy 2,800 Kcal/kg. The feed was given for three weeks in the grower quail (aged 1-4 weeks). The observed parameters were: feed consumption (g/head/day), body weight gain (g/head/day), and feed conversion.

The data obtained were analyzed by analysis of variant of completely randomized design (CRD). Further testing between treatments was tested with Duncan's multiple range test (DMRT).

Result and Discussion

Effect of treatment on crude protein content and nitrogen retention

Crude protein content and nitrogen retention from fermented cassava peel waste could be seen in Table 2 and Table 3. Table 2 and Table 3 showed that crude protein content and nitrogen retention was high at treatment of 3% Natura dosage with 11 days of fermentation length (A3B2) and treatment with 3% Natura and 15 days of fermentation length (A3B3). The high increase in crude protein in the A3B2 and A3B3 treatments which were not significantly different due to the use of high Natura doses and long fermentation times. When Natura doses given were increased, the microbial body proteins and enzymes that were contained in fermented cassava peel waste products were increased so that crude protein content was also increase. The microbial body proteins and enzymes themselves were proteins. Nuraini *et al*. (2015a). that the crude protein content was higher on the substrate after fermentation, due to the addition of protein donated by microbial and yeast cells due to its growth which produced a single cell protein product (PTS) or cell biomass containing around 40-65% protein.

The high crude protein shown in the treatment of A3B2 and A3B3 was caused by an increase in the probiotics of *Lactobacillus sp*. And *Saccharomyces sp*. which produced the protease enzyme. Nuraini *et al*. (2015b) also explained that

Tabel 1. Composition of ingredient and nutrient content of quail feed

Feed ingredient	Feed (%)				
	RA	RB	RC	RD	RE
Yellow corn	41.00	40.00	39.00	38.00	37.00
Concentrate 126	33.00	32.00	31.00	30.00	29.00
Rice bran	13.50	12.50	10.50	8.50	6.50
Fermented cassava peel waste	0.00	4.00	8.00	12.00	16.00
Bone meal	2.00	1.00	1.00	1.00	1.00
Soybean meal	10.00	10.00	10.00	10.00	10.00
Top mix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Nutrient contents (%)	RA	RB	RC	RD	RE
Protein	20.45	20.47	20.37	20.27	20.17
Lipid	4.53	4.40	4.22	4.04	3.87
Crude fiber	5.07	5.32	5.43	5.55	5.67
Calcium	2.55	2.27	2.24	2.20	2.16
Avalaible phosphorus	0.72	0.59	0.58	0.57	0.56
Metabolizable energy	2820.80	2828.90	2816.00	2803.10	2790.20
Methionine	0.41	0.42	0.44	0.45	0.46
Lysine	0.80	0.83	0.86	0.88	0.91

RA: Ration A (0%); RB: Ration B (4%); RC: Ration C (8%); RD: Ration D (12%); RE: Ration E (16%) contains fermented cassava peel waste. The ratio of Ca: P (3.40-3.86: 1) could still be tolerated (Bakrie et al., 2011 giving Ca:P ratio was 3: 1), while lysine was lack but it could be added synthetic lysine at the time of laying.

Tabel 2. crude protein (%) in cassava peel waste through fermentation with Natura

Natura dose	The length of fermentation			Average
	B1 (7 days)	B2 (11 days)	B3 (15 days)	
A1 (1%)	11.89^{Bb}	13.26^{Ab}	13.32^{Ab}	12.82
A2 (2%)	12.40^{Ba}	13.66^{Ab}	13.75^{Ab}	13.27
A3 (3%)	12.87^{Ba}	14.14^{Aa}	14.19^{Aa}	13.73
Average	12.39	13.69	13.75	

$^{A, B, a,b,}$ The uppercase on row and lowercase on the same column indicated significantly differences ($p<0.05$).

Tabel 3. Nitrogen retention (%) of cassave waste through fermentation with Natura

Natura dose	The length of fermentation			Average
	B1 (7 days)	B2 (11 days)	B3 (15 days)	
A1 (1%)	43.61^{Bc}	49.81^{Bc}	55.73^{Ab}	49.72
A2 (2%)	46.91^{Bb}	56.88^{Ab}	58.90^{Ab}	54.23
A3 (3%)	49.72^{Ba}	62.90^{Aa}	63.27^{Aa}	58.63
Average	48.74	56.53	59.30	

$^{A, B, a, b,c}$ The uppercase on row and lowercase on the same column indicated significantly differences ($p<0.05$).

bacteria that carried out fermentation could produce amino acids which was synthesized into proteins. The amino acid profile after fermentation (A3B2) was increase compared to before fermentation (Table 4).

The high nitrogen retention was also found in the treatment of A3B2 and A3B3 compared to other treatments, this was due to high protein consumption in A3B3 treatment 2.79 g/head and A3B3 2.75 g/head, while in A1B1 2.45 g/head. High consumption of protein indicated that a large number of proteins which would be digested and used by livestock were high. High consumption of crude protein in the treatment of A3B2 and A3B3 was associated with an increase in the probiotics of *Saccharomyces sp*. in fermented cassava peel waste products consumed by broilers, in line with the opinion of Corzo *et al*. (2005), that the factors that determined the value of nitrogen retention were protein consumption, protein digestibility and metabolism energy of feed.

Nitrogen retention in the A3B2 treatment with A3B3 was not significantly different which showed that the protein quality of two treatments was higher than the other treatments. Commonly, essential amino acid content increased except histidine amino acids, so the protein quality of A3B2 feed seen in Table 4 was significantly better than other treatments.

Effect of treatment on crude fiber content and crude fiber digestibility

The crude fiber content and crude fiber digestibility of cassava peel waste fermented with Natura could be seen in Tables 5 and 6. In Table 5, it could be seen that the crude fiber content in the treatment of A3B2 (Natura dose 3% and length of fermentation 11 days) was 11.34% and A3B3 treatment (Natura dose 3% and length of fermentation 15 days) was 11.11%, so they were not significantly differed, but significantly different lower compared to other treatments. The low

Tabel 4. Amino acid of product A3B2

Amino acids	Pre fermentation	Post fermentation	Percentages of changes between pre and post fermentation
	---------- (%DM) ----------		
Aspartate	1.31	1.28	-3.00
Glutamate	2.79	2.54	-8.96
Serine	0.67	0.71	+5.97
Histidine	0.68	0.67	-1.47
Glycine	0.54	0.56	+1.70
Threonine	0.64	0.67	+4.69
Arginine	0.79	0.81	+1.80
Alanine	1.20	1.25	+4.17
Tyrosine	0.33	0.38	+15.15
Methionine	0.70	0.68	-2.86
Valine	0.62	0.66	+6.45
Phenyl alanine	0.65	0.67	+3.08
Iso-leucine	0.54	0.55	+1.85
Leucine	0.32	0.34	+6.25
Lysine	1.37	1.38	+0.73
Cystine	0.70	0.74	+5.71
Proline	0.38	0.40	+5.26

Analysis results from animal science laboratory of Bogor Agricultural University, 2016.

crude fiber of the two treatments was related to the use of Natura in high doses and long length of fermentation. Natura doses given were increasing, the increasing enzymes contained in fermented products.

Increased Natura dosage caused microbes contained in Natura to increase so that the work of enzymes such as cellulase and hemicellulase to hydrolyze crude fiber, especially cellulose and hemicellulose to glucose, was optimal in fermented product of cassava peel waste products with proven decrease in crude fiber. The level of Natura addition which was higher would be effective compared to the lower one, this was related to the availability of substrate that could be hydrolyzed by the enzyme which was added (Zuraida *et al*., 2013). James *et al*. (2005) stated that an increase in the inoculum concentration in general would give a greater influence during fermentation process. Optimal reduction of crude fiber from fermented cassava peel waste products also required optimal Natura dosage and length of fermentation which was shown in A3B3 treatment (Natura dose 3% and length of fermentation 15 days) and A3B2. The long duration of fermentation process caused more substrate to be degraded and product quality produced would increase.

Nelson and Suparjo (2011) stated that reduction in crude fiber content could occur due to the process of decomposition of fiber components by cellulase enzymes. The high dose of Natura and longer the length of incubation, the more optimal work of fiber breaking enzymes, so that it reduced crude fiber content of fermented cassava peel waste products.

In the Table 6, it could be seen that the digestibility of crude fiber in A3B3 (51.50%) with A3B2 (47.58%) was not significantly differed, but was significantly higher than other treatments. Crude fiber digestibility was high in A3B3 and A3B2 treatments that was caused by the low crude fiber in the 2 treatments. Low crude fiber was caused by high doses of enzymes and long incubation period (15 days), so that the work of cellulase and hemicellulase enzymes to hydrolize crude fiber, especially cellulose and hemicellulose into glucose was more optimal, this caused the low crude fiber that was produced and it could be digested properly by livestock because it had become a simple molecule. Nuraini *et al*. (2013) explained that the more cellulase enzymes which was produced to break down cellulose into glucose caused increased digestibility of crude fiber. Fermented feeds usually have better nutritional value than the original ingredients due to catabolic microorganisms which break down complex components into simpler substances that are easier to digest. Low content of crude fiber could be digested by quail and high content of crude fiber in feed would reduce efficiency of the use of other food substances (Nuraini *et a*l., 2017).

Phase 2. Experiment of the use of fermented cassava peel waste with Natura in quail

The performance of laying quail in grower period that was given various treatments could be seen in Table 7. Treatment of fermented cassava peel waste with Natura from 0% to 16% had no significant effect on feed consumption. This condition showed that fermented cassava peel waste was liked by quail, although there was a reduction in the use of corn 10% and a reduction in concentrate 12%

Cassava peel waste was agro-industrial waste containing high crude fiber, but after it was fermented with Natura which was organic, there was an increase in crude protein, reduction in crude fiber and an increase in palatability, consequently the use of fermented cassava peel waste in livestock feed increased.

Natura is a packaging product that has many enzymes, such as cellulase, xylanase, beta-glucanase, pectinase, amylase, lipase, protease and phytase. In addition it also contains probiotics:

Tabel 5. crude fiber in cassava peel waste through fermentation with natura

Natura dose	The length of fermentation			Average
	B1 (7 days)	B2 (11 days)	B3 (15 days)	
A1 (1%)	19.69^{Aa}	14.50^{Ba}	13.71^{Ba}	15.97
A2 (2%)	14.53^{Ab}	13.39^{Ab}	12.20^{Bb}	13.37
A3 (3%)	13.15^{Ab}	11.34^{Bc}	11.11^{Bc}	11.87
Average	15.79	13.08	12.34	

$^{A, B, a,b,c,}$ The uppercase on row and lowercase on the same column indicated significantly differences ($p<0.05$).

Tabel 6. digestibility of crude fiber (%) of fermented cassava peel waste with Natura

Natura dose	The length of fermentation			Average
	B1 (7 days)	B2 (11 days)	B3 (15 days)	
A1 (1%)	40.36^{Cc}	44.96^{Bc}	48.64^{Ac}	44.65
A2 (2%)	42.51^{Cb}	46.69^{Bb}	49.97^{Ab}	46.39
A3 (3%)	44.82^{Ca}	47.58^{Ba}	51.50^{Aa}	47.97
Average	42.56	46.41	50.04	

$^{A, B, C, a,b,c}$ The uppercase on row and lowercase on the same column indicated significantly differences ($p<0.05$).

Tabel 7. Performance of quail in grower phase (1-week of age) which consumed fermented cassava peel waste

Variable	Treatment (% fermented cassava peel waste in ration)					
	RA (0% Fermented cassava peel waste)	RB (4% (Fermented cassava peel waste)	RC (8% Fermented cassava peel waste)	RD (12% Fermented cassava peel waste)	RE (16% Fermented cassava peel waste)	Standar error (SE)
Feed consumption (gr/quail/day)	14.75	14.10	14.72	14.74	14.79	0.02
Weight gain (gr/quail/day)	5.70	5.77	5.40	5.85	6.73	0.04
Feed conversion	2.66	2.47	2.77	2.52	2.58	0.04

Information : Not significant (P>0.05).

Acetobacter sp, *Bacillus sp*, *Lactobacillus sp*, *Streptomyces*, *Aspergillus sp*, *Saccharomyces sp.* and *Trichoderma sp*. (Natura Product, 2013). The use of Natura aimed to improve appetite, increase body weight, reduce the density of pathogenic bacteria in livestock intestines, improve digestibility of crude protein and crude fiber and improve the release of aminophytic acid and energy.

The fermentation process of fermented cassava peel waste with Natura provided a physical change from cassava peel waste such as color of cassava peel waste which was initially dark before fermentation turns to light after fermentation. The feed consumption between treatments was the same, because the color of feed treatment A to feed treatment E was the same. The feed color on treatment A of fermented cassava peel waste was bright, this came from the abundance of corn use. The color of feed treatment B (4% fermented cassava peel waste), C (8% fermented cassava peel waste), D (12% fermented cassava peel waste), E (16% fermented cassava peel waste) was also bright, this was due to the feed treatment of fermented cassava peel waste had bright color from white donation from Natura inoculum, so that it was preferred by livestock. Poultry prefers bright color feed (Theresia *et al*., 2013).

Quail body weight gain was also the same due to the same feed consumption of each treatment. The same consumption meant the amount of food substances contained in feed needed in synthesis of meat was also the same, so that body weight gain was the same. Fermentation of cassava peel waste with Natura provided changes in ingredients that were difficult to be digested to be easier digested, for example cellulose and hemicellulose into simple sugars, so that increasing nutrient value. Microorganisms with enzymes produced in the fermentation process could decompose complex compounds such as carbohydrates, proteins, and fats into simple compounds such as glucose, amino acids and fatty acids. Cellulase enzymes produced by microbes in Natura were able to decompose some cellulose and lignin in cassava peel waste so that they could be used more in quail feed. Natura containing cellulase and ligninase enzymes could convert cellulose to glucose (Natura Product, 2013).

The results of analysis of variance showed no significant difference in body weight gain, this was due to the consumption of the same feed and consumption of the same protein. The treatment that had no significant effect on body weight gain also showed that the administration of fermented cassava peel waste up to 16% (treatment E) was still preferred by quail even though there was a reduction in the use of corn by 10% and concentrate 12% in feed, but it was still tolerable by quail, so that resulting the same body weight with feed that used a lot of corn and concentrate. This shortage was covered by fermentation products that produced more complete amino acids (Table 4) as the opinion of Nuraini *et al.* (2015b) that fermentation results in not only converting proteins into amino acids by the help of enzymes but also microbial bodies themselves contained amino acids.

The results of variance analysis were seen not significantly different on the feed conversion which showed that the use of fermented cassava peel waste with Natura up to the level of 16% with a reduction of corn by 10% and a reduction in concentrate by 12% in quail feed was also the same efficient in producing body weight gain compared to control feed that use a lot of corn and concentrate. The feed quality greatly determined the size of the feed conversion produced, high quality feed with balanced nutritional content and high palatability would result in better feed conversion, whereas low quality feed with low palatability resulted in bad feed conversion. The lower feed conversion, the higher the feed efficiency (Nuraini *et al*., 2017).

Conclusions

Natura was a multi-enzyme and probiotic product that could improve the quality of cassava peel waste. The 3% inoculum dose of Natura with 11 days of fermentation was the best treatment for increasing the nutritional content and quality of cassava peel waste. The use of 16% of fermented cassava peel waste with Natura in feed could maintain the performance of laying quail in the grower period, also reduce the use of corn 10% and concentrate 12%.

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