NUTRIENT DIGESTIBILITY OF THE WASTE OF SACCHARIFICATION PROCESS FROM CASSAVA BAGASSE ON THE LAYING HENS

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ABSTRAK

Penelitian bertujuan mempelajari kecernaan nutrien dan kandungan energi termetabolis limbah sakarifikasi onggok pada ayam petelur. Dua puluh ekor ayam petelur Strain ISA-Brown umur 72 minggu secara acak didistribusikan ke dalam tiga macam perlakuan pakan-uji meliputi onggok, limbah sakarifikasi onggok metode SSF (LSO-SSF) dan limbah sakarifikasi onggok metode SmF (LSO-SmF). Semua ayam dipuasakan selama 24 jam, kemudian 15 ekor diantaranya diberi makan onggok, LSO-SSF dan LSO-SmF (masing-masing 5 ekor). Lima ekor sisanya tetap dipuasakan. Selanjutnya semua ayam dipuasakan lagi dan dilakukan koleksi ekskreta selama 48 jam. Tingkat kecernaan nutrien yang diukur meliputi *apparent* dan *true digestibility* dari *dry matter* (ADDM dan TDDM), *crude fiber* (ADCF dan TDCF), *starch* (ADS dan TDS), dan *apparent* dan *true metabolizable energy* (AME dan TME). Hasil penelitian menunjukkan bahwa proses sakarifikasi onggok menghasilkan limbah padat dengan tingkat kecernaan nutrien (ADDM, TDDM, ADS, dan TDS) dan kandungan energi termetabolis (AME dan TME) nyata lebih rendah (P<0,05) dibandingkan dengan onggok. Tingkat kecernaan serat kasar limbah sakarifikasi mempunyai fenomena yang berkebalikan dimana LSO-SmF mempunyai tingkat kecernaan serat kasar (ADCF dan TDCF) lebih tinggi dibanding onggok. Penelitian disimpulkan bahwa tingkat kecernaan nutrien (kecuali tingkat kecernaan serat kasar) limbah sakarifikasi onggok lebih rendah dibandingkan dengan onggok.

Kata-kata kunci: kecernaan, onggok, limbah sakarifikasi, ayam petelur

ABSTRACT

The objective of this research was to study the nutrient digestibility and the metabolizable energy value of the waste of saccharification process from cassava bagasse (WSPCB) on the laying hens. Twenty ISA-Brown laying hens at the age of 72 weeks were randomly distributed into three feeding treatments which consisted of cassava bagase (CB), WSPCB of solid state fermentation method (WSPCB-SSF), and WSPCB of sub merged fermentation method (WSPCB-SmF). All of the hens were fasted for 24 hours and 15 of them were fed with CB, WSPCB-SSF and WSPCB-SmF (five hens for each test-diet). The other five hens were still fasted. Then, all of the hens were fasted again and their excreta were collected during 48 hours. The nutrient digestibilities which were measured consisted of the Apparent and True Digestibility of Dry matter (ADDM and TDDM), Crude Fiber (ADCF and TDCF), Starch (ADS and TDS), and the Apparent and True Metabolizable Energy (AME and TME). The result of this research showed that the saccharification process generated the solid waste with the nutrient digestibility value (ADDM, TDDM, ADS, TDS, AME, and TME) which were significantly lower (P<0.05) than those of CB. The crude fiber digestibility value of the WSPCB has an oposite phenomenon in which the ADCF and TDCF of WSPCB-SmF were greater than CB. In conclusion, the nutrient digestibility value, except for ADCF and TDCF, of the WSPCB on the laying hens were lower in value than those CB.

Keywords: digestibility, cassava bagasse, saccharification waste, laying hens.

INTRODUCTION

Indonesia has currently faced a sufficiently serious problem which is related to fossil oil fuel, including premium gasoline. The need of the fuel of premium type in 2006 reached 17 million kl out of the need of 70 million kl of oil fuels with the oil fuel subsidy as much as Rp 60.6 trillion (Prihandana *et al*., 2007). Bioethanol is a type of fuel which is programmed by the government of the Republic of Indonesia to substitute for the premium gasoline.

Bioethanol is the type of ethanol which is made of biomass through a biological process. Bioethanol can derive from the starch, sugar and the cellulose sources of biomass. The raw material of bioethanol which is not in competition against the allocation for food is the agricultural waste of cellulose source, including cassava bagasse (CB).

Cassava bagasse is a solid waste which results from the processing of cassava into tapioca. The production of cassava in Indonesia in 2002 reached the amount of 16.9 million tons. The output of cassava in majority is absorbed into the tapioca industry in such a way that more than1.2 million tons of CB are generated (BPS, 2003). The main nutrient element of CB is carbohydrate (Tisnadjaja, 1996) with high cellulose content of 29% (Ali-Mursyid *et al*., 2008). Cellulose is a characteristic nutrient which constitutes the cell wall of plants and has the chemical structure of D-glucose polymer with the β-1,4 glycosidic bond (Carlile *et al*., 2001).

The production of bioethanol from the material of cellulose source is initiated by the cellulolytic saccharification process to hydrolize cellulose into glucose (Atlas, 1997). Biologically the cellulolytic saccharification is a microbial activity to release the cellulase enzymes in degrading and transforming the cellulose into the simple compound of glucose which is easily consumed by microbes (Gianfreda and Rao, 2004). The use of the mutant of *Trichoderma* AA1 can increase the activities of cellulases (Ali-Mursyid *et al*., 2007).

The saccharification process goes through the cellulolytic fermentation from CB to generate the solid waste which is potential as the food or the supplement for fowls. The nutritive conversion from a cellulosic matter during the cellulolytic saccharification process can raise the nutritive value of the matter.

The increase of the digestibility of dry matter, protein, and metabolizable energy, in addition to the increase of protein and amino acid contents as well as the decrease of crude fibers and cellulose, occurs in the fermentation of CB by using the mutant of *Trichoderma* AA1 (Ali-Mursyid *et al*., 2008).) The significant increase of the digestibility of soluble protein and apparent metabolizable energy almost as much as 100 kcal/kg from the fermentation of CB by using *Aspergillus oryzae* (Ali-Mursyid and Zuprizal, 2005). Fermented CB can be used as substitute for corn up to 30% without affecting the performance and nutrient digestibility of broiler chicken (Ali-Mursyid *et al*., 2010).

The objective of this research was to study the nutrient digestibility and the metabolizable energy of the waste of saccharification process from cassava bagasse on the laying hens.

MATERIALS AND METHODS

Materials

The experiment was conducted *in vivo* to the laying hens of ISA-Brown at the age of 72 weeks with the weight ranged 1700 – 2000 g by using the total collection method and the wet force feeding technique (Lessire, 1990). The test-diets which were tested consisted of cassava bagase (CB), WSPCB of solid state fermentation method (WSPCB-SSF), and WSPCB of sub merged fermentation method (WSPCB-SmF). Each of the dry test-diet was finely ground, weighed, and then mixed with water in the proportion of 1:2. This test-diet was subsequently fed to the laying hens.

Experimental Design

Twenty hens were randomly arranged into individual battery cage which were equipped with a plastic tray excreta container. The experiment used was the completely randomized design. The treatments consisted of three kinds of test-diets, namely: CB, WSPCB-SSF, and WSPCB-SmF. Each of the test-diets was fed to five hens as a replications.

All of the hens were fasted for 24 hours, then 15 of them were fed with CB, WSPCB-SSF and WSPCB-SmF (five hens for each test-diet) by using the wet force feeding technique. The other five hens were still fasted. The amount of the feedings of the test-diet was 100g for each hen. Subsequently all of the hens were fasted again and at the same time their excreta were collected during 48 hours (Lessire, 1990). The drinking water was administered *ad libitum*. The collected excreta were dried under the sunlight for three days, separated from the feather and the foot scale of the hen, weighed, ground, and then their nutrient content which included dry matter, crude fiber, starch (Sudarmadji *et al*., 2004) and gross energy was analyzed.

The measured nutrient digestibility consisted of: the Apparent and True Digestibility of: Dry Matter (ADDM and TDDM in %), Crude Fiber (ADCF and TDCF in %), Starch (ADS and TDS in %), and Metabolizable Energy (AME and TME in kcal/kg). The calculations of nutrient digestibility and metabolizable energy based on Lemme *et al.* (2004) and Sibbald (1982), respectively. Equations were as shown bellow:

$$Apparent\ digestibility\ (\%) = \frac{NI - NE}{NI}\ x\ 100$$

$$True\ digestibility\ (\%) = \frac{NI - (NE + NEnd)}{NI}\ x\ 100$$

$$AME\ (kcal/kg) = \frac{EI - EE}{FI}$$

$$TME\ (kcal/kg) = \frac{EI - (EE + EEnd)}{FI}\ x\ 100$$

NI = Nutrient Intake (in g DM), NE = Nutrient Excrete (in g DM), NEnd = Nutrient Endogenous (in g DM), EI = Energy Intake (in g DM), EE = Energy Excrete (in g DM), EEnd = Energy Endogenous (g DM), and FI = Feed Intake (in g DM).

Statistical analysis

The data were analyzed by using the One-way analysis of variance with the Duncan's multiple range test as the further test (Ali-Mursyid, 2011).

RESULTS AND DISCUSSION

The saccharification process of CB produced solid waste which nutrient digestibility value (ADDM, TDDM, AME, and TME) were significantly lower than the raw materials of the CB. On the other hand, the saccharification method did not result in any significant difference in either the nutrient digestibility value of the WSPSB (Table 1). Although the SCW-SSF method was not statistically noticeable, it results in the nutrient digestibility levels which were a little lower than those of the SCW-SmF.

The phenomenon which occurs in this research was not in agreement with Ali- Mursyid and Zuprizal (2005) and Ali-Mursyid *et al*. (2008) which stated that the fermentation of the CB was able to increase ADDM, TDDM, AME, and TME on broiler. The decrease of the nutrient digestibility of this WSPCB was caused by the difference in the harvesting process. The harvesting process from the fermentation of the CB was conducted by Ali- Mursyid and Zuprizal (2005) and Ali-Mursyid *et al*. (2008) by picking up all of the biomass. In this research, the harvesting process was conducted by fractionating the liquid from the solid matter in such a way that some of the nutrients produce from the saccharification process got dissolved and then separated from the solid waste. The dissolved nutrient generated from the saccharification process, such as protein and amino acids (Ali-Mursyid *et al*., 2008), glucose (Ali-Mursyid *et al*., 2007) as well as the nutrient of the cell contents which were released in the fermentation process (Li *et al*., 2004) went along with the liquid fraction when harvested.

The results of the chemical analysis showed that the crude fiber content of the CB, the WSPCB-SSF and the WSPCB-SmF were 18.40%, 36.26% and 47.22%, respectively. The increasing of crude fiber in the WSPCB was a result of the loss of the nutrient with the liquid fraction at the time of the harvesting. The insoluble fiber contained in the diet causes the transit time of the digesta to decrease in such a way that the action of the digestive enzymes goes down as well (Choct, 2002).

Effect of separation of solid and liquid materials in the harvesting process also resulted in a decreased metabolizable energy of solid waste produced from saccharification, although its gross energy increased if compared to their raw materials. Gross energy of the CB, WSPCB-SSF, and WSPCB-SmF were 3391.86, 3685.61, 3797.33 kcal/kg, respectively.

The saccharification process produced the solid waste with the ADS and TDS which were significantly ($P<0.05$) lower than those of the raw materials. The digestibility value of crude fiber of the WSPCB have an oposite phenomenon. The saccharification process with the solid state fermentation (SSF) method was not significantly influential on the ADCF and the TDCF whereas that with the sub-merged fermentation (SmF) method significantly ($P<0.05$) increased the ADCF and the TDCF of the waste which is

Table 1. Digestibility Value of Dry Matter and Metabolizable Energy of Test-diets

Test-diet	Variables of Digestibility			
	ADDM (%)	TDDM (%)	AME (kcal/kg)	TME (kcal/kg)
CB	61.86 [b]	70.32 [b]	2173.68 [a]	2396.70 [a]
WSPCB-SSF	40.50 [a]	49.18 [a]	1522.35 [b]	1776.21 [a]
WSPCB-SmF	37.04 [a]	47.74 [a]	1801.53 [ab]	2114.12 [ab]

[ab] The different superscript in the same column indicates the significant difference (P<0.05), CB= Cassava Bagasse, WSPCB-SSF= Waste of Saccharification Process from Cassava Bagasse of Solid State Fermentation Method, WSPCB-SmF= Waste of Saccharification Process from Cassava Bagasse of Sub-merged Fermentation Method, ADDM= Apparent Digestibility of Dry Matter, TDDM= True Digestibility of Dry Matter, AME= Apparent Metabolizable Energy, TME= True Metabolizable Energy.

Table 2. Digestibility Value of Starch and Crude Fiber of Test-diets

Test-diet	Variables of Digestibility			
	ADS (%)	TDS (%)	ADCF (%)	TDCF (%)
NSCW	92.61 [a]	93.43 [a]	29.77 [b]	33.41 [b]
SCW-SSF	61.51 [c]	61.87 [c]	38.06 [b]	40.17 [b]
SCW-SmF	72.78 [b]	75.61 [b]	63.40 [a]	65.39 [a]

[ab] See Table 1

generated (Table 2).

The decrease of the digestibility value of starch (ADS and TDS) of the WSPCB was caused by the starch content of the waste which was 50% lower than its raw materials. The result of the chemical analysis indicated that the starch content of the CB, the WSPCB-SSF, and the WSPCB-SmF were 70.55%, 34.47%, and 23.57% respectively. As known, starch is the polysaccharide component which is easily digested by fowls.

Increasing of the digestibility value of the WSPCB is related to the microbial activities during fermentation. The degradation of cellulose into glucose during saccharification involves the complex cellulase enzyme which consists of endoglucanase (EG), cellobiohydrolase (CBH), and β-glucosidase which cooperate synergically (Meittinen-Oinonen *et al*., 2004). EG functions is to attack the inner side of cellulose and to fractionate the amorphous part (Haakana *et al*., 2004) which generates the new side with free chain end. This process causes the fibrillary formation of cellulose to become looser.

The difference in the digestibility value of crude fiber of WSPCB-SSF and WSPCB-SmF is related to the growth type of the microbe during saccharification. The Saccharification with the SSF method had lower water activity value (a_w) compared to the SmF method. The low value of a_w boosts the sporulation to occur earlier in such a way that the growth of mycelium will stop and the formation of spores will form immediately (Krishna, 2005). The growth of spores in the saccharification process with SSF method was higher than that in the process with SmF method which was opposite from the growth of mycelium. Spores have stronger cell walls compared to those of mycelium in such a way that spores are more difficult to digest.

CONCLUSION

The nutrient digestibility and the metabolizable energy of the waste of saccharification process from cassava bagasse on the laying hens are lower than those of its raw materials, except for the digestibility of crude fiber.

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