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Improving the Nutrient Quality of Carrot and Fruit Juice Wastes Mixture for Poultry Diet Through Utilization of Rice-Hull Ash Filtrate

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Abstract: Two experiments had been conducted to improve the nutrient quality of carrot and fruits (apple, mango, avocado, orange, melon and tree-potato) juice waste mixture. Experiment 1: to determine effects of rice-hull ash filtrate level and soaking length on nutrient contents of this juice waste mixture. A 3 x 4 factorial experiment in a completely randomized design with 3 replicates was performed. First factor was rice-hull ash filtrate level (10, 20 and 30%) and second factor was soaking length (0, 24, 48 and 72 h). Measured variables were: crude fiber, crude protein and ether extract contents. Experiment 2: to compare treated vs. untreated juice wastes mixture numerically. Nutrient contents (crude fiber, crude protein and ether extract), anti-nutrition contents (phytate and tannin) and nutritive values (amino acids profile, nitrogen retention and metabolizable energy) of treated juice waste mixture were compared with untreated one. Results of experiment 1: crude fiber and ether extract reduced ($p<0.01$) by soaking in 20% rice-hull ash filtrate for 72 h, while crude protein increased ($p<0.01$). In experiment 2, crude fiber and ether extract decreased from 17.10 to 12.70% and 6.18 to 5.50%, respectively. Crude protein and phytate increased from 9.58 to 12.22% and 0.84 to 1.28%, respectively. Tannin content did not differ (1.60 vs. 1.59%). Amino acid contents were improved. Nitrogen retention and metabolizable energy were augmented from 59.99 to 67.57% and from 1744 to 2717 kcal/kg, respectively. In conclusion, carrot and fruit juice wastes mixture soaking in 20% rice-hull ash filtrate for 72 h improved its nutrient quality.

Key words: Nutrient quality, carrot and fruit juice waste mixture, poultry diet, rice-hull ash filtrate

INTRODUCTION

Some experiments about the utilization of wastes from fruits and vegetables had been performed. Ghazi and Drakhshan (2006) reported that the inclusion of up to 15% of untreated tomato pomace could be recommended for practical poultry diet formulation. While, Al-Betawi (2005) found that tomato pomace could be used in broiler rations at a level of 10% from the total diet and more investigations are still needed on this subject. Another study had shown that the sun dried sweet orange (*Citrus sinensis*) rind could be used to replace dietary maize in the diet of broilers at 15% level (Oluremi *et al*., 2006). Further experiment by Aju *et al*. (2010) reported that sweet orange peel meal could be included up to 20% for maize replacement in broiler diets. Diarra *et al*. (2010) recommended that the boiled mango kernel meal could replace up to 60% of the maize in the diet of broilers without adverse effects on growth, carcass measurements and blood parameters. Apple by products could be included up to 10% in the broiler diet (Zafar *et al*., 2005).

Diversification of feeds is one of the alternative solutions to overcome the shortage of feed, especially corn in poultry diets. This diversification can be obtained from the mixture of juice waste of variety of fruits and other food stuffs. Rizal and Mahata (2009) investigated the utilization of carrot (*Daucus carotta*) and fruits apple (*Mallus sylvestris*), mango (*Mangifera indica*), avocado (*Persea americana*), orange (*Citrus* sp.), melon (*Cucumis melo* L.), tree tomato (*Cyphomandra betacea* Sendtn.) juice waste mixture in the same proportion for poultry diets. This juice waste mixture (JWM) was originated from fresh carrot and fruits after processing for making juice drink. Nutrient and energy contents of this JWM are: water 11.0%, dry matter (DM) 89.0%, crude protein (CP) 8.4%, crude fiber (CF) 17.1%, ether extract (EE) 6.2%, Ca 0.09%, P 0.01% and metabolizable energy (ME) 2744 kcal/kg (Rizal *et al*., 2010a). The fiber profile was neutral detergent fiber (NDF) 34.3%, acid detergent fiber (ADF) 24.4%, cellulose 12.2%, hemicellulose 9.9% and lignin 11.8% (Rizal *et al*., 2010b). This JWM could be used up to 20% to effectively replace 40% corn in poultry diets (Rizal *et al*., 2010a). The amino acid (AA) contents, especially for tryptophan in JWM is 4 times higher than in corn and for lysine 1.6 times, glycine 1.6 times and threonine 1.3 times (Rizal *et al*., 2010a). The comparison of AA contents of the JWM to corn is depicted in Table 1.

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The constraints in the utilization of JWM in the broiler diet are the high in its CF and the low in its ME contents, while other problems have not been investigated yet. For maximizing of JWM utilization in poultry diets, its CF content should be degraded by physical, chemical or biological treatment. Biological treatment conducted by Sarwar (1994), physical and chemical treatment (Sarwar *et al*., 2004a; Sarwar *et al*., 2004b) had been used to weaken and breakdown the ligno-cellulose bonds of crop residues.

Chemical treatment such as the utilization of alkali or hydrogen peroxide had been studied intensively and reported to decrease the crude fiber content of feed stuffs. Alkali solution can be obtained from the mixing of rice-hull ash with water and filtered it to produce the rice-hull ash filtrate. The 10% use of the rice-hull ash filtrate for soaking the shrimp waste for 48 h, decreased its chitin content (Mirzah, 2008). Suwandyastuti and Bata (2010) reported that the use of 10% rice-hull ash filtrate improved volatile fatty acid (VFA) production, ammonia nitrogen and microbial protein synthesis in ruminants. There is no information available on the use of this rice-hull ash filtrate for improving the nutrient quality of JWM. The main aim of these experiments was to study the improvement of the nutrient quality of JWM through chemical treatment by using the rice-hull ash filtrate. The specific objectives of the experiment 1 are: (a) to determine the effects of the level of rice-hull ash filtrate and the length of soaking on the CF, CP and EE contents of the JWM and (b) to obtain the appropriate level of rice-hull ash filtrate and length of soaking for improving the nutrient quality of this JWM. The specific objectives of experiment 2 were to compare the nutrient contents (CF, CP and EE), the anti nutrition contents (phytate and tannin) and the nutritive values (AA content, nitrogen retention and ME) of the best treated JWM from experiment 1 versus untreated one.

MATERIALS AND METHODS

Experiment 1: Carrot juice waste and fruit juice wastes (apple, mango, avocado, orange, melon and tree tomato) were dried individually under sunlight until their water content reach approximately 12%. Next, each juice waste was mixed together in the same proportion to produce JWM.

Rice-hull ash was mixed with water at different concentrations (10, 20 and 30%) for producing different level of rice-hull ash filtrate concentrations. Then, this solution was filtered to obtain its filtrate.

This experiment was performed in a 3 x 4 factorial experiment in a completely randomized design with 3 replications. The first factor was the concentration of rice-hull ash filtrate (10, 20 and 30%) and the second factor was the soaking length (0, 24, 48 and 72 h) of samples. The measured variables were crude fiber, crude protein and ether extract content of carrot and fruit juice wastes mixture after treatment.

One hundred grams of JWM of each experimental unit was soaked in 300 mL of rice-hull ash filtrate in a plastic container according to the rice-hull ash filtrate concentrations (10, 20 and 30%). There were 36 samples (experimental units) in this experiment. Then, these samples were allowed in these plastic containers for the period according to treatments (0, 24, 48 and 72 h). After soaking, these samples were dried in the oven at 60°C for the preparation of the proximate analyses. The CF, CP and EE contents of JWM were determined according to AOAC International (2002).

All of the data obtained were statistically analyzed by analysis of variance of factorial experiment in a completely randomized design. The differences among treatments were determined by using DMRT according to Steel and Torrie (1980).

Experiment 2: The best result from experiment 1 was further analyzed its anti-nutrition contents (phytate according to Kwanyuen and Burton (2005) and tannin by FAO/IAEA (2000)) and nutrient quality (nitrogen retention and metabolizable energy according to Sibbald (1986) and amino acid content by using HPLC).

The data of crude fiber, crude protein, ether extract, phytate, tannin, nitrogen retention, metabolizable energy and amino acids were numerically compared with the untreated JWM.

RESULTS

Experiment 1

Effect of treatment on crude fiber: The effect of doses (10, 20 and 30%) of rice-hull ash filtrate and length (0, 24, 48 and 72 h) of soaking on the crude fiber content of JWM is figured out in Table 2. The result of experiment indicated that rice-hull ash filtrate concentrations (doses) very significantly affected ($p<0.01$) the CF

Table 1: Comparison of amino acid contents in carrot and fruit juice wastes mixture to corn*

	------- Amino acids concentration (%) -------	
Amino acids	Corn	Juice wastes mixture
Aspartate	-	0.71
Glutamate	-	0.98
Serine	0.37	0.46
Histidine	0.23	0.14
Glycine	0.33	0.54
Threonine	0.29	0.39
Arginine	0.38	0.37
Alanine	-	0.54
Tyrosine	0.30	0.43
Methionine	0.18	0.13
Valine	0.40	0.44
Phenylalanine	0.38	0.37
Iso leucine	0.29	0.34
Leucine	1.00	0.54
Lysine	0.26	0.42
Proline	-	0.68
Cysteine	0.18	0.05
Tryptophan	0.06	0.23

*Rizal *et al*. (2010a)

Table 2: Effect of rice-hull ash filtrate level and soaking length on the crude fiber content (%)

Treatment	B0 (0)	B1 (24)	B2 (48)	B3 (72)	Average
A1 (10%)	16.31^{Aa}	16.19^{Aa}	15.09^{Ba}	14.49^{Ca}	15.52
A2 (20%)	14.99^{Ab}	15.40^{Ab}	13.38^{Bb}	12.70^{Cb}	14.12
A3 (30%)	14.62^{Ab}	14.61^{Ac}	12.80^{Bc}	13.33^{Bc}	13.84
Average	15.31	15.40	13.76	13.51	

^{A,B,C}Means with different capital letter superscripts in the same row indicated statistically different ($p<0.05$)
^{a,b,c}Means with different small letter superscripts in the same column indicated statistically different ($p<0.05$)

Table 3: Effect of rice-hull ash filtrate level and soaking length on the crude protein content (%)

Treatment	B0 (0)	B1 (24)	B2 (48)	B3 (72)	Average
A1 (10%)	9.58^{Ca}	11.92^{Ba}	12.22^{ABa}	12.53^{Aa}	11.56
A2 (20%)	9.88^{Ba}	11.00^{ABa}	10.69^{Bab}	12.22^{Aa}	10.95
A3 (30%)	8.68^{Ba}	11.61^{Aa}	11.91^{Ab}	9.78^{Bb}	10.50
Average	9.38	11.51	11.61	11.51	

^{A,B,C}Means with different capital letter superscripts in the same row indicated statistically different ($p<0.05$)
^{a,b,c}Means with different small letter superscripts in the same column indicated statistically different ($p<0.05$)

Table 4: Effect of rice-hull ash filtrate level and soaking length on the ether extract content (%)

Treatment	B0 (0)	B1 (24)	B2 (48)	B3 (72)	Average
A1 (10%)	6.18^{Aa}	5.90^{Ba}	5.63^{Cb}	5.45^{Da}	5.79
A2 (20%)	6.14^{Aa}	5.72^{Bb}	5.81^{Ba}	5.50^{Ca}	5.79
A3 (30%)	5.91^{Ab}	5.70^{Bb}	5.38^{Cc}	5.22^{Cb}	5.55
Average	6.08	5.77	5.61	5.39	

^{A,B,C,D}Means with different capital letter superscripts in the same row indicated statistically different ($p<0.05$)
^{a,b,c}Means with different small letter superscripts in the same column indicated statistically different ($p<0.05$)

content of JWM and length of soaking also very significantly influenced ($p<0.01$). The interaction between doses and length of soaking was detected very significantly ($p<0.01$) in the CF content of JWM.

Effect of treatment on crude protein: The effect of doses (10, 20 and 30%) of rice-hull ash filtrate and length (0, 24, 48 and 72 h) of soaking on the CP content of JWM are depicted in Table 3. Crude protein content of the JWM was highly affected by doses ($p<0.01$) and significantly influenced ($p<0.05$) by length of soaking. There was a very significant interaction ($p<0.01$) between doses and soaking length in the CP content of JWM.

Effect of treatment on ether extract: The effect of doses (10, 20 and 30%) of rice-hull ash filtrate and length (0, 24, 48 and 72 h) of soaking on the EE content of JWM is illustrated in Table 4. Results of this experiment indicated that EE of the JWM was very significantly affected ($p<0.01$) by rice-hull ash filtrate doses and by the soaking length ($p<0.01$). An interaction between doses and soaking length was detected very significantly ($p<0.01$) in the EE of this JWM.

Experiment 2

Comparison between treated vs. untreated juice wastes mixture: The comparison between the nutrient contents, anti-nutrition contents, nitrogen retention and ME content of treated JWM versus untreated one are illustrated in Table 5 and the comparison of AA content between treated and untreated JWM is depicted in Tabel 6.

DISCUSSION

Experiment 1: There was an interaction between rice-hull ash filtrate dose and soaking length in the CF content of the JWM. When the dose was increased, there was a reduction in CF content at the same length of soaking, but when the length of soaking was also increased, there was a dramatic reduction in CF content. This dramatic reduction of CF content occurred at the dose A2 (20%) and length of soaking B3 (72 h), even though it was not different from A3 (30%) and B2 (48 h). The result of experiment by Mirzah (2008) showed that the soaking of shrimp wastes in 10% rice-hull ash filtrate for 48 h could reduced its chitin content from 15.24 to 9.48%. The decrease in CF content might be related to the decrease in hemicelluloses content as found by Arisoy (1998) that alkali treatment (NaOH) reduced the hemicelluloses content of barley straw. When the dose of rice-hull ash filtrate was increased at the same length of soaking, there was no difference in CP content. However, when the length of soaking was increased at the same level of dose, there was an increase in CP content. When the dose and length of soaking were augmented to a certain level, the CP content went up. However, at the peak level of dose and length of soaking, the CP content went down again. In this study, the dose of 20% and the length of soaking 72 hr was enough to increase the CP content. Labib *et al.* (2010) reported that alkaline (NaOH) treatment increased the CP content of water lettuce. This result was also in accordance with the result found by Ameen *et al.* (2014) that the CP content of *Jatropha curcas* seed cake was augmented by alkaline treatment. Makishi

Table 5: Nutrient content, anti-nutrition content, nitrogen retention and metabolizable energy of untreated vs. treated juice wastes mixture

Compound and energy	Untreated	Treated
Crude fiber (%)	17.10	12.70
Crude protein (%)	8.40	12.22
Ether extract (%)	6.24	5.50
Phytate (%)	0.84	1.28
Tannin (%)	1.60	1.59
Nitrogen retention (%)	59.99	67.57
Metabolizable energy (kkal/kg)	1744	2717

Table 6: Amino acids content of untreated and treated carrot and fruit juice wastes mixture (% as fed)

Amino Acids	Untreated	Treated
Aspartate	0.71	0.79
Glutamate	0.90	0.92
Serine	0.32	0.40
Histidine	0.13	0.17
Glycine	0.41	0.50
Threonine	0.36	0.48
Arginine	0.31	0.34
Alanine	0.43	0.47
Tyrosine	0.23	0.27
Tryptophan	0.13	0.17
Methionine	0.06	0.09
Valine	0.41	0.51
Phenyl alanine	0.31	0.39
Iso-leucine	0.34	0.43
Leucine	0.48	0.58
Lysine	0.34	0.42
Cystine	0.01	0.02
Cysteine	0.02	0.03
Proline	0.50	0.54

et al. (2014) also found that alkaline treatment increased the CP content of freeze-dried proteins extracted Castor bean cake. However, Parnian *et al.* (2014) reported that there was no effect of alkaline treatment on the CP content of sorghum grain. Suksombat (2004) also reported that the CP content of bagasse and rice straw was not influenced by alkali (NaOH) treatment. The result of this experiment was in contrast to Steiner *et al.* (1983) who found that the CP content of feather meal decreased when the level of alkali (NaOH) treatment increased. When the dose of rice-hull ash filtrate was increased, there was a slightly decrease in the EE content at the same soaking length. However, when the soaking length was augmented, a very significant decline in EE occurred. In this experiment the rice-hull ash filtrate dose of 20% (A2) and soaking length of 72 h (B3) was appropriate to reduce the EE content of JWM. This result was in accordance with Arisoy (1998) who found that EE content of barley straw was declined by alkali (NaOH) treatment. Makishi *et al.* (2014) also reported that alkaline treatment decreased the EE content of freeze-dried proteins extracted Castor beancake. However, the EE content of bagasse and rice straw was not affected by alkali treatment (Suksombat, 2004).

Experiment 2: The soaking of JWM in 20% rice-hull ash filtrate for 72 h declined its CF and EE contents from 17.10 to 12.70 and 6.24 to 5.50, respectively. On the other hand, the CP, nitrogen retention and ME increased from 8.40 to 12.22%, 59.99 to 67.57% and 1747 to 2717 kcal/kg, respectively. The soaking in 20% rice-hull ash filtrate for 72 h increased the phytate content of JWM. This result was in contrast to Ochanda *et al.* (2010) who reported that alkaline treatment decline the phytate content of red sorghum, white sorghum and pearl millet. Tannin content of JWM was not affected by soaking in rice-hull ash filtrate for 72 h. Meanwhile, Ochanda *et al.* (2010) and Parnian *et al.* (2014) found that alkali treatment decrease the crude tannin content of sorghum grain. Amino acid contents of the JWM were numerically different between untreated and chemically treated by using rice-hull ash filtrate. When this JWM was treated chemically by using rice-hull ash filtrate at the level of 20% for 72 h, there was an increase in most of the AA content of the JWM. All of its AA content were numerically higher than those of the untreated JWM. Ameen *et al.* (2014) also reported that there was an improvement of *Jatropha curcas* seed cake when it was treated with alkaline. So, the overall results of these experiments showed that the soaking of JWM in 20% rice-hull ash filtrate for 72 h improved its nutrient quality.

Conclusion: The soaking of JWM in 20% of rice-hull ash filtrate for 72 h was appropriate to reduce its CF and EE and to augment its CP contents. This combination of treatments improved the nutrient quality of JWM.

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