

**Production Performance and Carcass Percentage of Broilers Fed Distillers Dried Grain From rice Husks With Co-culture Fermentation of *Saccharomyces cerevisiae* With *Candida tropicalis***

By:  
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**Abstract**

**Background and Objective:** Distillers dried grains of bioethanol production can be used as an alternative source of energy and protein for poultry feed. Sources of raw material for energy are very important to reduce the cost of poultry feed. The present study aims to find the proportion of distillers dried grains from a rice husk with co-culture fermentation of *Saccharomyces cerevisiae* with *Candida tropicalis* as feed ingredients for broiler chickens to replace corn. **Materials and Methods:** One hundred day-old chicks (DOC) were used in the present study. The experiment used a completely randomized design (CRD) with 6 treatments and different replications. Six formulations of treatment feed were made for the starter and finisher periods, each consisting of 0, 5, 10, 15, 20 and 25% rice husk DDG in broiler chicken rations. In the present study, the composition of DDG nutrients and formulated feed were analyzed according to AOAC recommendations. **Results:** Corn substitution with rice husk DDG up to a proportion of 15% does not negatively affect the growth and weight of harvest, feed consumption and feed conversion, carcass, liver organ and gastrointestinal tract percentage and nitrogen retention of broiler chicken. However, replacement of corn with 20-25% rice husk DDG can decrease growth and harvest weight, feed conversion and nitrogen retention of broiler chicken. **Conclusion:** The rice husk DDG can be used as a formulation material and replaces 15% corn in broiler chicken rations.

Key words: distillers dried grain, rice husk, *Saccharomyces cerevisiae*, *Candida tropicalis* broiler chicken, and ration

## INTRODUCTION

Lignocellulose biomass is an ideal raw material for the production of bioethanol as a liquid fuel that can be ordered<sup>1</sup>. Conversion of lignocellulose biomass including agricultural waste to bioethanol is an important choice for exploiting alternative energy sources and reducing air pollution<sup>2,3</sup>.

The development of the bioethanol industry can produce by-products that are quantitatively potential as raw material for other industries including the animal feed industry. Utilization of distillers dried grains for various purposes including as raw material for livestock is very important to maximize the benefits of the bioethanol industry<sup>4</sup>. Distillers dried grains as the main by-product of bioethanol production are known to be sources of protein, energy, water soluble vitamins and minerals and good amino acids for poultry<sup>5,6,7</sup>. Distillers dried grains of bioethanol production can be used as an alternative source of energy and protein for poultry feed<sup>8</sup>.

The previous study indicated that co-culture *Saccharomyces cerevisiae* with *Candida tropicalis* can produce bioethanol from rice husk<sup>9,10</sup>. However, research on the potential use of distillers dried grains from rice husk fermentation by co-culture *S. cerevisiae* with *C. tropicalis* as animal feed, especially poultry has never been carried out. Sources of raw material for energy are very important to reduce the cost of poultry feed<sup>11</sup>. Feed energy costs can reach 70% of the total cost of feed<sup>12</sup>. Distillers dried grain is generally used in poultry feed which functions as dietary energy, digestible amino acids, and bioavailable phosphorus and can reduce the use of corn, soybean meal, and inorganic phosphorus<sup>13</sup>. Increasing prices and non-availability of corn as a source of feed energy encourage poultry nutritionists to look for alternative energy sources for corn<sup>14</sup>. The present study aims to find the proportion of

distillers dried grain from a rice husk a co-culture fermentation of *S. cerevisiae* with *C. tropicalis* as feed ingredients for broiler chickens to replace corn.

## MATERIALS AND METHOD

The present study was conducted at the Laboratory of Animal Physiology, Department of Biology, Faculty of Mathematical and Natural Science, University of PGRI Adi Buana Surabaya, Indonesia, in April – June 2018.

**Preliminary treatment of rice husks:** Local farm-sourced rice husks from Sidoarjo, Indonesia were air dried for 2 days and then ground to approximately 2-mm-diameter particles using a grinder mill. The milled rice husks were steamed at 130°C for 3 hours, cooled to room temperature, mixed with 0.25% H<sub>2</sub>SO<sub>4</sub> and autoclaved for 15 min at 121°C. The rice husk hydrolysate was cooled and stored at 1°C to 5°C in the dark until it was used.

**Fermentation:** The rice husks hydrolysate is dissolved in water, filtered in cotton cloth, and the filtrate is dried. A total of 5 kg of rice husks hydrolysate was added to a 100 l plastic drum added 1.0 molasses, 1.0 kg fish meal, 60.0 g NaNO<sub>3</sub>, 100 g NH<sub>4</sub>NO<sub>3</sub>, 20.0 g KH<sub>3</sub>PO<sub>4</sub> and 14.0 g MgSO<sub>4</sub>• 7H<sub>2</sub>O and sterile water until the volume reached 100 l. The mixture was then stirred and the pH of the medium was adjusted by adding NaOH until the pH reached 5.5, tightly closed and left for 24 hours. The mixture of medium was inoculated with 2 l of starter culture containing 10<sup>6</sup> ml<sup>-1</sup> of *S. cerevisiae* and 10<sup>6</sup> ml<sup>-1</sup> of *C. tropicalis* spores. The inoculated media was incubated for 7 days at 28-30°C, 60-70% relative humidity in the dark. After fermentation, medium was harvested and distilled at 70-75°C until thick and dried at 60°C, ground in miller and then sieved to obtain DDG meal. The fermentation process with new media is carried out repeatedly until distillers dried grain reaches approximately 75 kg. Distillers dried grain (DDG) rice husks was analyzed for proximate composition in accordance with Association of Official Analytical Chemists (AOAC)<sup>15</sup> recommendations consists of dry matter, crude protein, crude fat, carbohydrates, calcium and phosphorus.

**Feed formulation:** Broiler rations were formulated to replace part of the corn with rice husk DDG according to the range of broiler nutritional requirement as recommended by National Research Council (NRC)<sup>15</sup>. All feed ingredients in dry conditions were mixed and made in the form of granules for starter broiler (days 1-21) and pellets for the finisher period (days 22-42). A total of 6 feed formulations for starter and finisher broiler were made in this study with the proportion of rice husk DDG 0 (A), 5 (B), 10 (C), 15 (D), 20 (E), and 25% (F). Each feed formulation was analyzed for proximate composition in accordance with AOAC recommendations consists of dry matter, crude protein, crude fat, carbohydrates, calcium and phosphorus.

**Experimental design:** This study was conducted in a completely randomized design (CRD) with 6 treatments of feed formulations (0, 5, 10, 15, 20, and 25% DDG in diets) and different replications. One hundred day old chicks (DOC) were randomly divided into 6 groups. The first four groups (A, B, C, and D) each consisted of 17 heads broilers and 2 second groups (E and F) each consisting of 16 heads. Each group was given formulated feeds (0, 5, 10, 15, 20 and 25% DDG) for both the starter and finisher period feed. All chickens were kept in individual cages bamboos (30 x 30 X 30 cm) for 42 days at 27-28°C. The birds were vaccinated at 4 days (eye drops), 14 and 21 days (intramuscular) against Newcastle disease. Each cage was equipped with a plastic feeder and a plastic drinker. The experimental diets and water were offered for *ad libitum* consumption.

**Data collection:** Collected data were feed intake (kg head<sup>-1</sup>), live weight (kg head<sup>-1</sup>), feed conversion, carcass percentage (% live weight head<sup>-1</sup>), liver organ (% live weight head<sup>-1</sup>), gut tract (% live weight head<sup>-1</sup>) and nitrogen retention (%) of broilers. Feed intake and live weight of broiler were recorded weekly to assess feed conversion. Carcass, liver organ, gastrointestinal tract percentage were recorded at 41 days and nitrogen retention (%) was recorded at 40 days of rearing.

**Data analysis:** All observational data were analyzed using one-way analysis of variance for complete randomized design at 5% level of significance ( $P < 0.05$ ). Further test was carried out by Tukey's test to determine differences among treatments if the treatment has a significant effect ( $P < 0.05$ ) on the observational variable.

## RESULTS.

**Nutritional composition of rice husk DDG:** Nutritional composition of DDG from rice husks with co-culture fermentation of *S. cerevisiae* with *C. tropicalis* is shown in Figure. 1. The rice husk DDG shows high carbohydrate (57.51%) but low in crude protein (9.43%) content. DDG rice husk also shows high fat, calcium and phosphorus content.

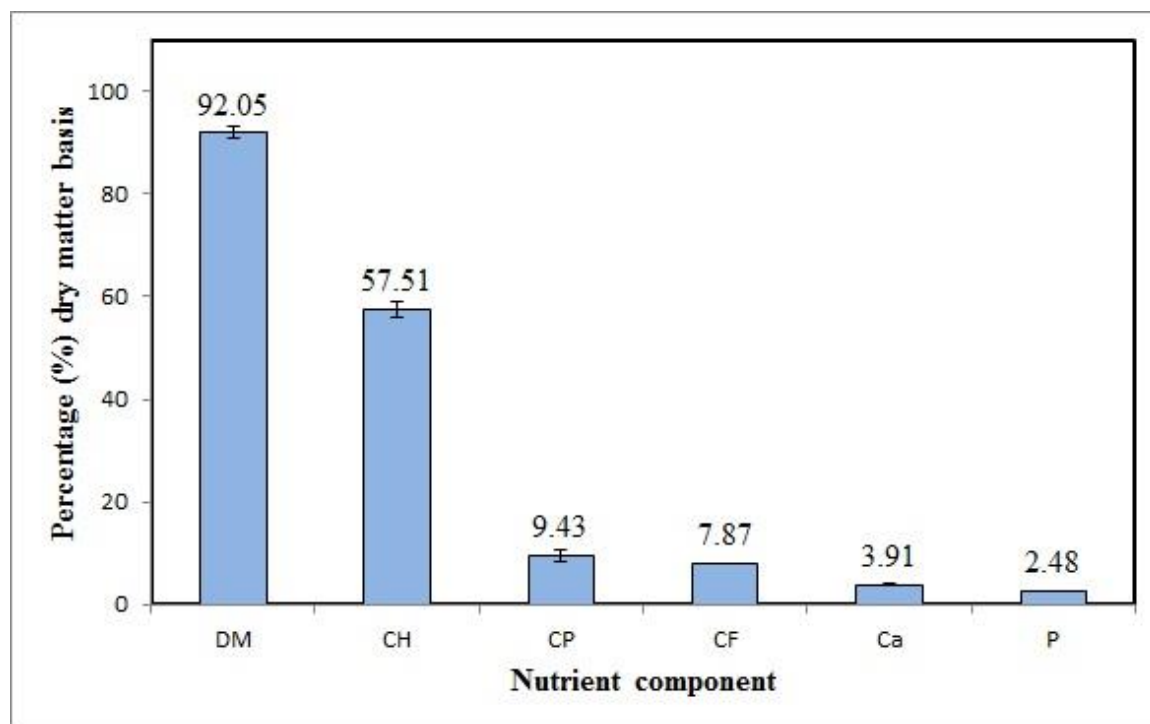


Figure 1. Nutrient composition of rice husk DDG, DM: dry matter, CH: Carbohydrate, CP: crude protein, CF: crude fat, Ca: calcium, P: phosphorus

**Formulation and nutrient ration:** Ingredient and nutritional composition of the experimental diets fed to broilers from 1 to 21 days of age is shown in Table 2. Gradual

replacement of corn with rice husk DDG in starter period of ration formulations decreases crude protein levels but increases carbohydrates, crude fat and energy.

Ingredient and nutritional composition of the experimental diets fed to broilers from 22 to 42 days of age is shown in Table 2. Like the starter period ration, the gradual replacement of corn with rice husk DDG in the finisher period of ration formulation decreases crude protein content but increases carbohydrate, crude fat and energy.

Table 1. Ingredient and nutritional composition of the experimental diets fed to broilers from 1 to 21 days of age (starter period).

Ingredient	Formulation					
	A	B	C	D	E	F
Rice bran (%)	1.00	1.00	1.00	1.00	1.00	1.00
Yellow corn (%)	50.00	45.00	40.00	35.00	30.00	25.00
Soybean meal (%)	10.00	10.00	10.00	10.00	10.00	10.00
Pearl millet (%)	1.00	1.00	1.00	1.00	1.00	1.00
Distiller dried grain (%)	0.00	5.00	10.00	15.00	20.00	25.00
Local fish meal (%)	25.00	25.00	25.00	25.00	25.00	25.00
Meat bone meal	11.50	11.50	11.50	11.50	11.50	11.50
Topmix (%)*)	1.40	1.40	1.40	1.40	1.40	1.40
Bone meal (%)	0.10	0.10	0.10	0.10	0.10	0.10
Nutritional composition						
Crude protein (%)	22.24	21.96	20.92	19.68	19.64	19.27
Crude fat (%)	3.19	3.69	3.75	3.97	4.05	4.15
Carbohydrate (%)	46.27	49.08	49.25	49.33	49.72	51.66
Calcium (%)	2.18	2.24	2.29	2.34	2.4	2.45
Phosphorus (%)	1.66	1.69	1.73	1.76	1.79	1.82
Energy (Kcal kg <sup>-1</sup> **)	3027.50	3173.70	3144.30	3117.70	3138.90	3210.70

\*) Topmix composition per kg as follows: vitamin A, 1,000,000 IU; vitamin B12, 400 mg; vitamin D, 100,000 IU;DL-methionine, 22,700 mg; vitamin E, 700 mg; antioxidant, 12,500 mg, vitamin K3, 100 mg, Mg, 5,000 mg; vitamin B1, 100 mg; Fe, 1,000 mg; vitamin B2, 600 mg, Cu, 200 mg; vitamin B6, 50 mg, Mn,1,500 mg; Niacin 1,000 mg; Zn, 1,000 mg; Panthothenic acid, 50 mg; I, 10 mg, and Choline chloride, 1,000 mg

\*\*)Calculated

**Live weight:** Present study showed that the use of rice husk DDG in the experimental ration significantly ( $P<0.05$ ) decreased the live weight of broiler chickens. At ages 3 to 6 weeks (Table

3), the live weight of broiler chickens fed 25% proportion of rice husk DDG was significant ( $P < 0.05$ ) lower than 0, 5, 10, 15 and 20%. There were no significant ( $P > 0.05$ ) differences in live weight of broilers fed 0, 5, 10, 15, and 20% proportion of rice husk DDG, but 25% was significantly ( $P < 0.05$ ) lower than the others.

Table 2. Ingredient and nutritional composition of the experimental diets fed to broilers from 22 to 42 days of age (finisher period).

Ingredient	Formulation					
	A	B	C	D	E	F
Rice bran (%)	2.50	2.50	2.50	2.50	2.50	2.50
Yellow corn (%)	60.00	55.00	50.00	45.00	40.00	35.00
Soybean meal (%)	11.00	11.00	11.00	11.00	11.00	11.00
Pearl millet (%)	3.00	3.00	3.00	3.00	3.00	3.00
Distiller dried grain (%)	0.00	5.00	10.00	15.00	20.00	25.00
Local fish meal (%)	20.00	20.00	20.00	20.00	20.00	20.00
Meat bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Topmix (%) <sup>*)</sup>	1.40	1.40	1.40	1.40	1.40	1.40
Bone meal (%)	0.10	0.10	0.10	0.10	0.10	0.10
Nutritional composition						
Crude protein (%)	19.56	19.72	18.58	18.49	18.76	18.15
Crude fat (%)	2.98	4.17	4.39	4.53	4.51	4.69
Carbohydrate (%)	49.31	52.08	55.97	57.68	58.78	61.06
Calcium (%)	2.2	2.78	2.91	3.29	3.53	3.71
Phosphorus (%)	1.25	1.48	1.74	1.82	1.95	2.14
Energy (Kcal kg <sup>-1</sup> ) <sup>**) </sup>	3023.00	3247.30	3377.10	3454.50	3507.50	3590.50

<sup>\*)</sup> Topmix composition per kg as follows: vitamin A, 1,000,000 IU; vitamin B12, 400 mg; vitamin D, 100,000 IU; DL-methionine, 22,700 mg; vitamin E, 700 mg; antioxidant, 12,500 mg; vitamin K3, 100 mg; Mg, 5,000 mg; vitamin B1, 100 mg; Fe, 1,000 mg; vitamin B2, 600 mg; Cu, 200 mg; vitamin B6, 50 mg; Mn, 1,500 mg; Niacin, 1,000 mg; Zn, 1,000 mg; Panthothenic acid, 50 mg; Iodine, 10 mg, and Choline chloride, 1,000 mg

<sup>\*\*)</sup>  Calculated

**Feed intake:** Table 4 shows feed intake of broiler chicken fed different proportion of rice husk DDG ration. Feed intake of broiler chicken was not significantly ( $P > 0.05$ ) affected by the proportion of rice husk DDG.

**Feed conversion:** Table 5 shows that feed conversion was significantly ( $P<0.05$ ) affected by the proportion of rice husk DDG in the ration. There were no significant ( $P>0.05$ ) differences in feed conversion of broilers fed 0, 5, 10, and 15 proportion of rice husk DDG, but 25% was significantly ( $P<0.05$ ) higher than 0, 5, 10, and 15% of rice husk DDG. Feed conversion of broiler in the proportion of 20% rice husk DDG at week 2, 3 and 6 was not significantly ( $P>0.05$ ) different from 0, 5, 10, 15, 20 and 25%. However, at weeks 4 and 6, feed conversion of broiler in the proportion of 20 and 25% rice husk DDG was significantly ( $P<0.05$ ) higher than 0, 5, 10, and 15%.

Table 3. Live weight of broiler chickens fed different proportion of rice husk DDG

Proportion of rice husk DDG (%)	Live weight DOC (kg head <sup>-1</sup> )	Live weight (kg head <sup>-1</sup> ) of the week					
		1	2	3	4	5	6
0	0.03 <sup>a</sup>	0.13 <sup>a</sup>	0.32 <sup>a</sup>	0.55 <sup>a</sup>	0.96 <sup>a</sup>	1.48 <sup>a</sup>	1.76 <sup>a</sup>
5	0.03 <sup>a</sup>	0.12 <sup>a</sup>	0.33 <sup>a</sup>	0.52 <sup>a</sup>	0.95 <sup>a</sup>	1.49 <sup>a</sup>	1.78 <sup>a</sup>
10	0.04 <sup>a</sup>	0.12 <sup>a</sup>	0.34 <sup>a</sup>	0.51 <sup>a</sup>	0.93 <sup>a</sup>	1.46 <sup>a</sup>	1.74 <sup>a</sup>
15	0.03 <sup>a</sup>	0.11 <sup>a</sup>	0.31 <sup>a</sup>	0.50 <sup>a</sup>	0.92 <sup>a</sup>	1.51 <sup>a</sup>	1.73 <sup>a</sup>
20	0.04 <sup>a</sup>	0.11 <sup>a</sup>	0.29 <sup>a</sup>	0.49 <sup>a</sup>	0.88 <sup>ab</sup>	1.49 <sup>a</sup>	1.71 <sup>a</sup>
25	0.03 <sup>a</sup>	0.09 <sup>a</sup>	0.29 <sup>b</sup>	0.46 <sup>b</sup>	0.85 <sup>b</sup>	1.39 <sup>b</sup>	1.62 <sup>b</sup>

Data presented as the means of 16-17 replication (N=16-17 bird each). <sup>a-b</sup> values in the same column with different superscripted letters are significantly different ( $P<0.05$ ).

Table 4. Feed intake of broiler chickens fed different proportion of rice husk DDG

Proportion of rice husk DDG (%)	Accumulation feed intake (kg head <sup>-1</sup> ) at week					
	1	2	3	4	5	6
0	0.133	0.394	0.743	1.469	2.708	3.467
5	0.126	0.422	0.723	1.501	2.771	3.524
10	0.125	0.432	0.719	1.460	2.759	3.428
15	0.120	0.400	0.760	1.500	2.929	3.495
20	0.122	0.389	0.794	1.505	2.950	3.642
25	0.119	0.320	0.759	1.496	2.794	3.532

Data presented as the means of 16-17 replication (N=16-17 bird each).

Table 5. Feed conversion of broiler chickens fed different proportion of rice husk DDG



Proportion of rice husk DDG (%)	Feed convertin at week					
	1	2	3	4	5	6
0	1.02 <sup>a</sup>	1.23 <sup>a</sup>	1.35 <sup>a</sup>	1.53 <sup>a</sup>	1.83 <sup>a</sup>	1.97 <sup>a</sup>
5	1.05 <sup>a</sup>	1.28 <sup>a</sup>	1.39 <sup>a</sup>	1.58 <sup>a</sup>	1.86 <sup>a</sup>	1.98 <sup>a</sup>
10	1.04 <sup>a</sup>	1.27 <sup>a</sup>	1.41 <sup>a</sup>	1.57 <sup>a</sup>	1.89 <sup>a</sup>	1.97 <sup>a</sup>
15	1.09 <sup>a</sup>	1.29 <sup>a</sup>	1.52 <sup>a</sup>	1.63 <sup>a</sup>	1.94 <sup>a</sup>	2.02 <sup>a</sup>
20	1.11 <sup>a</sup>	1.34 <sup>ab</sup>	1.62 <sup>ab</sup>	1.71 <sup>b</sup>	1.98 <sup>ab</sup>	2.13 <sup>b</sup>
25	1.13 <sup>a</sup>	1.39 <sup>b</sup>	1.65 <sup>b</sup>	1.76 <sup>b</sup>	2.01 <sup>b</sup>	2.18 <sup>b</sup>

Data presented as the means of 16-17 replication (N=16-17 bird each). <sup>a-b</sup> values in the same column with different superscripted letters are significantly different (P<0.05).

**Carcass percentage:** Figure 2 shows carcass percentage of broiler chicken fed different proportion of rice husk DDG in ration. The carcass percentage of broiler chicken was not significantly (P>0.05) affected by the proportion of rice husk DDG.

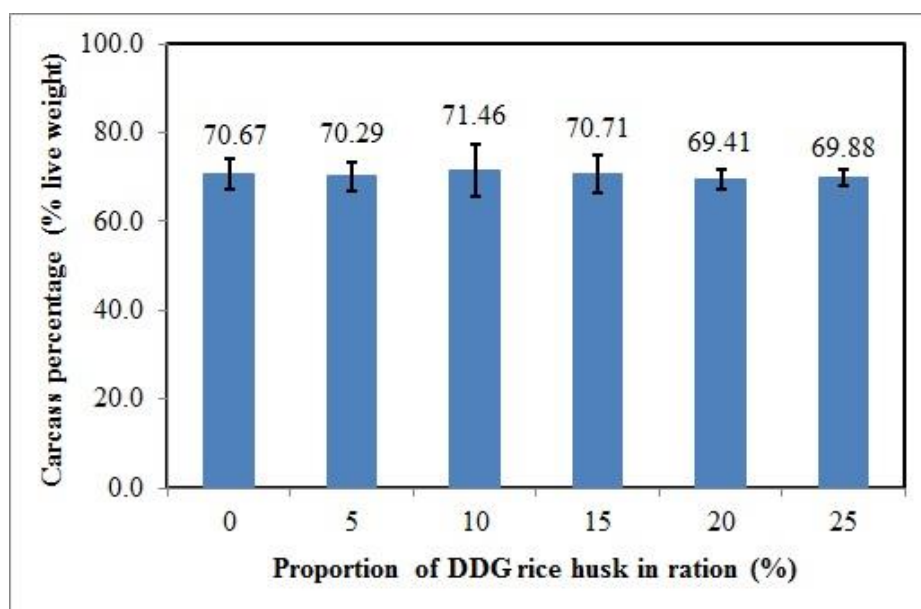


Figure 2. Carcass percentage of broiler chicken fed rice husk DDG in ration. Data presented as the means of 16-17 replication (N=16-17 bird each).

**Liver organ:** Figure 3 shows liver organ percentage of broiler chicken fed different proportion of rice husk DDG in ration. The liver organ percentage of broiler chicken was not significantly (P>0.05) affected by the proportion of rice husk DDG in ration.

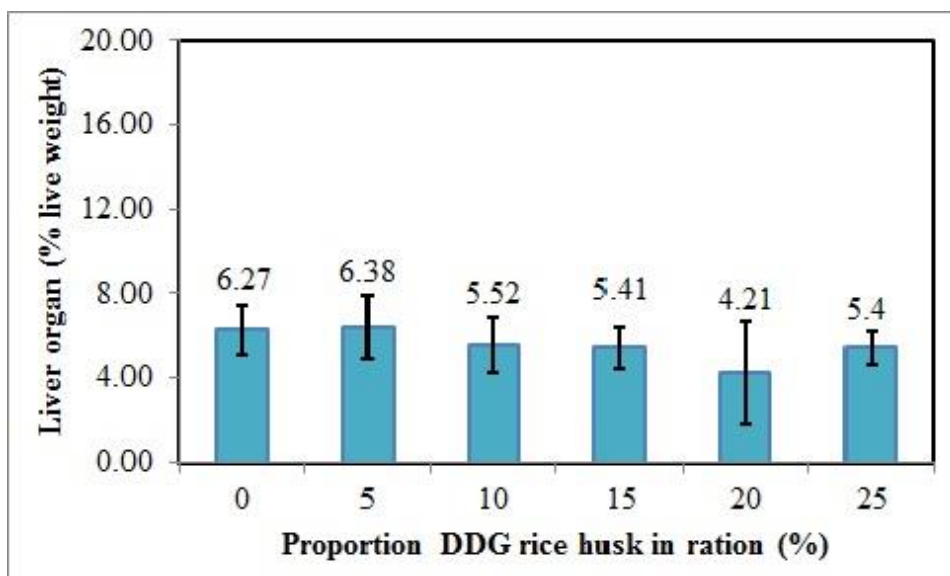


Figure 3. Liver organ percentage of broiler chicken fed rice husk DDG. Data presented as the means of 16-17 replication (N=16-17 bird each).

**Gastrointestinal tract :** Figure 4 shows gastrointestinal tract of broiler chicken fed different proportion of rice husk DDG in ration. The gastrointestinal tract of broiler chicken was not significantly ( $P>0.05$ ) affected by the proportion of rice husk DDG in ration.

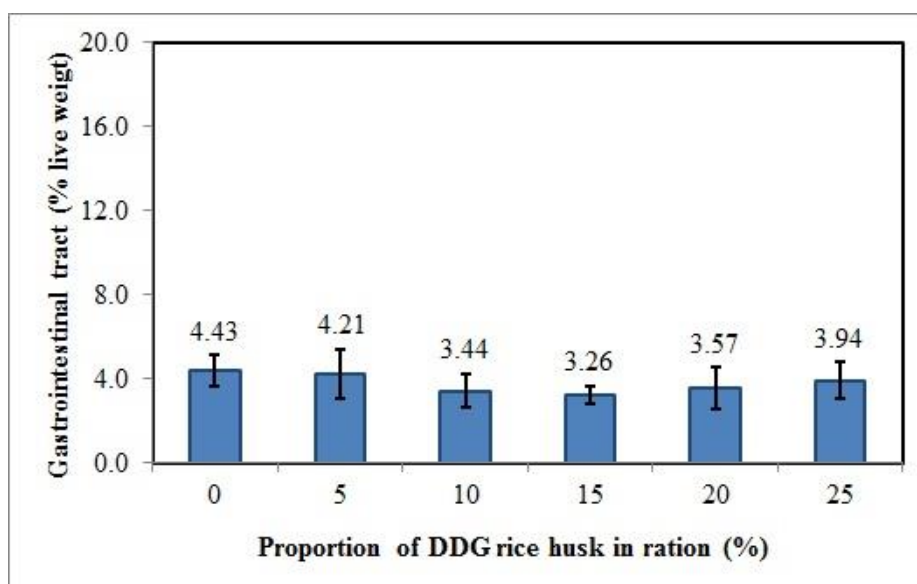


Figure 4. Gastrointestinal tract percentage of broiler chicken fed rice husk DDG in ration. Data presented as the means of 16-17 replication (N=16-17 bird each).

**Nitrogen retention:** Table 6 shows that nitrogen retention was significantly ( $P<0.05$ ) affected by the proportion of rice husk DDG in the ration. There were no significant ( $P>0.05$ )

differences in nitrogen retention of broilers fed 0, 5, 10, and 15 proportion of rice husk DDG, but 25% was significantly ( $P<0.05$ ) lower than 0, 5, 10, 15 and 20%.

Table 6. Nitrogen retention of broiler chickens fed different proportion of rice husk DDG in ration

Proportion of rice husk DDG (%)	Nitrogen consumption (kg)	Nitrogen in faeces (kg)	Nitrogen retention
0	0.085 <sup>a</sup>	0.048 <sup>a</sup>	56.47 <sup>a</sup>
5	0.087 <sup>a</sup>	0.049 <sup>a</sup>	56.32 <sup>a</sup>
10	0.082 <sup>a</sup>	0.046 <sup>a</sup>	56.10 <sup>a</sup>
15	0.087 <sup>a</sup>	0.048 <sup>a</sup>	55.17 <sup>a</sup>
20	0.089 <sup>a</sup>	0.049 <sup>a</sup>	55.06 <sup>a</sup>
25	0.081 <sup>b</sup>	0.044 <sup>b</sup>	54.32 <sup>b</sup>

Data presented as the means of 6 replication (N=16-17 birds each). <sup>a-b</sup> values in the same column with different superscripted letters are significantly different ( $P<0.05$ ).

## DISCUSSION

The present study indicates that the crude protein content of distillers dried grain (DDG) from rice husks with co-culture fermentation of *Saccharomyces cerevisiae* with *Candida tropicalis* is low, but the content of energy, calcium and phosphorus are high. The calculated rice husk DDG energy content is 3385.50 kcal kg<sup>-1</sup>. Some researchers report variations in the composition of DDG nutrients. Shurson *et al.*<sup>17</sup> reported that corn DDG contained 29.2% crude protein, 3065 kcal/kg metabolic energy, 0.04% calcium and 0.83% phosphorus. Ning *et al.*<sup>11</sup> reported that distiller dried grain with soluble (DDGS) corn contented 27.81% crude protein and 4.94 Mcal kg<sup>-1</sup> metabolic energy. Meanwhile, wheat bran DDGS contained 18.82% crude protein and 4.09 Mcal kg<sup>-1</sup> metabolic energy. Distiller dried grain of corn contained 89,48-94% dry matter<sup>16,18,19</sup>, 23,0-53,39% crude protein<sup>19,20,21</sup> and 2146-3554 kcal kg<sup>-1</sup> metabolic energy<sup>16,19,22,23</sup>. Belyea *et al.*<sup>24</sup> and Shurson *et al.*<sup>25</sup> suggested that the composition of DDG nutrients varied greatly and influenced by fermentation processes, raw materials and microorganisms.

The present study indicates that the nutritional composition of all experimental feed formulations was in accordance with the range of nutritional composition recommended by NRC<sup>16</sup>. However, the replacement of corn by rice husk DDG decreases the crude protein content but increases the metabolic energy content of the experimental ration. The high proportion of rice husk DDG to replace corn produces low levels of crude protein and high metabolic energy in rations. It was assumed that the rice husk DDG crude protein content in this study was lower than the yellow corn. Lallujan *et al.*<sup>26</sup> reported that the crude protein content of the local corn yellow was 10-11%. Sudiastara and Suasta<sup>27</sup> reported that the crude protein of corn yellow was 14.35%. It was assumed that the rice husk DDG metabolic energy content in this study was higher than the yellow corn. Sudiastara and Suasta<sup>27</sup> also reported that the metabolic energy of corn yellow was 3294 kcal kg<sup>-1</sup>.

The present study indicated that replacing corn with 15% rice husk DDG did not reduce the growth performance and harvest weight of broiler chickens. Decreased growth of broiler chickens appears on corn replacement by 20-25%. This decrease occurs due to a decrease in crude protein levels in the ration. The proportion of DDG in broiler chicken rations that has been reported by several researchers varies. Cortes-Cuevas *et al.*<sup>28</sup> reported that the use of 6% or 12% corn DDG did not significantly affect the production performance of broiler chicken. The use of corn DDG in broiler and laying rations can reach 15%<sup>7,29</sup>. The corn DDG can be used in poultry feed up to 20% as long as nutritional profiles, especially amino acids, are sufficient in the ration<sup>30,31,32</sup>.

This study indicates that corn replacement with 5-25% rice husk DDG does not significantly influence on feed intake of broiler chicken. However, replacing corn with 25% rice husk DDG significantly increases feed conversion. The results of this study are different from Thacker and Widyaratne<sup>33</sup> who reported that no significant differences were observed in feed intake and feed conversion ratio of broiler chickens fed 20.0% wheat DDGS. However,

Wang *et al.*<sup>5</sup> reported that feeding 25.5% DDGS increased feed intake and decreased feed conversion ratio.

The present study indicated that the replacement of corn with 5-25% rice husk DDG did not negative affect the carcass, liver organ and gastrointestinal tract percentage of broiler chicken. These results are in agreement with Wang *et al.*<sup>5</sup> who reported that birds fed diets with 15% DDGS did not differ significantly in dressing percentage. Also Choi *et al.*<sup>34</sup> reported that, there was no negative effect of DDGS supplementation up to 15% on meat qualities.

The present study indicates that replacing corn with 25% rice husk DDG decreases nitrogen retention. This was presumably due to the crude protein content and nitrogen consumption in the formulation of 25% rice husk DDG lower than 0, 5, 10, 15 and 20%. Low nitrogen consumption causes low nitrogen retention in broiler chickens. In previous studies, Leytem *et al.*<sup>35</sup> and Applegate *et al.*<sup>21</sup> also have reported linear decreases in nitrogen retention with increasing wheat DDGS levels in broiler diets.

In general, this study agrees with several previous studies which reported that the proportion of 15% DDG in the diet did not have a negative effect on growth performance, carcass percentage and nitrogen retention of broiler chicken. Previous studies (Waldroup *et al.*<sup>36</sup>, Wang *et al.*<sup>5</sup>, and Youssef *et al.*<sup>37</sup>) agree with the use of 15% DDG in the diet of broiler chicken.

## **SIGNIFICANCE STATEMENT**

This study discovers that distiller dried grain from rice husk with co-culture fermentation of *S. cerevisiae* with *C. tropicalis* can utilize as feedstock for the preparation of broilers diet. This study will help the researchers to uncover the critical area of using distiller dried grain in broiler diet as feed stock.

## **CONCLUSION**

The present study has concluded that feeding the proportion of 15% rice husk DDG in rations does not have a negative effect on production performance and the percentage of broiler carcasses. The distiller dried grain from rice husk with co-culture fermentation of *S. cerevisiae* with *C. tropicalis* can replace 15% of the proportion of corn in broiler chicken rations.

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## Conflict of Interest

No conflict of interest declared. All authors read and approved the final version of the manuscript.

## REFERENCES

1. Yang, Tao; Liu, Junwen; Lin, Qinlu; Jiang, Xiaoqing. 2009. *Penicillium expansum* YT01: A Lignocellulose-Degrading Fungal Strain Isolated from China Gaoligong Mountain Humus Soil. J. Biobased Materials and Bioenergy. Vol. 3(4): 348-353.
2. Sa´nchez, O.J and Cardona, C.A. 2008. Trends in biotechnological production of fuel ethanol from different feedstocks. Review. Biores. Technol. 99: 5270–5295.
3. Patel, J.S., Onkarappa, R and Gurumurthy, S.B. 2012. Ethanol production from lignocelluloses hydrolysates by different yeast. Asian J. Exp. Biol. Sci. Vol. 3(2): 350-354.
4. Giesemann, M.A., M.L. Gibson, K. Karges. 2015. The Ethanol Industry and Its Co-Product for Swine Feeding: A Primer on an Emergent Industry. Dakota Gold Marketing, Sioux Falls, South Dakota.
5. Wang, Z., S. Cerrate, C. Coto, F. Yan and P.W. Waldroup. 2007. Utilization of distillers dried grains with solubles (DDGS) in broiler diets using a standardized nutrient matrix. Int. J. Poult. Sci., 6: 470-477.
6. Purdum, S., K. Hanford and B. Kreifels, 2014. Short-term effects of lower oil dried distillers grains with solubles in laying hen rations. Poult. Sci., 93: 2592-2595.
7. Ezzat M. Abd El-Hack, M. Alagawany, M. R. Farag and K. Dhama. 2015. Use of maize distiller’s dried grains with solubles (DDGS) in Laying Hen Diets: Trends and Advances. Asian J. Anim. Vet. Adv., 10 (11): 690-707.
8. Youssef, A.W., M.M. El-Moniary and A.H. Abd El-Gawad, 2009. Evaluation of Distiller Dried Grains with soluble (DDGS) as a feedstuff in poultry diets. Am.-Eurasian J. Agric. Environ. Sci., 5: 540-544.

9. Sopandi, T and A. Wardah. 2015. Sugar consumption in mono and co-culture *Saccharomyces cerevisiae* and others selected microorganism for bioethanol production from stream rice husk medium. Asian Jr. of Microbiol. Biotech. Env. Sc. 17(3): 577-586.
10. Sopandi, T and A. Wardah, 2017, Improving ethanol production by co-culturing of *Saccharomyces cerevisiae* with *Candida tropicalis* from rice husk hydrolysate media. Africa. J. Microbiol. Res. Vol.11(3); 65-74.
11. Ning, D., J. M. Yuan, Y. W. Wang, Y. Z. Peng, and Y. M. Guo. 2014. The Net Energy Values of Corn, Dried Distillers Grains with Solubles and Wheat Bran for Laying Hens Using Indirect Calorimetry Method. Asian Australas. J. Anim. Sci. Vol. 27(2); 209-216.
12. Steiner, Z., M. Domacinovic, Z. Antunovic, Z. Steiner, D. Sencic, J. Wagner and D. Kis. 2008. Effect of dietary protein/energy combination on male broiler breeder performance. Acta Agric. Slovenica, supplement 2 (september 2008), 107–115.
13. Rochell, S.J. 2018. Formulation of broiler chicken feeds using distillers dried grains with solubles. Fermentation. 4(3), 64;1-10.
14. Rao.S.V.R., M. V. L. N. Raju, M. R. Reddy and A. K. Panda. 2004. Replacement of Yellow Maize with Pearl Millet (*Pennisetum typhoides*), Foxtail Millet (*Setaria italica*) or Finger Millet (*Eleusine coracana*) in Broiler Chicken Diets Containing Supplemental Enzymes. Asian-Aust. J. Anim. Sci. Vol 17, (6); 836-842.
15. Association of Official Analytical Chemists (AOAC). 1990. Official Methods of Analysis. 15<sup>th</sup> Edn., Association of Official Analytical Chemists. Washington, DC., USA.
16. National Research Council (NRC). 1994. Nutrient Requirements of Poultry. National Research Council, National Academy Press, Washington, D. C., 9<sup>th</sup> Revised Edition.
17. Shurson, J., S. Noll, and J. Goihl. 2005. Corn by-product diversity and feeding value to non-ruminants. In “Proceeding 66<sup>th</sup> Minnesota Nutrition Conference and Technical Symposium; Future of Corn in Animal Feed”. University of Minnesota, St. Paul. Minnesota.
18. Deniz, G., H. Gencoglu, S.S. Gezen, I.I. Turkmen, A. Orman and C. Kara, 2013. Effects of feeding corn distiller's dried grains with solubles with and without enzyme cocktail supplementation to laying hens on performance, egg quality, selected manure parameters and feed cost. Livestock Sci., 152: 174-181.
19. Hassan, S.M and A.A. Al Aqil. 2015. Effect of Adding Different Dietary Levels of Distillers Dried Grains with Solubles (DDGS) on Productive Performance of Laying Hens. Int. J. Poult. Sci. 14 (5): 279-284.
20. Spiehs, M.J., M.H. Whitney, and G.C. Shurson. 2002. Nutrient database for distiller's dried grains with solubles produced from new ethanol plants in Minnesota and South Dakota. J. Anim Sci. 80:2639.
21. Applegate, T.J., C. Troche, ., Z. Jiang, Z. and T. Johnson. 2009. The nutritional value of high protein corn distillers dried grains for broiler chickens and its effect on nutrient excretion. Poult. Sci. 88: 354-359.
22. Batal, A. B. and N. M. Dale. 2006. True metabolizable energy and amino acid digestibility of distillers dried grains with solubles. J. Appl. Poult. Res. 15:89-93.
23. Fastinger, N.D., J.D. Latshaw, and D.C. Mahan. 2006. Amino Acid Availability and True Metabolizable Energy Content of Corn Distillers Dried Grains with Solubles in Adult Cecectomized Roosters. Poult. Sci. 85: 1212-1216.
24. Belyea, R.L., K.D. Rausch and M.E. Tumbleson. 2004. Composition of corn and distillers dried grains with solubles from dry grind ethanol processing. Bioresour. Technol. 94:293-298.

25. Shurson, J., M. Spiehs, M. Whitney, S. Baidoo, L. Johnnton, B. Shanks, and D. Wulf. 2001. The value of distillers dried grains with solubles in swine diets. In: Mn. Nutr. Conf. Mn. Corn Growers Assoc. Tech. Sympos. Bloomington. MN.
26. Lalujan, L.E., G.S. S. Djarkasi, T.J.N. Tuju, D. Rawung, and M. F. Sumual. 2017. Chemical and Nutritional Composition of Local Corn Var. Manado Kuning as Rice Substitute. *J. Tek. Pertanian* Vol. 8 (1), Juni 2017
27. Sudiastara, I W. dan I M. Suasta. 1997. Pemanfaatan Limbah Roti untuk Makanan Ternak Babi. Laporan Penelitian Dosen Muda. Fakultas Peternakan Universitas Udayana Denpasar.
28. Cortes-Cuevas A, Ramírez-Estrada S, Arce-Menocal J, Avila-González E, López-Coello C. 2015. Effect of Feeding Low-Oil DDGs to Laying Hens and Broiler Chickens on Performance and Egg Yolk and Skin Pigmentation. *Braz. J Poult Sci.* 17(2); 247-254.
29. Youssef. I.M.I, C. Westfahl, A. Sünder, F. Liebert, and J. Kamphues. 2008. Evaluation of dried distillers' grains with solubles (DDGS) as a protein source for broilers. *Arc Anim. Nut.* 62(5); 404-414.
30. Shim, M.Y., G.M. Pesti, R.I. Bakalli, P.B. Tillman, and R.L. Payne. 2011. Evaluation of DDGS as an alternative ingredient for broiler chickens. *Poult. Sci.* 90:369-376.
31. Loar, R.E. II, J. S. Moritz, J.R. Donaldson, and A. Corzo. 2010. Effects of feeding distillers dried grains with soluble to broilers from 0 to 28 days posthatch on broiler performance, feed manufacturing efficiency, and selected intestinal characteristics. *Poult. Sci.* 89:2242-2250.
32. Masa'deh, M.K., S.E. Purdum, and K.J. Hanford. 2011. Dried distillers grains with soluble in laying hen diets. *Poult. Sci.* 90:1960-1966.
33. Thacker, P.A. and G.P. Widyaratne. 2007. Nutritional value of diets containing graded levels of wheat distillers dried grains with solubles fed to broiler chicks. *J. Sci. Food Agric.*, 87: 1386-1390.
34. Choi, H. S., Lee, H. L., Shin, M. H., Cheorun, J., Lee, S. K., and Lee, B. D., 2008: Nutritive and Economic Values of Corn Distiller's Dried Grains with Solubles in Broiler Diets. *Asian - Australasian Journal of Animal Sciences*, 21, 414-419.
35. Leytem, A. B., P. Kwanyuen, and P. Thacker. 2008. Nutrient excretion, phosphorus characterization, and phosphorus solubility in excreta from broiler chicks fed diets containing graded levels of wheat distillers grains with solubles. *Poult Sci.* 87(12):2505-2511.
36. Waldroup, P. W., J. A. Owen, B. E. Ramsey, and D. L. Welch. 1981. The use of high levels of distillers dried grains plus solubles in broiler diets. *Poult. Sci.* 60:1479- 1484.
37. Youssef, A.W., N.A. Abd El-Azeem, E.F. El-Daly and M.M. El-Monairy, 2013. The Impact of Feeding Graded Levels of Distillers Dried Grains with Solubles (DDGS) on Broiler Performance, Hematological and Histological Parameters. *Asian Journal of Poultry Science*, 7: 41-54.



# **MIKOLOGI**

## **Dasar dan Aplikasi**



**Oleh:**  
**Tatang Sopandi**  
**dan Wardah**

**2019**

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