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Improving the Nutrient Quality of Juice Waste Mixture by Steam Pressure for Poultry Diet

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Abstract: The problem of juice waste mixture as poultry diet was high in crude fiber and low in metabolizable energy contents. Experiments were performed to improve the nutrient quality of juice waste mixture by using steam pressure. The first experiment was designed in a completely randomized design with 4 different incubation times of juice waste mixture (0, 15, 30, and 45 minutes) in Autoclave (15 psi pressure and 121°C), and each treatment was replicated 5 times. Measured variables were crude fiber, crude protein, crude fat. The second experiment was to compare of crude fiber, crude protein, ether extract, NDF, ADF, cellulose, hemi-cellulose, lignin, nitrogen retention, amino acid profile, and metabolizable energy of juice waste mixture between treated vs. untreated one. The results showed that the crude fiber, crude protein, and crude fat of juice waste mixture were significantly affected ($P<0.05$) by incubation time in autoclave. The incubation time for 30 minutes decreased crude fiber and crude fat, but increased crude protein contents of the juice waste mixture. The crude fiber, ether extract, NDF, ADF, cellulose, and lignin contents between untreated vs treated reduced from 17.10, 6.24, 34.30, 24.40, 12.20, and 11.80% to 12.02, 4.06, 32.62, 22.05,10.50,11.55%, respectively. Meanwhile, nitrogen retention, crude protein, hemi-cellulose, and metabolizable energy increased from 59.99, 8.40, 9.90%, and 1744 kcal/kg to 65.51, 13.35, 10.57%, and 2550 kcal/kg, respectively. In conclusion, the incubation time for 30 minutes in autoclave was the best treatment for improving the nutrient quality of juice waste mixture.

Key words: Juice waste mixture, steam pressure, nutrient quality, poultry

INTRODUCTION

Diversification of feeds is one of many alternative solutions to overcome the shortage of feed, especially corn in poultry diets. In producing fresh drink from some fresh fruits by extracting produces a waste which has a potency as a poultry feed for corn substitution. Our last experiment showed that the juice waste mixture from: carrot, apple, mango, avocado, orange, melon, and tree tomato in the same amount could be included in broiler diet upto 20% to effectively replace 40% corn in broiler diets (Rizal *et al*., 2010). The amino acid content of this juice waste mixture especially for tryptophan was 4 times higher than in corn and for lysine 1.6 times, glycine 1.6 times, and threonine 1.3 times. The problem of the juice waste mixture as poultry diet was the high in crude fiber content (17.10%). Result of fiber analysis by using Goering and Van Soest method (1970) indicated that the juice waste mixture content of NDF 34.30%, ADF 24.40%, cellulose 12.20%, and hemi-cellulose 9.90%, so that it was difficult to be digested in digestive tract of broilers. Besides, its metabolizable energy content was also low (1774 kcal/kg).

The improvement of juice waste mixture nutrient quality through reducing the crude fiber is necessary to be performed in order to be maximally included in poultry diet. Physical treatment by using autoclave could reduce the crude fiber content of the feed stuff. The steam pressure changed the chemical structure of cells and destroy some parts of crude fiber composition like ligno-cellulose and hemi-cellulose in feed stuffs, and it also modified the hemi-cellulose become more soluble component (Wong *et al*., 1974; Pate 1982; Kling *et al*.,1987). Mahata and Rizal (2000) found that crude fiber in *Desmanthus virgathus* decreased from 16.75 to 10.76% after processing by steam pressure in autoclave (15 psi, 121°C) for 45 minutes. Mirzah (1990) treated the crude fiber in shrimp waste by using steam pressure in Autoclave for 30 minutes, and this treatment decreased the crude fiber from 14.49 to 11.52%. There is no information available on the use of autoclave for improving the nutrient quality of the juice waste mixture.

MATERIALS AND METHODS

Experiment 1: The objective of experiment 1 was to improve the nutrient quality of juice waste mixture. The treatment was the incubation times (0, 15, 30, and 45 minutes) of the juice waste mixture (100 g per experimental sub unit) in autoclave (15 psi at 121°C). The experimental design was a completely randomized design with 5 replications for each treatment. Measured

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variables were crude fiber, crude protein, and ether extract which were analyzed according to AOAC (1984). The difference among treatment was determined by DMRT procedure according to Steel and Torrie (1980).

Experiment 2: The objective of this experiment was to compare the nutrient content of the best treated sample of the juice waste mixture which was obtained from the experiment 1 vs. untreated one. The nutrient contents to be compared were crude fiber, crude protein, ether extract, fiber profile (NDF, ADF, cellulose, hemi-cellulose and lignin), amino acid profile, nitrogen retention, and metabolizable energy of the juice waste mixture. Crude fiber, crude protein, and ether extract were analyzed by proximate analysis (AOAC, 1984), while NDF, ADF, cellulose, hemi-cellulose, and lignin, according to Goering and Van Soest (1970). Amino acid profile was analyzed by HPLC. Nitrogen retention and metabolizable energy were assayed according to Sibbald (1986).

RESULTS

Experiment 1

The Influence of steam pressure on crude fiber content in juice waste mixture: The crude fiber content of the juice waste mixture decreased very significantly ($P<0.01$) after treating by steam pressure. The lowest crude fiber content in the juice waste mixture occurred when this juice waste mixture was incubated for 30 minutes in autoclave (Table 1).

The influence of the steam pressure on the crude protein content of the juice waste mixture: The crude protein content of the juice waste mixture after treating by steam pressure increased very significantly ($P<0.01$). The highest crude protein content was found in the 45 minutes incubation of the juice waste mixture in the autoclave (Table 2).

The influence of the steam pressure on the ether extract content of the juice waste mixture: The steam pressure very significantly affected ($P<0.01$) the ether extract content of the juice waste mixture. Incubation of the juice waste mixture for 30 minute in autoclave showed the lowest content of ether extract (Table 3).

Experiment 2

The nutrient content, nitrogen retention, and metabolizable energy of treated vs. Un-treated juice waste mixture: The comparison of the nutrient content, nitrogen retention, and metabolizable energy between treated vs. un-treated juice waste mixture was shown in Table 4. The crude fiber, NDF, ADF, cellulose, ether extract, and lignin of the juice waste mixture decreased after it was treated by steam pressure, while the nitrogen retention and metabolizable energy content increased.

Table 1: The influence of steam pressure on crude fiber content in juice waste mixture

Treatment time incubation (minute) in autoclave (1 Atm 121°C)	Crude fiber content in juice waste mixture (%)
0	13.36[b]
15	13.31[b]
30	12.02[c]
45	14.15[a]
SE	00.17

SE: Standard Error

Table 2: The influence of steam pressure on crude protein content in juice waste mixture

Treatment time incubation (minute) in autoclave (1 Atm 121°C)	Crude protein content in juice waste mixture (%)
0	13.07[b]
15	13.60[b]
30	13.35[b]
45	15.17[a]
SE	00.35

SE: Standard Error

Table 3: The influence of steam pressure on ether extract content in juice waste mixture

Treatment time incubation (minute) in autoclave (1 Atm 121°C)	Ether extract content in juice waste mixture (%)
0	5.42[a]
15	5.46[a]
30	4.06[b]
45	5.35[a]
SE	0.11

SE: Standard Error

The amino acid profile of treated vs. Un-treated juice waste mixture: The amino acid profile of treated vs. un-treated juice waste is shown in Table 5. Several amino acid contents of the juice waste mixture increased after treated by steam pressure for 30 minutes in autoclave, while most of the amino acids decreased.

DISCUSSION

The crude fiber content of juice waste mixture decreased in relation to the increase in incubation time in autoclave. The lowest crude fiber content in juice waste mixture was achieved after incubated in autoclave for 30 minutes. The result of this experiment indicated that the steam pressure destroyed part of crude fiber in juice waste mixture cell wall, especially for ligno-celluloses. This condition was supported by the decrease in NDF and ADF and increase in hemi-celluloses after treated by steam pressure (Table 4). The decrease in ADF and NDF will increase the amount of soluble carbohydrate. According to Wong *et al.* (1974); Pate (1982) and Kling *et al.* (1987) the steam pressure changes the chemistry structure of cell wall and destroy part of crude fiber composition like ligno-celluloses and hemi-cellulose in feed stuff, and modify the hemi-celluloses become more soluble component. This result is in accordance with the result of experiment by Mahata and Rizal (2000) in

Table 4: Nutrient content, nitrogen retention and metabolizable energy of treated vs un-treated of juice waste

Nutrient content (%), nitrogen retention (%) and metabolizable energy (kkal/kg)	Un-treated juice waste	Treated juice waste by steam pressure (1 Atm 121°C for 30 min)
Crude fiber	17.10	12.02
Neutral Detergent Fiber (NDF)	34.30	32.62
Acid Detergent Fiber (ADF)	24.40	22.05
Cellulose	12.20	10.50
Hemicellulose	9.90	10.57
Lignin	11.80	11.55
Crude protein	8.40	13.35
Ether extract	6.24	4.06
Nitrogen retention	59.99	65.51
Metabolizable energy	1744.00	2550.00

Table 5: Amino acid profile of treated vs un-treated juice waste mixture

Amino acid	Un-treated juice waste mixture	Treated juice waste mixture by steaam pressure (1 Atm 121°C for 30 min)
Aspartate	0.71	0.61
Glutamate	0.90	0.77
Serine	0.32	0.32
Histidine	0.13	0.12
Glysine	0.41	0.39
Threonine	0.36	0.35
Arginine	0.31	0.25
Alanine	0.43	0.36
Tyrosine	0.23	0.21
Tryptophan	0.13	0.12
Methionine	0.06	0.07
Valine	0.41	0.39
Phenil alanine	0.31	0.31
Iso-leucine	0.34	0.32
Leucine	0.48	0.45
Lysine	0.34	0.20
Cystine	0.01	0.02
Cysteine	0.02	0.02
Proline	0.50	0.50

evaluation of crude fiber, ADF, and NDF content in *Desmanthus virgathus* after processing by steam pressure, in which the crude fiber declined from 16.75 to 10.76% at incubation time for 45 minutes. This result also is in accordance with Mirzah (1990) who found that the crude fiber in shrimp waste decreased from 14.4 to 11.52% after treated by steam pressure for 30 minutes. The prolong of the incubation time to 45 minutes in this experiment increased the crude fiber content of juice waste mixture. In this case, it was predicted there were other materials accumulated in the crude fiber, and increased the amount of total crude fiber in juice waste mixture. The increase in the crude protein content of the juice waste mixture in this experiment appeared at 45 minutes incubation in autoclave. It revealed the increasing of protein related with the destroyed of the cell wall by the steam pressure. In plant cell wall, there are some non-protein nitrogen compounds which are separated from crude fiber when treated by steam pressure. The non protein nitrogen compound will be accounted as crude protein, and contribute to the total amount of protein in the juice waste mixture. The ether extract decreased by increasing the time of incubation, and the lowest content of this ether-extract occurred at 30 minutes incubation time in autoclave. It was predicted that steam pressure destroyed the fat-soluble vitamin in ether extract (vitamin A, D, E and K), and the carotenoid content of the juice waste mixture, so that it decreased the total ether extract in this juice waste mixture. In this experiment, the prolong of incubation time upto 45 minutes increased the ether extract. In this case, it cannot be understood the factor that affected the increase of it. Nitrogen retention increased after treated by steam pressure. This condition was related to the separation of crude protein from the crude fiber-protein complex in the cell wall. The crude fiber was already destroyed by steam pressure, and it affected the rate of passage of protein in broiler digestive tract. This condition will bring more protease to digest the crude protein and increased nitrogen absorption. Metabolizable energy increased after treated by steam pressure. It was related to the increase in the nutrient digestibility which contributes to energy. Most of the amino acids decreased, while several of them increased after treated by steam pressure. It indicated that some of amino acids were destroyed by steam pressure and in the percentage increased the total amount of other amino acids. In the other side, some of amino acids were stable in response to steam pressure.

Conclusion: The incubation for 30 minutes in the steam pressure (15 psi at 121°C) was the best treatment for improving the nutrient quality of the juice waste mixture.

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