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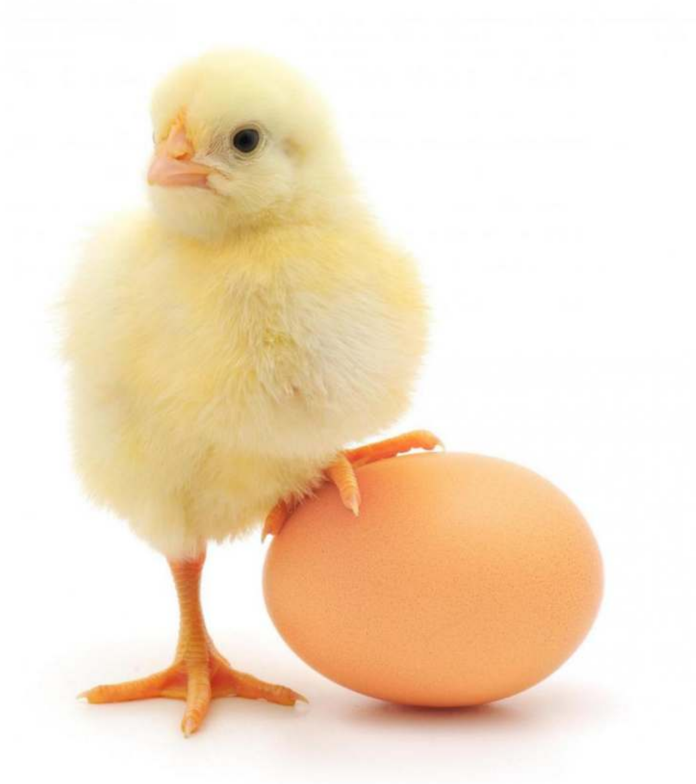

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Research Article
Utilization of Sago Waste with Cellulase Enzyme Fermentation as a Local Feed for Broilers in Southeast Sulawesi

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Abstract
Background and Objective: The dominant content of crude fibre is cellulose and if it is used as a feed ingredient, cellulase enzyme must be added. The aim of this research was to investigate the effect of using sago waste with cellulase enzyme as a local feed ingredient on the production performance of broiler chickens. **Materials and Methods:** Three hundred Day Old Chickens (DOC) broiler strain CP 707 were kept in enclosed litter cages. There were 30 cage plots. The size of each plot was (1×1) m^2. The cage wall was made of metal. The wall height was 0.5 m. Each plot was equipped with a feeding and drinking container. There were10 DOC broilers in every plot with six replications. The treatment for this research was sago waste with cellulase enzyme at 0.75 g kg^{-1} sago waste. The sago waste is added at levels of 0.00, 5.00, 10.00, 15.00 and 20.00% of total feed. The variables measured in this research were feed consumption, body weight gain, feed conversion, the abdominal fat weight, the percentage of abdominal fat and fatty meat. The data were analyzed by using a one-way ANOVA with a Completely Randomized Design and if there was a difference between treatments ($p<0.05$), Duncan's New Multiple Range Test (DMRT) was used. **Results:** The results of this research show that the addition of sago waste with cellulase enzyme in the feed did not significantly influence consumption and fat content of the meat of 35 days old broiler chickens but did significantly influence body weight gain, feed conversion, the weight of abdominal fat and percentage of abdominal fat of 35 days old broiler chickens ($p<0.05$). **Conclusion:** Sago waste with cellulase enzyme as a broiler feed ingredient can improve body weight gain as well as decrease feed conversion, the weight of abdominal fat and the percentage of abdominal fat. It is more effective if it is used at a level of 15% of total broiler feed and it does not have a negative effect on feed consumption and fat content of 35 days old broiler chicken meat.

Key words: Sago waste, cellulase enzymes, production performance, abdominal fat, glucose content

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The supporting factors of broiler chicken productivity depend on feed management, which is managed based on production needs[1]. Therefore, in choosing feed ingredients, we not only consider the availability of nutrients needed for poultry wellbeing and production but also the competition between poultry needs and other needs so that the impact of price can be minimized[2]. One alternative ingredient for poultry feed is agricultural waste[3]. In Sulawesi Tenggara, the agriculture waste that is most commonly available as a local feed source is sago waste. Sago is still used as a local food[4]. The production of sago involves separation of sago skin and sago waste. Each production process produces as much as 75.17% sago waste or 12.01 t ha^{-1} and 24.83% sago or 3.97% ton ha^{-1} [5]. The sago waste is often not used. It is often left in the production area and leads to environmental pollution[6].

Even when sago waste utilization as a broiler feed is limited to a crude fibre content of 11.65 and 2.08% crude protein[7], it still has a metabolizable energy content of 2,900 kcal kg^{-1}, 0.53% calcium and 0.09% phosphorus[8]. However, sago waste is one energy source feed material used in feed for poultry, pigs and ruminants[9]. The carbohydrate content of sago waste (crude fibre and extract materials without nitrogen) is high, at 89.02% and is thus a potentially useful feed material source for energy[10]. High crude fibre content in the feed can degrade the production performance of broiler chickens because they lack the enzyme component of the fibre[11]. The dominant components of crude fibre contained in sago dregs are cellulose, hemicellulose and lignin at 10.62, 1.56 and 1.67%, respectively[5].

The dominant component in sago waste is cellulose; therefore, the appropriate enzyme to break it down is cellulase. Cellulase enzymes generally play a role in catalysing cellulose into glucose[12]. The addition of cellulase enzymes at a level from 0.00-1.00 g kg^{-1} waste sago can alter the composition of crude fibre from 16.76-12.79% and the cellulose content therein also drops from 11.23-7.91%. Additionally, the *in vitro* dry matter digestibility becomes 21.68 and 20.47% for organic matter[13]. Sago waste with a balanced nutrient composition can be given to poultry at up to 12.5% in broiler rations and 25% in rations for other chickens[9]. Based on the problem explained above, it is important to conduct research on the utilization of sago waste with cellulase enzymes as a source of local feed for broilers).

MATERIALS AND METHODS

Broiler chickens, cages and feed: The experiment was carried out from June-August, 2016 at the Department of Poultry Production Animal Experimental Farm at the Faculty of Animal Science, Halu Oleo University, Kendari, Indonesia. A total of 300 day old chicks (CP 707® strain) of mixed sex were kept in litter cages. The cage size was $1\times1\times0.5$ m^2. The cages were divided into 30 plots in which each plot was equipped with feeding and drinking containers[14]. The tools used were digital scales with a capacity of 5 kg and a sensitivity of 20 g to measure body weight and feed, an Ohaus balance with a capacity of 20 kg and a sensitivity 100 g and digital scales with a capacity of 1.2 kg. The treatment in this research was sago waste with cellulase enzymes at 0.75 g kg^{-1} sago waste[5]. The ingredients and nutrients of this research are displayed in Table 1. The feed of each treatment was composed based on the nutrient content of each feed ingredient (Table 1). The composition and nutrient content for every treatment is displayed in Table 2.

Methods: Sago waste with cellulase enzyme addition was used as a treatment. It was added in the feed at levels of 0.00, 5.00, 10.00, 15.00 and 20.00% of total feed and was tested in 1-35 days old broiler chickens. The treatments tested in broiler chickens were designated as R1, R2, R3, R4 and R5. The R1 was the treatment without sago waste and cellulase enzyme addition (control), while R2, R3, R4 and R5 were the treatments with sago waste and enzyme addition. The percentages of sago waste addition for R2, R3, R4 and R5 treatment were 5, 10, 15 and 20%, respectively. Food and drink were provided *ad libitum*. Prevention of Newcastle Disease (ND) was achieved through vaccination using the "Medivac ND La Sota B1" Vaccine when the chickens were 3 days old and "Medivac ND La Sota B_2" when the chickens were 21 days old. The vaccines are made by Medion Bandung-Indonesia. The poultry was given sugar water and anti-stress "*Vita stress*" to avoid stress, especially when the poultry arrived in the research location and their body weights were measured.

Research variables: The variables measured in this research reflected production performance (feed consumption, body weight gain and feed conversion) and fat characteristics (the weight of abdominal fat, percentage of abdominal fat and the fat of broiler meat).

Table 1: Nutrient content of diet ingredients for the research

Raw material	Kanlungan nutrients Metabolic energy (kcal)	Crude protein (%)	Crude fibre (%)	Fat (%)	Calcium (%)	Phosphorus (%)
Concentrate broiler[a]	2,800	39.00	7.00	3.00	3.00	1.70
Corn[b]	3,350	8.50	2.20	3.80	0.02	0.08
Rice bran[b]	2,980	11.90	11.40	13.00	0.07	0.21
Fish meal[b]	2,580	64.20	1.00	5.00	3.73	2.20
Top mix	0.00	0.00	0.00	0.00	0.00	0.00
Filler	0.00	0.00	0.00	0.00	0.00	0.00
Coconut oil[c]	8,728	0.00	0.00	0.00	0.00	0.00
Sago waste[d]	2,610	2.01	12.79	0.03	0.61	0.01
Cellulase enzyme	0.00	0.00	0.00	0.00	0.00	0.00

[a]Produksi Confeed Jafa. Feed, [b]Results of National Research Council (1994), [c]Results of laboratory analysis of the University Centre (IUC) for Food and Nutrition Universitas Gadjah Mada, 2007, [d]Analysis Results of Nutritional Biochemistry Laboratory of Animal Science Universitas Gadjah Mada, 2015

Table 2: Ingredient composition and nutrient content of experimental broiler diets

Feed ingredients	Treatments R1	R2	R3	R4	R5
Broiler concentrate	30.00	28.50	30.00	32.80	30.65
Corn	47.00	45.00	40.00	32.50	30.00
Rice bran	12.00	9.00	5.50	1.50	0.00
Fish meal	8.50	10.00	10.50	10.30	11.90
Top Mix	0.20	0.20	0.20	0.40	0.50
Filler	0.50	0.50	1.00	2.50	2.40
Sodium chloride (NaCl)	0.30	0.30	0.30	0.40	0.50
Coconut ail	1.50	1.50	2.50	4.60	4.05
Sago waste	0.00	5.00	10.00	15.00	20.00
Total	100.00	100.00	100.00	100.00	100.00
Feed nutrient content*					
Metabolic energy (kcal kg^{-1})	3,017	3,014	3,046	3,097	3,046
Crude protein (%)	22.58	22.53	22.70	22.65	22.55
Crude fibre (%)	4.59	4.75	4.99	5.20	5.48
Ether extract (%)	4.67	4.24	3.66	2.93	2.66
Calcium (%)	1.23	1.27	1.36	1.47	1.49
Phosphorus (%)	0.76	0.76	0.78	0.81	0.81

*Results calculated based on nutrient content of feed ingredients, R: Treatments, R1: Feed control, R2: Control feed+5% sago waste and cellulase enzymes 0.75 g kg^{-1}, R3: Control feed+10% sago waste and cellulase enzymes 0.75 g kg^{-1}, R4: Control feed+15% sago waste and cellulase enzymes 0.75 g kg^{-1} and R5: Control feed+20% sago waste and cellulase enzymes 0.75 g kg^{-1}

Data analysis: The data were analyzed using one-way ANOVA with a Completely Randomized Design (CRD). If there was a significant average difference among the treatments ($p<0.05$), Duncan's New Multiple Range Test (DMRT) was used[15].

RESULTS AND DISCUSSION

Response of performance: The results of the research show that there was no significant difference ($p>0.05$) in feed consumption but there was a significant influence ($p<0.05$) in body weight gain and feed conversion of 35 days old broiler chickens (Table 3). The body weight gain was significantly improved ($p<0.05$) for the treatment with 15% sago waste and cellulase enzyme. Body weight gain decreased for the treatment with 20% sago waste and cellulase enzyme. The treatment with 15% sago waste had the lowest feed conversion value at 1.76 (Table 3).

Fat characteristics: In this research, fat production included abdominal fat and meat fat. Abdominal fat is measured by two indicators: The weight of abdominal fat and the percentage of abdominal fat. Abdominal fat is found in the abdominal cavity and is adipose tissue. The result of this research shows that the addition of sago waste and cellulase enzyme in the feed has significant influence ($p<0.05$) on the weight and percentage of abdominal fat but it does not significantly influence ($p>0.05$) the fat content in the meat of 35 days old broiler chickens (Table 4). If we do a comparison between the control and treatment, the weight and percentage of abdominal fat decreases along with the addition of sago waste in the feed.

Feed consumption of broilers: The average cumulative feed consumption of 35 days old broilers for the five treatments was within the range of 3,003.30-3,060.35 g/bird. The results of other studies reveal that the cumulative

Table 3: Effects of sago waste and cellulase enzymes on 35 days old broiler performance

	Parameters observed		
Treatments	Feed consumption (g)[ns]	Increases of body weight (g)	Feed conversion
R1	3,108.24±153.01	1,540.57±44.28[c]	2.02±0.11[a]
R2	3,003.30±80.21	1,610.17±7800[b]	1.87±0.11[b]
R3	3,060.34±99.53	1,681.25±44.43[a]	1.82±0.06[bc]
R4	3,003.70±114.79	1,702.83±19.37[a]	1.76±0.05[c]
R5	3,012.85±94.84	1,695.77±34.27[a]	1.78±0.05[c]

ns: Non-significant, [a,b,c,d]Different superscripts on the same column indicate a highly significant difference ($p<0.05$), R: Treatments, R1: Feed control, R2: Control feed+5% sago waste by cellulase enzymes 0.75 g kg^{-1}, R3: Control feed+10% sago waste and cellulase enzyme 0.75 g kg^{-1}, R4: Control feed+15% sago waste and cellulase enzymes 0.75 g kg^{-1}, R5: Control feed+20% sago waste and cellulase enzymes 0.75 g kg^{-1}, Range±Standard Deviation

Table 4: Effects of sago waste and cellulase enzymes to feed on fat characteristics in 35 day old broilers

	Parameters observed		
Treatments	Abdominal fat weight (g)	Abdominal fat (%)	Fat meat (%)
R1	30.37±1.30[a]	1.91±0.10[a]	3.66±0.16
R2	26.18±1.49[b]	1.57±0.08[b]	3.79±0.36
R3	25.33±2.89[b]	1.47±0.20[bc]	3.59±0.36
R4	23.70±1.71[b]	1.35±0.11[cd]	3.92±0.91
R5	21.22±2.16[c]	1.21±0.11[d]	3.70±0.33

ns: Non significant, [a,b,c,d]Different superscripts on the same column showed highly significant the difference ($p<0.05$), R: Treatments, R1: Feedcontrol, R2: Control feed+5% sago waste and cellulase enzymes 0.75 g kg^{-1}, R3: Control feed+10% sago waste and cellulase enzymes 0.75 g kg^{-1}, R4: Control feed+15% sago waste and cellulase enzymes 0.75 g kg^{-1}, R5: Control feed+20% sago waste by cellulase enzymes 0.75 g kg^{-1}, range of use standard deviation

feed consumption for 5 weeks old broilers was within a range of 2,185.0-2,453.4 g/bird[16] and 2.90-3.24 kg/bird[17]. Factors affecting the consumption included feed type, feed quality, feeding method, health condition of the chickens, feeding tray and management[18].

Statistical analysis showed that the addition of waste sago and cellulase enzymes at 0.75 g kg^{-1} of sago waste did not have a significant influence on the cumulative feed consumption of broilers. This fact indicates that the feed quality of the treatment did not make a significant difference and so the same nutrients were used for all treatments. Adding 0.75 g cellulase enzyme to sago waste and then mixing it with the feed does not influence feed nutrient content. The addition of cellulase enzymes to the sago waste increased the *in vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD)[13] but the sago waste with cellulase enzymes did not increase the consumption of broilers, as seen in the values for cumulative feed consumption of all the treatments (Table 3).

The results of this research show that using enzymes in poultry feed, such as the enzyme phytase, did not affect feed intake[19]. A study of supplementation of 1 g kg^{-1} of xylanase enzyme in the feed did not affect the feed intake of broilers and the range of feed intake was 3,229-3,244 g/bird[20]. The feed consumption of broilers fed palm kernel cakes and fermented oil sludge does not have an impact on feed consumption[21].

Important factors that affect feed consumption in this study led to the same response among treatments and may be caused by the adequacy of the nutrient content of metabolizable energy in the feed for each treatment. Feed containing low metabolizable energy will be consumed more often than a diet containing high energy[22]. Referring to the average consumption of feed, it can be said that the addition of sago waste and cellulase enzymes at 0.75 g kg^{-1} of feed at a level of 20% sago waste still has the same nutrient value, although there are different proportions of ingredients. The addition of the xylanase enzyme to poultry feed based on barley or wheat managed to reduce the effects of polysaccharides and non-starch ingredients. Furthermore, the xylanase enzyme also converts hemicellulose into glucose that can be used by poultry so that enough energy can be derived from the feed[23].

Broiler body weight: The cumulative body weight gain of 35 day old broilers (Table 3) ranged from 1,540.57-1,702.83 g/bird. Statistical analysis showed that the addition of sago waste and cellulase enzymes at 0.75 g kg^{-1} for a level of 5% of the diet increases the body weight gain of broilers ($p<0.01$). As much as 10% sago waste led to an increase in body weight gain ($p<0.01$). A level of 15% sago waste in the feed led to an increase in body weight gain of broilers but the results were not significant. Increasing the level of sago waste to 20% showed a decrease in body weight gain that was not significant.

The increase in body weight with increased levels of sago waste and cellulase enzymes ranged from 1540.57-1,702.83 g/bird or an increase of 10.48% at a level of

15% sago waste (R4 Table 3). The increase in body weight was likely the result of adding the cellulase enzymes, which can degrade the cellulose component contained in crude fibre to a more modest form of glucose. The process of cellulose degradation contained in sago waste by cellulase enzymes in this research led to an improved glucose content of 26,918.15 mg kg^{-1} of sago waste, which was detected by using High Performance Liquid Chromatography (HPLC) (Fig. 1). The addition of cellulase enzymes at 0.75 g kg^{-1} of sago waste decreased the composition of crude fibre from 16.76-12.79% and the cellulose component decreased from 11.23-7.91%[13]. The phenomenon seen in these results is that the nutrients vary for all treatments in terms of calories and protein, which led to body weight differences between the treatments. The enzymes in poultry feed are classified as feed additives, whereas the mechanism of action of the enzyme as an additive increases the use of nutrients contained in the feed materials of plants (carbohydrates, lipids and proteins) that cannot be digested by digestive enzymes due to the impermeable nature of the plant cell wall structure (i.e., the impermeable cell-wall structure)[24]. The use of enzymes in feed generally reduces unusual nutrients in feedstuffs, improves digestibility, increases certain nutrients and reduces environmental pollution from manure[25].

Broiler feed conversion: A feed conversion ratio of feed consumption to body weight for the broiler chickens was obtained in the same period. The high number for feed conversion shows that the more feed is needed for increasing amounts of body weight per weight unit, the lower the conversion value of the feed. This result means that the quality of the feed is better[26]. The addition of sago waste and cellulase enzymes at 0.75 g kg^{-1} of sago waste to the feed for 35 days old broiler chickens led to feed conversion values (Table 3) in the range of 1.76-2.02.

Statistical analysis showed that the addition of cellulase enzymes to sago waste at 0.75 g kg^{-1} of sago waste at a 5% sago waste level in the diet decreases the feed conversion value of broiler chicken ($p<0.01$). After the sago is added to feed pulp with enzymes at 0.75 g kg^{-1}, as much 10% of sago waste in the diet appears to not significantly affect feed conversion ($p>0.05$). Increasing the level of sago pulp and cellulase enzymes to 15% of the diet turned out to simultaneously lead to a decrease in the feed conversion of broiler chickens that was not significant compared to the treatment of R_3 (10% sago dregs and cellulase enzymes at 0.75 g kg^{-1}). After adding 20% sago waste to the feed, the conversion value did not significantly increase ($p>0.05$) compared to treatment R_4 (15% sago waste with cellulase enzyme). The highest feed conversion value (2.02) was for the R_1 treatment and decreases (1.76) as the level sago waste and cellulase enzymes increases for the R_4 treatment or a 12.87% reduction of the feed conversion value compared to the R_1 treatment. The results of research on the use of enzymes in broiler chicken feed include examining the effects of adding 0.05% β-xylanase enzyme to a diet containing 15% rice bran on the performance of broilers up to 3 weeks of age, which improved feed conversion by 7.55% compared to the control diet[27].

The low value of feed conversion in treatments with sago waste and cellulase enzymes may be caused by the ability of cellulase enzymes to degrade macromolecules and transform the cellulose into simple molecules that are easily absorbed. These results were apparent from the value of feed intake for

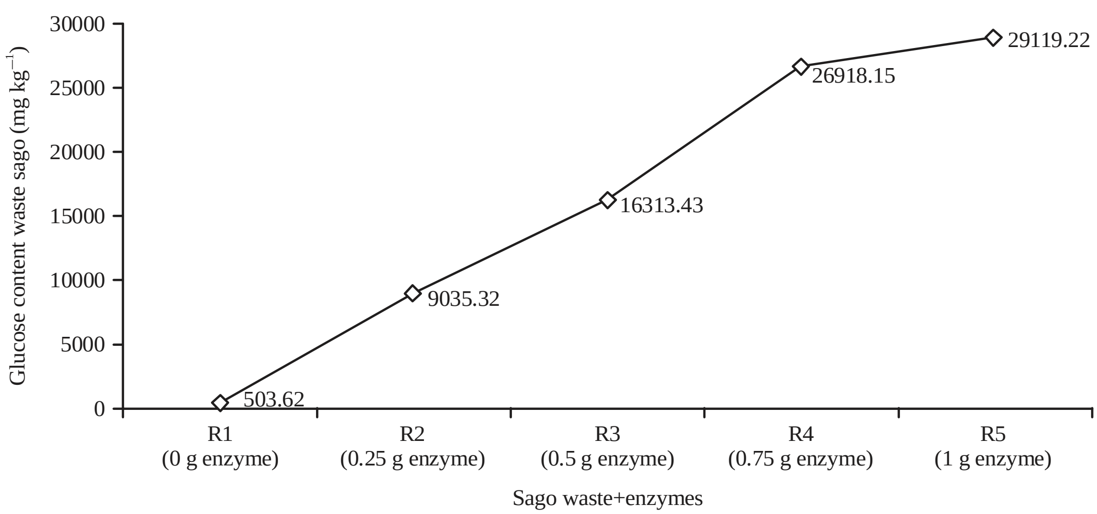

Fig. 1: Results of analysis of the glucose content of sago pulp treated with cellulase enzyme

Integrated Research and Testing Laboratory-Gadjah Mada University, 2016, R: Treatments, R1: Sago waste, R2: Sago waste+0.25% cellulase enzymes, R3: Sago waste+0.50 cellulase enzymes, R4: Sago waste+0.75% cellulase enzymes, R5: Sago waste+1.00% cellulase enzymes the R_4, which is not significant compared to other treatments but still shows the value of R_4 body weight gain from an optimal treatment with a low feed conversion value (Table 3). The degradation of the cell wall as a result of enzymatic hydrolysis causes the release of cell contents[28]. The enzymatic hydrolysis process could be affected by digestion from endogenous enzymes in poultry. The value of high feed conversion allegedly led to low quality in rations, especially amino acids, benefitting the broiler rations because their bodies are very small[29].

Weight of abdominal fat: Fat stored in the abdominal cavity, where adipose tissue has a role in that fat storage process[30]. Abdominal fat in chickens is considered to be waste in the broiler processing industry[31]. The weight of abdominal fat obtained in this study was in the range of 21.22-30.37 g/birds. The results of other studies show abdominal fat weight gains of broilers in the range of 32.46-41.78 g/birds[32]. Broilers fed fermented cassava had a gain in abdominal fat ranging from 11.10-17.27 g/birds of bird weight or slaughter weight[33]. Factors leading to differences in the abdominal fat of broiler chickens included the rate of growth and crude fibre content in the feed. The differences in abdominal fat were caused by differences in growth rate[34] and the crude fibre content in the feed affects the abdominal fat content of broilers[21].

Statistical analysis showed that the addition of sago waste and cellulase enzymes in the feed significantly decreased the abdominal fat weight of broilers ($p<0.05$). The addition of sago waste and cellulase enzymes at a level of 5% of the feed for broilers showed a significant reduction of abdominal fat weight ($p<0.05$). After the addition of sago waste and cellulase enzymes in feed increased to a level of 10%, there was still a decrease in abdominal fat weight that was not significant but there was a significant decrease moving from the R_2 to R_1 treatment ($p<0.05$). Increasing the level of sago waste to 15% in the diet decreased abdominal fat weight but the result turned out to be not significant. The next level of 20% sago waste in the feed led to a significant decrease in abdominal fat weight ($p<0.05$).

The abdominal fat weight of broilers produced in this research study suggests that the higher the level of sago waste used with cellulase enzymes would produce lower abdominal fat weight, ranging from 30.37-21.22% or a decrease of 30.13%. A decrease in abdominal fat content in this research was likely caused by the fibre in the feed (Table 2), which showed that crude fibre increased with increasing levels of sago waste. Fibre content in the treatment feed led to a low content of abdominal fat without disturbing growth performance and efficiency of broiler chicken feed in this research. That trend showed that in these results, the range of crude fibre content of feed use was 4.59-5.48% but did not adversely affect the performance of broiler production (Table 3). That broiler chickens are still able to tolerate using palm oil waste up to a level of 20% without affecting performance and feed efficiency[3].

Percentage of abdominal fat: The percentages of abdominal fat obtained in this study were in the range of 1.21-1.91%. The abdominal fat percentages were in the range of 0.73-3.86% of the live weight[35]. The abdominal fat percentages have been observed in the range of 1.06-2.07%[21] and under normal circumstances, the abdominal fat percentages range between 1-2.5% of body weight[36].

The result of statistical analysis shows that adding sago waste and cellulase enzymes to the feed produced a significant difference ($p<0.05$) in abdominal fat percentage for broiler chickens. Statistical analysis showed that the addition of sago waste and cellulase enzymes in feed provides a significant difference ($p<0.05$) in the percentage of abdominal fat in broiler chickens. Differences in the percentage of the abdominal fat of broilers with the addition of sago waste and cellulase enzymes by as much as 5% of the diet led to a significant reduction ($p<0.05$). After the level of sago waste in the feed was elevated to 10%, there was still a decrease in the percentage of abdominal fat that was not significant but decreased significantly from the R_2 to the R_1 treatment ($p<0.05$). Increased levels of sago residue through the addition of cellulase enzyme to the 15% level of sago waste in the diet decreased the percentage of abdominal fat, although the decrease was not significant for R_3 and was significant ($p<0.05$) for the R_1 and R_2 treatments. The next level of adding sago dregs and cellulase enzymes at 20% in the feed did not lead to a significant decrease ($p<0.05$) in abdominal fat but there was a significant decrease from the R_4 treatment to the R_1, R_2 and R_3 treatments ($p<0.05$).

The percentage of abdominal fat in broilers produced in this study indicates that the control diet (R_1) without the addition of sago waste had a higher percentage of abdominal fat by 1.91%, whereas treatment with the addition of sago waste and cellulase enzymes showed that the higher levels of sago waste in the feed reduced abdominal fat to 1.21% for the R_5 treatment (20% waste sago) or a decrease of 36.65%. The low percentage of abdominal fat obtained from higher levels of added sago waste in this study was likely due to the crude fibre content in the feed being higher in treatments R_2-R_5 compared to treatment R_1 (control). The high crude fibre content in the feed will affect the weight of abdominal fat, which in turn affects the abdominal fat percentage. The crude fibre can absorb fat so that the fat deposition in the body can be reduced[37].

Broiler meat fat: The amount of fatty broiler meat obtained in this study was in the range of 3.66-3.92%. Other studies determined broiler meat fat content was in the range of 2.09-2.91%[38] and 3.05-5.45%[31]. The fat content of broiler chicken meat was 2%[39]. The results of the statistical analysis showed that the addition of sago waste with cellulase enzymes at a level of 20% sago waste produced an insignificant difference (p>0.05) for the fat content of broiler chickens in this research. This result suggests the 20% level of sago waste and cellulase enzymes in the feed produced the same response for the fat content of broiler meat in this study. This outcome probably occurred because the nutrient contents of the feed for each treatment are the same, so the absorption of nutrients that can be utilized by broilers in this study had no effect on the fat content of broiler chicken meat. The one factor that affected production performance, carcass and meat quality of chickens was the nutrient content of the feed[40].

CONCLUSION

The use of sago waste and cellulase enzymes at 0.75 g kg^{-1} sago waste can increase the body weight gain, feed conversion, abdominal fat weight and abdominal fat percentage as well as lead to a more effective feed use at a level of 15% sago waste in total broiler chicken feed with no negative effects on feed intake and fat content of 35 days old broiler chickens.

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