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# Enzyme Supplementation of Commercial Feed Diluted with Copra Meal for Laying Hens

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## ABSTRACT

The study investigated the effect of enzyme supplementation of commercial feed diluted with copra meal in laying hens. Two hundred 126 d old Shaver Star-Cross pullets were fed commercial feed alone or diluted with 2 levels (20 and 30%) of copra meal (CM) with or without enzyme in 4 replicates of 10 birds each. Feed intake, hen-day production and egg quality measurements formed the response criteria. Results showed no significant differences (P<0.05) among the treatments in terms of feed intake, hen-day production, egg weight, egg mass and FCR (feed: egg). Egg surface area was lower (P<0.05) on the control compared to the dilution diets. There were no effects of diet on egg shell thickness, Haugh unit and yolk colour (P>0.05). Eggs produced on the control had higher shape index compared to the 30% CM without enzyme (P<0.05). Cost of per kg feed reduced linearly with the dilution. Feed cost per unit egg produced was lower on 30% dilution with enzyme compared to the 20% without (P<0.05). In conclusion, diluting commercial feed with CM up to 30% does not compromise egg production and egg quality traits. This will reduce production cost and add value to CM. There is need for more research into higher rates of dilution, enzyme source and concentration.

**Keywords:** Copra meal, Enzyme, Egg quality traits, Laying performance,

## INTRODUCTION

Commercial poultry production in the South Pacific region is constrained by high feed cost (Diarra, 2017). In the region, feed makes up to 80% of the total cost of production (Ayalew, 2011). Traditional protein sources such as soybean, fishmeal and meat and bone meal are expensive in the region; thus, there is need to research on strategies to maximise the utilisation of alternative ingredients. Copra meal, a moderate source of protein, is readily available in the region. Several nutritional characteristics, including high fibre and deficiency of essential amino acids, limit the efficient utilisation of CM in poultry feeding (Sundu *et al.,* 2009). The fibre of CM is primarily in the form of non-starch polysaccharides (NSP) which are not broken by digestive enzymes (Thorne *et al.,* 1990; Olude *et al.,* 2008; Choct, 2015). Amino acid and enzyme supplementation (Panigrahi, 1992; Pluske *et al.,* 1997; Moorthy and Viswanathan, 2006; Diarra *et al.,* 2014; 2015; 2018), pelleting, crumbling and soaking (Sundu *et al.,* 2005) and diet dilution (Pandi, 2005) improved the feeding value of CM for poultry. Pandi (2005) observed that village broilers grown to 53 weeks can utilise commercial feed diluted with 40% CM. Studies reporting the effect of commercial feed dilution with CM and enzyme supplementation for laying hens are however, still scanty. This study investigated the potential of commercial layer feed diluted with CM and enzyme supplementation for laying chickens with the hypotheses that (i) the birds will utilise higher levels of CM in commercial feed; and (ii) enzyme supplementation will improve the utilisation of the diluted feed by the hens.

## MATERIALS AND METHODS

The experimental site was the Poultry Unit of the Vanuatu Agriculture College Livestock-Based Integrated Farm, Luganville, Vanuatu. The dietary treatments consisted of a commercial layer feed alone and the commercial feed diluted with 2 levels (20 and 30%) of CM (on protein basis) with and without enzyme. Challenzyme 1309A, a complex enzyme manufactured by Beijing Challenge in China was the enzyme of choice. Challenzyme 1309A has the following eight enzyme activities (U/g): β-glucannase

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800, xylanase 15,000, β-mannanase 100, α-galactosidase 100, proteases 800, amylase 500, pectinase 500, and cellulase 300.

The control commercial feed contained protein 190 g/kg, fat 50 g/kg, fibre 42 g/kg and ash 55 g/kg. Copra meal used in the experiment was analysed to contain per kg dry matter: crude protein 211 g, crude fibre 164 g, total NSP 523 g, lysine 4.7 g and methionine 2.9 g. The animal ethic committee of the University of the South Pacific approved the experimental protocol.

Two hundred 126 d old Shaver Star-Cross point of lay pullets were individually weighed and randomly allocated to one of 5 treatments groups in a completely randomized design with 4 replicates each. The birds were housed in an opened-sided floor pen with wood shavings as litter materials. Feed and water were provided *ad libitum* throughout the experimental period of 84 days. The lighting programme consisted of 17 hours light and 7 hours dark.

Weighed quantities of feed were fed and the left over weighed to account for feed intake by difference. Eggs laid were recorded per pen and hen-day production (HDP) calculated as:

$$\text{HDP} = \frac{\text{Eggs Produced}}{\text{Hens in the house}} \times 100$$

Sample of eggs were weighed weekly per pen using a stainless steel IP68 waterproof digital electronic scale. Egg mass was calculated as the product of eggs produced by mean egg weight and feed conversion ratio (FCR) was derived as the ratio of feed consumed to egg mass. Fortnightly, five eggs were randomly selected per pen for egg quality measurements. Egg length and width, shell thickness and albumen height were taken using a digital Varnier caliper (0.02mm). Egg shape index was calculated according to (Anderson *et al.,* 2004) as:

$$\text{Shape index} = \frac{\text{W}}{\text{L}} \times 100$$

Where W is the width of the egg at the widest point and L, the length of the egg.

Egg surface area was calculated according to Nasr *et al.* (2012) as:

$$\text{Egg surface area} = 3.9782 \times \text{W}^{0.7056}$$

Where W is the egg weight in grams.

Immediately after taking the width and length, the egg was broken into a smooth surfaced glass. The height of the albumen was taken at 3 points (plateau of the thickest part and 2 other points on the plane surface) using a tripod spherometer and Haugh unit calculated as:

$$\text{Haugh Unit} = 100 \text{ Log}(h - 1.7w^{0.37} + 7.6)$$

(Eisen *et al.,* 1962)

Where h is the mean of the three albumen height measurements (in millimetres) and w, the egg weight in grams.

Yolk colour was determined using the Roche Yolk Color Fan.

Data on egg production performance and quality measures were treated to analysis of variance (ANOVA) using the General Liner Models (GLM) procedures of the Minitab 18 Statistical Software (Minitab Inc, USA). Treatment means were compared using the Tukey pair-wise test and significant differences reported at 5% probability level.

## RESULTS AND DISCUSSION

The results of egg production of the hens are presented in Table 1. There was no significant dietary effect (P>0.05) on any of the egg production parameters observed (feed intake, hen-day production, mean egg weight, egg mass and FCR). These results are consistent with those of Moorthy and Viswanatha (2010) who reported similar feed intake in 147 to 364 d old Single Comb White Leghorn layers fed CM at 20% level of inclusion. In contrast, Diarra *et al.* (2014) and Diarra *et al.* (2018) observed higher feed intake in CM-based diet compared to the control diet. Diarra *et al* (2014) also reported that Shaver Brown laying hens (126 to 196 d old) fed enzyme supplemented CM diets ate more feed than the control based on fishmeal. The authors attributed this to improved breakdown of fibre by enzyme and increased energy availability. Ochetim (1992) observed similarity in feed intake between two maize copra meal-based diets (33% CM) containing

**Table 1. Egg production of Shaver Star Cross laying hens fed commercial feed alone or diluted with copra meal with and without enzyme**

| Variables | Control | Diets (% CM inclusion; on protein basis) | | | | SEM | P-Values |
|---|---|---|---|---|---|---|---|
| | | ECM no enzyme | | ECM with enzyme | | | |
| | | 20 | 30 | 20 | 30 | | |
| Daily feed intake (g/bird) | 153.30 | 151.33 | 157.82 | 154.36 | 147.98 | 4.19 | 0.681 |
| Hen-day production (%) | 58.33 | 41.74 | 53.12 | 56.23 | 44.24 | 4.77 | 0.104 |
| Mean egg weight (g) | 53.35 | 53.21 | 52.95 | 53.65 | 52.71 | 0.81 | 0.937 |
| Egg Mass (kg) | 21.54 | 15.28 | 19.40 | 20.85 | 16.12 | 1.83 | 0.113 |
| FCR (Feed: egg) | 3.42 | 4.56 | 3.79 | 3.50 | 4.33 | 0.37 | 0.213 |

$^{a,b}$ Means that do not share a letter are significantly different (P=0.05); SEM: Standard error of mean.

either meat and bone meal (MBM) or fishmeal (FM) as protein sources in 140 to 504 d old laying hens and attributed this to similar nutrient characteristics between MBM and FM. In an earlier study, Wignjosoesastro *et al.* (1972) observed linear increases in feed intake in White Leghorn layers fed increasing levels of CM from 10 to 40%. Egg-type birds may tolerate higher levels of CM in the diet due to their lower energy requirement compared to meat-type birds.

The results of hen-day production agree with earlier findings. Hen-day production was similar in Shaver Brown laying hens fed 20% CM with and without enzyme and the control commercial diet (Diarra *et al.,* 2014). Ochetim (1992) also found no effect on 33% CM with MBM or FM on hen-day production of Shaver Brown hens. In an earlier study, Panigrahi (1989) observed that 10 and 20% CM does not negatively affect egg production in Shaver Star Cross 288 hens, but egg production decreased as inclusion level increased to 40% level. In contrast, Moorthy and Viswanathan (2010) reported reduction in hen-day production at 20% CM level in soybean meal compared to fishmeal based diets, probably due to the combined effect of NSP in soybean and CM. These findings suggest that ingredient composition of the basal diet is a major factor affecting the utilisation of CM by poultry. Diarra *et al.* (2018) reported higher hen-day production on 20% CM inclusion level with enzyme supplementation compared to the diet without enzyme and the control diet in laying hens. This trend in laying performance may be due to similarity in nutrient characteristics of the dietary treatments on one hand and possible longer digesta

**Table 2. Egg quality of Shaver Star Cross laying hens fed commercial feed alone or diluted with copra meal with and without enzyme**

| Variables | Control | Diets (% CM inclusion; on protein basis) | | | | SEM | P-Values |
|---|---|---|---|---|---|---|---|
| | | CM without enzyme | | CM with enzyme | | | |
| | | 20 | 30 | 20 | 30 | | |
| Exterior qualities | | | | | | | |
| Egg surface area (cm) | 71.11$^{b}$ | 88.39$^{a}$ | 87.67$^{a}$ | 88.03$^{a}$ | 87.82$^{a}$ | 0.74 | 0.000 |
| Shell thickness (mm) | 1.05 | 1.50 | 1.05 | 1.05 | 0.98 | 0.05 | 0.428 |
| Egg shape index (%) | 80.36$^{a}$ | 78.71$^{ab}$ | 77.46$^{b}$ | 79.14$^{ab}$ | 78.94$^{ab}$ | 0.48 | 0.032 |
| Interior qualities | | | | | | | |
| Haugh Unit | 93.52 | 97.06 | 96.30 | 93.57 | 101.32 | 1.89 | 0.069 |
| Yolk colour | 8.98 | 8.60 | 8.85 | 9.10 | 9.03 | 0.31 | 0.817 |

$^{a,b}$Means that do not share a letter are significantly different (P=0.05); SEM: Standard error of mean.

retention of the CM based diets resulting in increased nutrient absorption on the other hand. Diarra *et al.* (2014) also attributed improved laying performance and heavier eggs to increased nutrient absorption resulting from longer retention of CM-based diets in the small intestine.

Similar to previous reports, dietary treatment did not affect mean egg weight and mass in this study (P>0.05). Diarra *et al.* (2018) observed no difference in mean egg weight amongst CM-based diets with and without enzyme and the control feed. Contrary to these findings however, Diarra *et al.* (2014) reported heavier eggs and egg mass in hens fed 20% CM without supplemental enzyme compared to the supplemented group. There was no treatment effect on feed conversion ratio in this study. Similar to this result, inclusion of CM at 20% in Leghorn hens (Moorthy and Viswanatha, 2010) and Shaver Brown layers (Diarra *et al.,* 2014) had no effect on FCR. In a recent study, Diarra *et al.* (2018) also found no effect of 20% dietary CM on the efficiency of feed utilisation in Shaver Brown hens from 133 to 217 d old compared to the control diet. Increasing CM level to 33% in isocaloric diets produced similar FCR between diets based on MBM or FM as protein sources (Ochetim, 1992). These findings suggest that both the composition of the basal diet and energy concentration affect the utilisation of CM by poultry.

The results of egg quality traits presented in Table 2, showed no effect of dietary treatment on eggshell thickness (P>0.05). Our results are in agreement with those of Diarra *et al.* (2018) who reported no effect of enzyme supplementation on shell thickness in laying hens fed 20% CM. Egg shape index was higher (P<0.05) on the control diet compared to 30% CM-based diet without enzyme, but did not differ between the control and other test diets as well as among the test diets (P>0.05). All eggs had shape index above the 76 considered round (Sarica and Erensayin, 2009 cited in Duman *et al.,* 2016). Egg shape index is a very important quality measure as round eggs are more likely to break during transportation because they do not fit well in egg cartons. Egg surface area was lower (P<0.05) in the control compared to the CM-based diets (P<0.05) but did not differ among CM-based diets (P>0.05). Egg surface area predicts shell quality characteristics, and egg interior parameters and influences the amount of oxygen, carbon monoxide and water vapour exchanged between the egg and external environment. The reason for larger surface area of eggs produced on CM-based diets was not clear and needs further investigations.

Haugh unit and yolk colour were similar across the dietary treatments (P>0.05). All eggs had Haugh unit of around 90, which is above the 70 ranked ‘A’ by the USDA (1984). Xanthophyll is the primary natural yellow pigment in the egg yolk (Barbosa *et al.,* 2011). The similarity in yolk colour suggests that the inclusion of CM did not influence the pigment content of the diets. Panigrahi (1989) observed increased in pale yellow yolks when CM level was increased to 40% in a maize-based diets, suggesting low pigment content of CM. The commercial feed used in this study was wheat-based. The low xanthophyll contents of wheat

**Table 3. Feed cost of production of Shaver Star Cross laying hens fed commercial feed alone or diluted with copra meal with and without enzyme**

| Variables | Control | Diets (%CM inclusion; on protein basis) | | | | SEM | P-Values |
|---|---|---|---|---|---|---|---|
| | | CM without enzyme | | CM with enzyme | | | |
| | | 20 | 30 | 20 | 30 | | |
| Cost /kg feed (US$) | 0.99 | 0.85 | 0.78 | 0.85 | 0.78 | NA | NA |
| FCR (feed: egg) | 3.42[ab] | 4.56[a] | 3.79[ab] | 3.50[ab] | 4.33[b] | 0.370 | 0.026 |
| Feed cost (US$)/kg egg | 3.39[ab] | 3.89[a] | 2.97[ab] | 2.98[ab] | 2.28[b] | 0.257 | 0.011 |

[ab]Means that do not share a letter are significantly different (P=0.05); SEM: Standard error of mean; NA: Not analysed

and CM may explain the trend of yolk colour.

Data pertaining to feed cost of egg production presented in Table 3 showed a linear reduction in the cost of feed with the level of dilution. This is due to the lower market price of CM. Feed conversion ratio (feed: egg) and feed cost per unit egg produced were reduced on 30% dilution with enzyme compared to 20% without enzyme. This could be due to increased enzymatic hydrolysis and nutrient availability for egg production.

## CONCLUSIONS

From these results, we conclude that diluting commercial layer feed with CM (on protein basis) up to 30% had no adverse effect egg production. Enzyme supplementation may not be required at this level of dilution. The dilution will reduce cost of egg production and add value to copra meal in the study area. There is need for further research on higher dilution rates, enzyme sources and levels.

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