Performance of Australorp Layers Fed Copra Meal Protein Concentrate and Sweet Potato Meal as Energy and Protein Sources in a Choice Feeding System

William Nano

ABSTRACT

The performance of a strain of cross bred Australorp layers was studied when they were offered free-choice diets. This paper presents the results of a study on the innate ability of layer hens to self-select nutrients from locally available ingredients (copra meal and sweet potato chips) to meet their nutrient requirements. Copra meal (CM) was used to prepare three different protein concentrate diets labelled CFD1, CFD2, and CFD3 containing 50 %, 60 % and 70 % CM respectively. Dried sweet potato chips were used as separate ingredients supplied in combination with each of the three concentrate. 60 points of lay pullets were divided into 20 for the 3 dietary treatments. Test period was 20 weeks and the response variables measured were feed intake (FI) Eggs/Hen /Day, Feed conversion ratio (FCR).Chemical composition of the diets and sweet potato chips and their metabolizable energy (ME) content were also obtained. Diets have highly significant effects ($p<0.01$) on FI, FCR, and egg/hen/day. Mean FI, FCR, egg/hen/day for diets 3 were significantly lower than for diets 3 but were reasonable and significantly higher than for diets 1 and 2. Mean FI for diets 1 and 2 were significantly higher than for diet 3. FCR values are similar as the FI. It was therefore concluded that the copra meal inclusion up to 60% and sweet potato chips can be used on free choice feeding of village Australorp layers.

Key words: Australorp, diets, protein, concentrate metabolizable energy

INTRODUCTION

In Papua New Guinea in the last two decades, there was massive and aggressive distribution of Australorp chickens by the Department of Agriculture and Livestock (DAL) to the rural areas to help improve poor human nutrition and food security program in support of United Nation FAO food security program. The aim of providing nutrition and deliberate of cross breeding of the local chickens with the introduced Australorp chickens will improve the genetic potentials of the chickens in the villages and therefore would improve chicken performance and human nutrition.

Currently most of the chickens in PNG besides the commercial chickens, including those in very remote and inaccessible areas are genetically unimproved village chickens, which probably have adapted to difficult environments and management conditions. The egg production of village chickens in developing countries is generally low, compared to improved commercial layers (Ballard, 1985; North and Bell, 1990; Glatz, 2012). One of the main causes of low meat and egg production of village chickens is poor nutrition. Even though commercial feeds are available in PNG their cost is very high and the poor transport infrastructure makes it difficult to use such feeds in most parts of PNG. Although, the response of village chickens to expensive commercial feeds is very good, the highlighted problems above make it potentially unprofitable to use commercial feeds for the village chickens. In order to minimize feed cost and improve upon efficiency of village chicken production, many workers have suggested the use of cheap locally available feed ingredients and agro-industrial by-products as a source of energy in combination with a protein concentrate (Bennet, 2003; Pousga *et al*., 2005; Glatz, 2012). The protein concentrate and the energy feeds could

University of Technology, Department of Agriculture, PMB, LAE, Papua New Guinea
Corresponding author: e-mail: wnano@ag.unitech.ac.pg

capitalize on the innate ability of chickens to self-select different feed ingredients to meet their requirements. This type of feeding is practiced by many keepers of village chickens, who provide different feedstuffs, including crop residues and left over from the kitchen and allow the chicken to select nutrients from these ingredients. This may be accepted as scavenging but nutritionally it is choice feeding that is whilst scavenging the ingredients; they are actually self- selecting nutrients using their innate abilities to balance the nutritional need for the day (Cumming, 1992a; Ciszuk, *et al.,* 1998; Olver and Malan, 2000; Haskell *et al.,* 2001; Dana and Ogle, 2002; Henuk and Dingle, 2002; Pousga *et al*., 2005; Glatz, 2012). This experiment was conducted to study feeding copra meal protein concentrates in a choice feeding with sweet potato meal (SPM) on egg production performance of Australorp laying hens.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Animal Husbandry Research Centre of the National Agricultural Research Institute (NARI), formerly, DAL, Poultry Research Centre, Labu (6 ° 41' S 146 ° 4' E), Morobe Province. The station is situated at about 20m above sea level, has an average relative humidity (RH) of 80 %, receives an average annual rainfall of about 2300 mm, and an average daily temperature of 27 °C.

Experimental diets

Three different choice feeding diets (CFD) were used in this study (Table 1 and Table 2). These diets comprised of different rations of copra meal concentrate (CFDs) and sweet potato meal (SPM). The CMCs of the CFDs had high protein content and had 50 %, 60 %, and 70 % copra meal, were coded as copra meal concentrates CFD1, CFD2 and CFD3 (Table 1) respectively. These concentrates were formulated using the methods of Scott *et al.* (1976). Samples of each of the CFD diets and CM and SPM were used for proximate analyses following the procedures of AOAC (1990).

Table 1. Ingredients composition of the diets (%)

Ingredients	CFD1	CFD2	CFD3
Copra meal	50.00	60.00	70.00
Mill run	37.00	27.00	17.00
Meat& bone meal	10.00	10.00	10.00
Premix[1]	3.00	3.00	3.00

[1]Premix consisting of Niugini Table Birds commercial layer Premix

Table 2. Analysed composition of the diets

	CFD1	CFD2	CFD3	SPM
Crude protein (%)	21.10	21.40	22.40	4.10
Ether extract (%)	5.50	4.00	4.50	0.60
Crude fibre (%)	16.90	18.70	19.40	4.70
ME. (Cal. MJ/kg)	14.13	13.94	14.04	0.00
ME:CP ratio	0.669	0.651	0.637	0.00

ME = metabolizable energy is calculated, ME: CP= ME/CP

Experimental chickens

Two hundred day-old mixed sex Australorp chicks were hatched from the centre's hatchery and the chicks were subsequently vaccinated against Fowl Pox, and Mareks diseases. An opened sided shed with deep litter floor and chick guard was used to brood and rear the chicks to the first 133days. And chick starter diet containing (18% crude protein and 12.00 MJ/kg (ME)) was fed ad libitum and water was freely available to the chickens during the brooding period. After six weeks of age, a total of 100 female chickens were selected for the experiment. The chickens were fed a controlled pullet grower and developer diet (16% crude protein and 12.00 MJ/kg ME) and water ad *libitum* to 19 weeks of age. A total of sixty, 19 weeks old Australorp pullets were selected from the batch of one hundred pullets to be used in this experiment. The selected pullets were then randomly assigned to individual single-tier layer cages. Each cage had feeding troughs that were partitioned equally in the middle to separate the sweet potato meal from the copra meal concentrate mash and each bird had access to both types of feeds and this allows them to make choice of food to meet the nutrients need. The birds were acclimatized to the cage condition and the CFD rations for a week. After which, their initial weights were recorded before the onset of the choice feeding experiment. The pullets were individually weighed using a Salter^{O} top weighing balance (5kg x 10g division), and those weighing the heavier (1800g±133) and the lighter than (1400g±133) were excluded to minimise body weight variation and the selected pullets were then randomly assigned to individual single-tier layer cages.

Experimental design

A completely randomized experimental design was used in this experiment. Sixty, 19 weeks old Australorp pullets were allocated to three treatments and each treatment was assigned randomly to 20 pullets and one pullet was put in each cage. The experiment was conducted for 19 weeks from 20 to 40 weeks of age and measurements of variables were taken during that period. All treatment diets were fed ad libitum throughout the testing period. Water was also freely available to each chicken throughout the experiment via a nipple type drinker.

Response variables.

The main response variables measured were daily feed intake (FI), feed to egg ratio (FCR), mean Hen-day % (HD %), mean egg weights (MEW), as well as mean daily feed intake of CFDs and SPMs. Mortality was also recorded to help explain the results. Intake of CFDs, and SPMs were measured on a weekly basis for each chicken. Fresh feed was weighed and added to each container on a daily basis and at the end of each week the residual feed left was weighed. Weekly feed consumption was calculated as the difference in weight between feed supplied and residual feed for each week. Daily feed intake (FI) for each treatment (CFD1, CFD2 and CFD3) was calculated as the sum of the weekly CFDs and SPMs intake during the feeding period. HD % was measured as the numbers of eggs produced per hen per day divide by number of layers alive multiply by 100, during the test period. The eggs produced by each hen were graded by size (40g, 45g, 50g and 55g) and MEW of eggs in each grade was also recorded. While feed conversion ratio (FCR) was calculated as the mean CFI as fraction of the mean MEW.

Statistical analysis

FI, FCR, HD %, MEW, SPMs and CMCs were each subjected to analysis of variance (ANOVA) using Microsoft Office Excel (2007) computer program. Where treatments were found to have significant effects on the variable after ANOVA, then mean separation was carried out using the least significant difference method (Steele and Torrie, 1980) at the 5 % probability level.

RESULTS

The chemical composition of copra meal concentrates had high crude protein and crude fibre content (Table 3). As the CM content of the CFCs increased their crude fibre contents also increased respectively. The daily intake of the different CFDs was not too variable (Table 5). Contrastingly, the mean intake of sweet potato meal was higher for CFD1 while CFD3 had the lowest however CFD1 had the highest mean daily feed intake. The analysis of the composition of sweet potato in the choice feeding diets ranges remains same for CFDs of the total CFDs. On the other hand, the production indicators showed similar levels of variation: HD % ranged for chickens fed a CFD3 to those fed on CFD1 and MEW for chickens fed CFD3 to for those fed on CFD1. This is reflected in the FCRs where CFD3 had the highest FCR while CFD1 had the lowest FCR. The ANOVA detected significant differences (P<0.01) among all the choice feed combinations in all the parameters measured (Table 4). The choice feeding combination of CFD3 has significantly (P<0.01) lower compared to the rest, while CFD1 has a significantly (P<0.01) higher mean daily feed intake than the rest (Table 6). There was no difference in the mean daily feed intakes of CFD1 and CFD2. Further, the consumption of the copra meal concentrate was not significantly (P<0.01) higher for CFD1. There was no difference (P>0.05) in the mean intakes of copra meal concentrate between CFD1, CFD2 and CFD3, while CFD3 had the least significant (P>0.05) consumption of the copra meal concentrate compared to the rest. The consumption of sweet potato meal in combination with CFD2 and CFD3 increased significantly (P<0.05) than when fed with CFD1. Nonetheless, the chickens offered the CFDs consumed similar amount of copra meal concentrate and they did for sweet potato meal. On the other hand, chickens fed on CFDs were not significantly (P<0.01) different in HD % and MEW (Table 4) with the three choice feed diets. The chickens that were fed to CFD1, CFD2 and CFD3, however, all performed similarly. The effect of the choice feed diets on the FCR was similar to that of HD % and MEW. Chickens fed on CFD1 and, CFD2 were similar but better FCR than those fed on CFD3. Nutrients composition of the CFDs and SPM used in this experiment are shown in Table 3.The choice feeds (CFD1, CFD2 and CFD3) had high ME and crude protein content and crude fibre content which proportional to increasing CM per cent in the CFD. The chickens being monogastric animals, they do not have the ability to utilize the higher crude fiber content of the diets. This may therefore, have negative effect on the digestibility and utilization of the diets.

Table 3. Mean separation values of variables HD %, MEW, FCR and mortality % and feed variables SPM, CFD, TFI and % SPM of FI as fed DM basis

Variable	CFD1	CFD2	CFD3	SEM	Significance
Mean egg numbers (bird/year)	237	233	204	3.67	NS
Mean egg weight (g)	29.75^{a}	29.23^{a}	25.11^{a}	5.36	*
Point of lay (HD %)	5.00	6.00	4.5	5.71	NS
Hen-day %	64.70^{a}	63.45^{a}	56.10^{b}	12.08	*
FCR	5.24	5.48	6.08	0.32	NS
Mortality %	0.00	0.00	0.00		
Average daily Sweet potato (g)	35.34	35.31	33.82	0.30	NS
Average daily CFDs intake. (g)	115.06	114.89	110-58	0.89	NS
Average daily total Intake (g)	150.4^{a}	150.20^{a}	144.4^{c}	1.03	*
% sweet potato intake	23.49	23.51	23.37		

*Values in the same row with different letter subscripts are (a, b) significantly (P<0.05) different between

treatments, and those with the same subscripts are not significantly different.

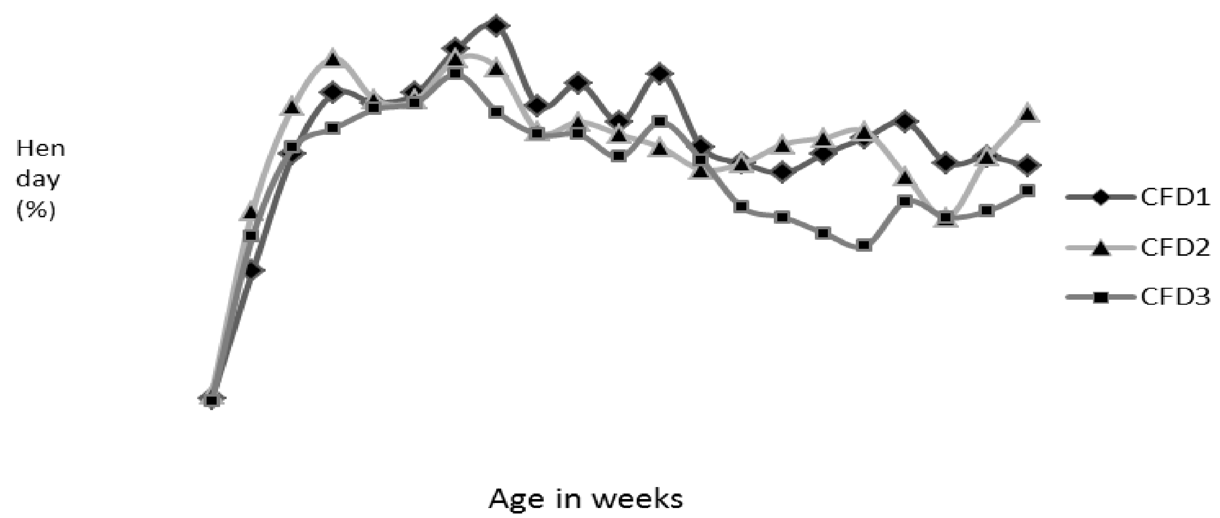

Figure1 Effect of different levels of CMCs + SPM (CFDs) on hen-day% egg production per week on Australorp pullets. (20-40 weeks)

The result of the ANOVA of HD% of layers showed that the experimental feeds had significantly (P<0.05) effect on total egg production. Mean separation was therefore carried out for the different experimental feeds and the results are shown in Table 3.

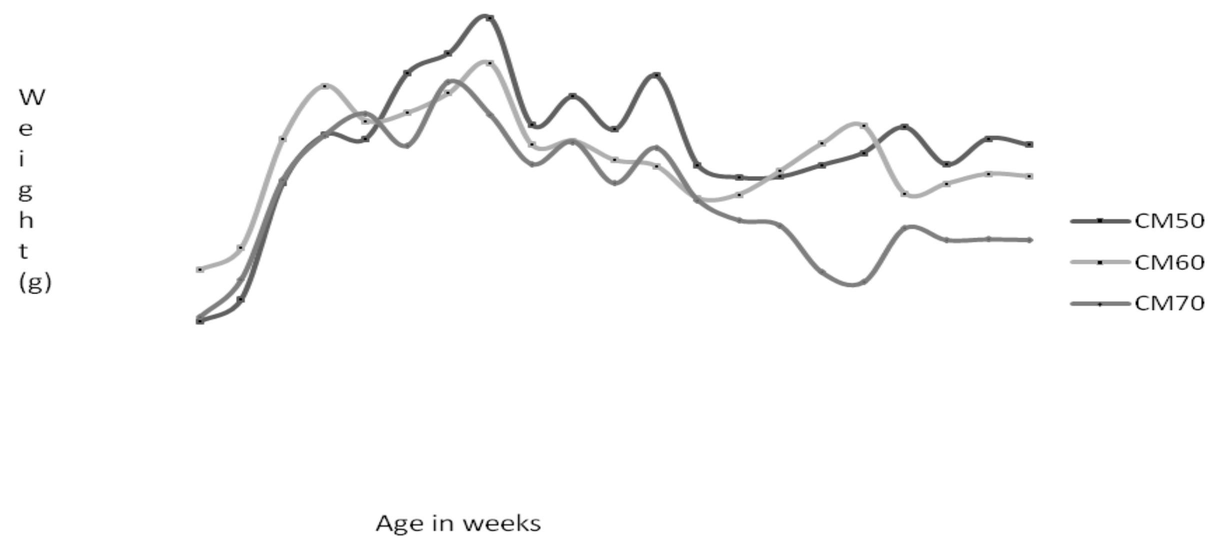

Figure 2 Effect of different levels of CMCs + SPMs (CFDs) on average weekly egg weight per treatment (20-40 weeks).The weekly average total eggs weights by the hens on the various treatments are shown in the figure 2. The egg weights curve follows similar trend as the normal weekly egg numbers curve. It rises to a peak between 24 week and 29 weeks of age and then falls of gradually (40 weeks of age) and appears to be similar to those normally shown by layer chickens.

DISCUSSIONS

The layers were able to self-select CFD and SPM when fed on a free choice basis. The results obtained in this experiment showed that 50 % CFD and SPM produced the best in egg production. 60 % CFD and SPM was the next best and lastly the 70% CFD and SPM. This indicates that as the level of Copra meal in CFD increases the layers performance in egg production declines. In others there is proportionally inverse relationship between the level of Copra meal in CFD and laying performance of the layers. This could have been the result of increasing level of fibre content in the copra meal in the CFD, as the level of copra meal increases so as the fibre content in the CFD. The effect of fibre on growth and other economical traits performance in animals is well document. It is often resulted in poor and declining results and in this case the egg production. Several authors have reported that poor performance of chickens may be due to low concentration of limiting amino acids, heat damage of the copra meal during processing and high dietary fiber content of copra meal (Knudsen, 1997; Sundu *et al*., 2006). They also concluded that increased levels of copra meal in the diet impaired feed digestibility and therefore productivity in young broilers. Balasubramaniam (1976) found that the non-soluble polysaccharides (NSPs) in the fiber of copra meal is in the form of mannan (26%), galactomannan (61%) and cellulose (13%) all of which have been found to have anti -nutritional properties in legumes. These NSPs contribute to low digestibility of protein and lipid by blocking the access of enzymes to cell contents (Knudsen, 1997). In general it is well known that chickens fed on copra meal diets generally perform at a lower level than those on commercial diets. Panigrahi *et al.* (1987) found that birds fed 25% copra meal had lower body weight in the first 5 weeks but accelerated their growth in the following weeks suggesting that chickens gain a better ability to handle copra meal as they get older. In this study, older chickens were used; and the results, however, suggest that inclusion of up to 50% copra meal was quite adequate in a choice feeding diet in combination with SPM to achieve optimal production. This study also demonstrated that with increasing levels of copra meal in the concentrate there is a declining effect on FCR, although there is no correlation between the ratio of copra meal concentrate to SPM and the FCR. This also indicates there is a need to look at increasing sample size of the experimental units and increase the trial period in future studies to fully appreciate the effects of such feeding regime. The components of the choice feeding diets need to be studied to determine their apparent metabolisable energy and protein digestibility to be able to corroborate this finding. In terms of the energy and protein consumption, the high fibre level in the CFD diets and low ME intake will definitely have an effect on the ME: CP ratio which affects the amino acid digestion and utilisation and this will affect egg production and growth performances. Interestingly, higher amounts of copra meal in the copra meal concentrate seemed to have a negative impact on the performance of the layers. (Purwadaria*, et al*., 1995; North and Bell, 1995). The chemical compositions of the CFDs showed that they were similar in their crude protein, fat, metabolisable energy, and energy to protein relationship which were nutritionally reasonable and stable. However crude fibres content were high in the CFDs and showed that the fibre content increases with increasing level of copra meal. This is considered as important problem to the layers performance in this experiment. There must be a proper ratio between total energy and the total protein in the diet to assure adequate intake levels of critical amino acids in a diet for formation of protein compounds in the an animal. The recommended ME:CP 64-66 as per North and Bell (1990) and the present layer diets ME:CP ranges from 64.0 -65.0. In this experiment the copra meal based protein concentrate were similar in the ME:CP ratio as recommended (NRC, 1984; North and Bell, 1990). Therefore the hens should have minimal problem in protein intake and utilisation by the hens.

The high FCR in the CFDs in this experiment might be due to the high fibre levels in the diets which stimulates increase fed intake and low total egg weights obtained. The performance of CFDs fed chickens may also have been affected by the anti-nutrition factors mentioned above by sweet potato and copra meals or the endogenous and environments factors, (Huang, 1999; Timmins, *et al*., 1992). Purwadaria, *et al*., 1995; Sattagroon, *et al*., 1983; Zamora, *et al*., 1989 reported that approximately 30% of copra is NSP and mannans and galactomannans.

The main message that can be conveyed to the farmers is that although there are impediments due the biological response to chemical compositions of the CFDs. Apparently, the chickens are able to handle the difficulties pretty well to produce and give us the eggs we want. About 50-60 % copra meal in co-operated in the CFDs concentrate is recommended for farmers to use in a choice feeding of laying hens in combination with sweet potato meal in egg production.

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