

11% ←

13% ←

was approximately 12% for ADG and approximately 8% for G:F. Similar findings were observed in previous studies with sunflower and rice hulls¹⁴ or oat hulls and soy hulls³. During this period, the ADFI of the birds was not affected by the diets, indicating that young broilers respond positively to the inclusion of 40 g kg⁻¹ rice hulls in the diet by improving feed utilization. Jimenez-Moreno *et al.*¹⁴ found that the inclusion of 25 g kg⁻¹ rice hulls improved the feed to gain ratio when diet was offered in mash form but no difference was detected when the level was increased to 50 g kg⁻¹ in the same form. In addition, there was a decrease in G:F when diet was offered in pelleted form. Hartini and Purwaningsih¹⁵ found that addition of 40 g kg⁻¹ rice hulls in a commercial starter diet did not improve ADG and ADFI but observed an increase in carcass weight. However, Sadeghi *et al.*¹⁶ supplemented 30 g kg⁻¹ rice hulls in the basal diet and found no effects on BW and carcass weight compared to the control diet. The information provided and the results found in the present study suggest that the effects of rice hulls inclusion on growth performance depends on the type of diet offered, the composition of the basal diets used and the manner in which the rice hulls were incorporated into the diet. Supplementation of either phytase and cellulase or phytase on the RH⁴ improved G:F. The ~~improvement on~~ G:F was greater for the phytase-cellulase than the individual phytase and it has been suggested that this is due to synergistic action between phytase and carbohydrase in improving nutrient utilization⁶.

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There was a reduction in the ADG by ~~increasing G:F with phytase~~. The reason for this finding is unknown but might be related to the release of P due to phytase supplementation. Waldroup *et al.*¹⁷ found that at higher levels of P at which the dietary level was sufficient, the addition of phytase had no significant effect on body weight. In the current study, the nutrient level was formulated to meet the broilers requirement. The P-phytate degraded by phytase might increase the absorption of P, which in addition, can interfere with homeostasis of the other nutrients and result in reduced growth rate¹⁸. Our data support the suggestion; the P-disappearance in digesta of broilers fed diets supplemented with enzymes was higher compared to others.

Supplementa
tion

Increases in gizzard size due to insoluble fiber have been reported due to the muscular activity of the gizzard during its physiological function to reduce particle size¹⁹. The result in our study supports the suggestion. There was a 7% increase in empty gizzard weight by the inclusion of 40 g kg⁻¹ rice hulls (2 mm in size). The increase, however, was 28% lower than the results when 30 g kg⁻¹ ground oat hulls (2 mm in size) was included in the diet³. Sadeghi *et al.*¹⁶, on the other hand, found that addition of 30 g kg⁻¹ rice hulls (2 mm in size) did not

affect gizzard weight. This finding indicates that the effect of insoluble fiber on gizzard activity was more depended on chemical characteristics of the fiber²⁰ and diet composition than the particle size and that the stimulatory effect of rice hull on the gizzard was less than that of oat hulls at the same particle size.

All insoluble fibers which increase the gizzard size would substantially increase the gizzard content¹⁹. The gizzard content in the present study was not different among diets. This is understandable since the gizzard's weight increase in this study was only 7%, therefore the increase in its content was also barely noticed, in contrast to Gonzalez-Alvarado *et al.*¹ where the increase of the gizzard weight was 35%. However, the improvement of ADG on birds given the RH treatment indicated that the presence of insoluble fiber in the gizzard is important to enhance the gizzard physiological activity in improving nutrient utilization. Supplementation of phytase but not supplementation of phytase and cellulase, in the RH treatment reduced the weight of empty gizzard. Hetland and Svihus²¹ also found a reduction in weight of digestive tract when oat-based diets were supplemented with enzymes. The reduction of empty gizzard weight might be related to the improvement of enzyme production and nutrient digestibility due to the inclusion moderate amount of fiber²². The supplementation of enzymes would further improve the nutrient digestibility and thereby reduced the muscular activity of the gizzard.

The inclusion of rice hulls increased the contents of the jejunum. Although, it was generally known that insoluble fibers results in more rapid passage, however inclusion of insoluble fibers in moderate amounts could slow the feed passage at least in the front part of the GIT¹⁹. The slow of digesta passage rate might result in reducing the fecal DM of broilers fed the RH. Supplementation of phytase and cellulase increased the rate of digesta passage and as a consequence increased the DM of the feces.

The reduction of P excretion found in the present study is in agreement with the results reported by Powell *et al.*²³ and Li *et al.*²⁴ that microbial phytase addition could increase P-disappearance in the gut and reduce P excretion in the environment.

CONCLUSION

The inclusion of 40 g kg⁻¹ rice hulls can improve growth performance of young broilers. Supplementation of phytase and cellulase increases the P-disappearance in the digesta and reduces the P-excreta better than the supplementation of phytase alone.