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GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS AND GROWING-FINISHING PIGS FED DIETS WITH CORN-SOYA REPLACER MEAL

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ABSTRACT

Feeding trials were conducted to determine the effect of replacing yellow corn (YC) and soybean oil meal (SBOM) with corn-soya replacer meal (CSRM) with and without antibiotic growth promoters (AGPs) on growth performance and carcass characteristics of broiler chickens and growing-finishing pigs. Growth performances were determined from starter to finisher stages. Carcass characteristics were evaluated after slaughter. The dietary treatments were: T1-basal diet without CSRM with AGPs; T2 and T3-diets replacing 40% and 10% of YC and SBOM inclusions, with and without AGPs, respectively; and T4 and T5-diets replacing 80% and 20% of YC and SBOM inclusions, with and without AGPs, respectively. Based on the results of the broiler experiment, diets with CSRM replacing 40% YC and 10% SBOM with and without AGPs can be fed to broilers without affecting performance and carcass characteristics. In the growing-finishing pigs, there were no significant differences on all the performance parameters and carcass characteristics measured. It can be concluded that CSRM can be used to partially replace YC and SBOM in the diets of growing-finishing pigs and of broiler chickens.

Key words: broiler chickens, maize, soybean meal, swine

INTRODUCTION

For the past few years, several feed ingredients have been introduced as replacement to yellow corn (YC) and soybean oil meal (SBOM) as main feed ingredient or as supplementation to diets. The steady increase in the world's human population increases the competition between non-ruminant livestock and people for grains with high nutrient density (CAST, 1999). The increased use of corn for ethanol production has also caused the increase in price of yellow corn which has led to high animal production cost (Willems, *et al.,* 2013). Corn has been the livestock and poultry industries' standard for supplying energy in a diet, but many other alternatives can easily meet the dietary nutritional requirements of the animals with proper formulation. On the protein side, SBOM has been the standard for supplying amino acids. Ingredients that can replace a portion of both yellow corn and soybean oil meal include distiller's grains with solubles, field peas, wheat middling and soybean hulls.

Due to increasing consumer awareness on food safety and the use of antibiotics in food animals, the use of several antibiotics in animal feeds is being monitored and restricted by the Philippine's Bureau of Animal Industry and National Meat Inspection Commission. Overuse of antibiotic growth promoters may lead to the local bacterial populations becoming resistant to the antibiotic which could also affect humans consuming

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animal products (Hughes and Heritage, 2002). A potential raw material for feed production that can be considered as alternative feed ingredient is corn-soya replacer meal (CSRM). It is a mixture of by-products from various industries such as ethanol production, milling, bakery, etc. It has been used in other countries as replacement to YC and SBOM at 80:20 ratio in feeds offered to pigs. CSRM contains fermentation products such as enzymes which can improve nutrient utilization and performance of animals (Kim *et al*, 2006).

The study aimed to determine the effects of feeding CSRM with and without AGPs on growth performance and carcass characteristics on broiler chickens and growing-finishing pigs.

MATERIALS AND METHOD

The experiments were conducted from January to May 2015 at the Animal and Dairy Sciences Cluster Animal Farm, University of the Philippines Los Baños, College, Laguna.

The corn-soya replacer meal used was Corn Miser Blend (Platte Valley Commodity Blends, Columbus, NE, USA) which contains processed grain by-products, plant protein by-products, L-lysine, calcium carbonate, dehydrated *Aspergillus niger* products and mineral oil. The product has a minimum nutrient content of the following: 15% crude protein, 0.82% total lysine, 4% crude fat, 8% crude fiber, 0.045% calcium, and 0.5% total phosphorus. The recommended maximum inclusion rate of this product is 80% replacement for YC and 20% replacement for SBOM.

The study was composed of two feeding trials. The first experiment was conducted on broiler chickens and the second was conducted on growing to finishing pigs. In the first trial, four hundred (400) Cobbs straight-run day-old chicks (DOCs) weighing 42 grams were purchased from a reliable hatchery farm. Day-old chicks were randomly distributed in 40 cages and were assigned to 5 treatments following the completely randomized design (CRD). For the second trial, thirty (30) commercial F1 weaners (barrows) with the approximate body weight range of 15±1.5 kg were purchased from a reliable piggery and placed in the Animal and Dairy Sciences Cluster's quarantine area for 15 days. After the quarantine period, animals were blocked by body weight and were randomly assigned to five (5) treatments following a randomized complete block design (RCBD). Each treatment was replicated six times with one pig as replicate.

Dietary treatments include: Treatment 1 (T1) – Control diet without CSRM with AGPs (75ppm each of chlortetracycline and zinc bacitracin); Treatment 2 (T2) – CSRM replacing 40% YC and 10% SBOM with AGPs (75ppm each of chlortetracycline and zinc bacitracin); Treatment 3 (T3) – CSRM replacing 40% YC and 10% SBOM without AGPs; Treatment 4 (T4) – CSRM replacing 80% YC and 20% SBOM with AGPs (75ppm each of chlortetracycline and zinc bacitracin); and Treatment 5 (T5) – CSRM replacing 80% YC and 20% SBOM without AGPs.

Inclusion of CSRM was derived by calculating the sum of percent substitution of YC and SBOM. Example in the case of T2 and T3 with replacement rate 40% YC and 10% SBOM, the amount of CSRM per 100 kg of feed in broiler booster diet was calculated to be equal to 24.67 kg (54.11 kg YC X 40% + 30.30 kg SBOM x 10%). The same calculation was used in deriving the inclusion rates of CSRM in other treatment diets.

For the broiler experiment, the body weight (BW) was recorded on a weekly basis. Feed consumption (FC) was measured per feeding stage. Feed conversion ratio (FCR) was calculated. Mortality rate was also recorded. For carcass characteristic evaluation, the dressing percentages were determined after slaughter. In the growing-finishing pig experiment, BW and FC were measured per stage of feeding. The body weight gain (BWG) and average daily feed intake (ADFI) of pigs were also calculated. Mortality rate

was recorded. Feed conversion ratio was computed from the feed consumption and body weight gain. For the carcass characteristics, hot carcass weight, dressing percentage, carcass length, backfat thickness, loin eye area and fat depth were determined. Equivalent cost of CSRM for the experimentally determined optimal substitution rate for YC and SBOM were also calculated for diets for both broiler chickens and growing-finishing pigs.

The birds were housed in conventional housing system and booster, starter and finisher feeds were fed for 10, 14 and 11 days, respectively. The flock was vaccinated against New Castle Disease on the 14th day. On the other hand, pigs were fed for 4 weeks each for starter, grower and finisher feeds. Care and management of the broilers and pigs followed the conventional system. Basal diet (Diet 1) was formulated following the typical feed specifications for broiler chickens and growing-finishing pigs (Tables 1 and 2). All AGPs were withdrawn two weeks before harvest. Feeding was ad libitum with clean drinking water available at all times.

To check for interaction and individual effects of CSRM and AGP, all data were analysed using ANOVA at 5% level of significance following a 2 x 2 factorial experiment (using only the data derived from treatments 2, 3, 4, and 5) in a CRD for broiler experiment and RCBD in the growing-finishing pigs experiment. All the data gathered from treatments 1, 2, 3, 4, and 5 were also analysed using ANOVA at 5% level of significance following single-factor experiment in CRD and in RCBD for broiler chicken experiment and growing-finishing pig experiment, respectively. Comparison of treatment means was done using Tukey's HSD.

RESULTS AND DISCUSSION

Broiler chicken trial

Interaction and main effects of CSRM and AGPs on FC, BW and FCR

Different levels of CSRM (replacement rate 40% YC: 10% SBOM and 80% YC: 20% SBOM) had no interaction effects with the levels of AGPs (with and without) in the diet for all production performance and carcass quality parameters. However, significant main effect of CSRM (Table 3) was observed on BW at 7 and at 28 days and on overall FCR. Chicks fed diet with CSRM replacing 80% YC and 20% SBOM (regardless of AGP level) had higher BW at 7 days compared to chicks fed diet with CSRM replacing 40% YC and 10% SBOM. However, at day 28, chickens fed diet with CSRM replacement level of 40:10 had higher body weight compared to chickens fed diet with 80:20 replacement level of CSRM. Similarly, chickens fed diets with 40:10 replacement level of CSRM were more efficient in converting feeds to body mass compared to chickens fed diet with 80:20 CSRM replacement level. In the study of Batal and Parsons (2002), chicks had low energy and amino acid digestibility especially on the first 2-3 days and increased with age. With this reason, supplementation of diet with enzymes during the first days of the chicks may be beneficial to efficiently utilize the nutrients in feeds. Undigested oligosaccharides can negatively influence growth rate of young chicks and according to Rosin *et al*. (2007), increasing the growth performance of broiler chickens by supplementing their diets with exogenous enzymes can contribute to positive changes in gut health.

Growth performance of broiler chickens

The data on the production performance of broiler chickens fed five different dietary treatments are presented in Table 4. No significant differences were observed on feed intake of birds during the booster, starter and finisher stages. This may imply that the partial replacement of YC and SBOM by CSRM did not have much effect on nutrient and energy density of the diets.

The average body weight of chickens from day 7 to 21 was not affected by the dietary treatments. However, differences in BW between treatments were observed at 28 and 35 days. Chickens in T1 and T2 were significantly heavier compared to T4 and T5 (Table 4).

Table 1. Ingredient composition of basal diets for broiler chickens.

Ingredients	Booster	Starter	Finisher
Yellow corn	54.11	52.87	55.92
Soybean oil meal	30.30	29.57	29.37
Rice bran d1	5.00	6.06	5.25
Fish meal replacer 65	2.00	2.00	0.00
Meat& bone meal 60%	1.00	1.00	0.00
Coconut oil	3.95	5.00	5.50
Limestone	1.15	1.21	1.62
Monodicalcium phosphate	0.86	0.85	1.23
Iodized salt	0.30	0.35	0.35
Vitamin pmx[1]	0.12	0.12	0.10
Mineral pmx[2]	0.12	0.12	0.13
DL-methionine	0.32	0.25	0.20
L-threonine	0.10	0.05	0.00
L-lysine	0.26	0.16	0.08
Choline chloride 50%	0.15	0.15	0.16
Mold inhibitor	0.05	0.05	0.05
Zinc bacitracin15%	0.05	0.05	0.05
Chlortetracycline 15%	0.05	0.05	0.05
Robenidine 6.6%	0.04	0.04	0.04
Toxin binder	0.05	0.05	0.05
Total (kg)	100.00	100.00	100.00
Calculated Nutrient Content			
ME, kcal/kg	3070	3120	3150
Crude protein, %	21.50	21.00	19.00
Lysine, %	1.35	1.25	0.91
Met + Cys, %	0.93	0.85	0.75
Threonine, %	0.90	0.83	0.62
Crude fat, %	7.17	8.27	8.47
Crude fiber, %	3.11	3.13	3.10
Calcium, %	0.90	0.90	0.95
Total P, %	0.77	0.78	0.75
Avail. P, %	0.45	0.45	0.43

[1] Per kg: Vitamin A 55,000,000 IU; D3 12,500,000 IU; E 150g; K3 10g; B1 10 g; B2 30g; B6 20g; B12 0.125g; Niacin 200g; Pantothenic acid 60 g; Biotin 0.75g; Folic Acid 5g

[2] Per kg: Iron 115,000mg, Manganese 50,000mg, Iodine 850mg, Selenium 150mg, Zinc 50,000mg, Copper 10,000mg, Carrier (+mg).

Table 3. Main effects of corn-soya replacer meal (CSRM) and antibiotic growth promoters (AGPs) on feed conversion ratio (FCR) and body weight (BW) of broiler chickens.

FACTORS	LEVELS	FCR	AVERAGE BODY WEIGHT				
			Day 7 (g)	Day 14 (kg)	Day 21 (kg)	Day 28 (kg)	Day 35 (kg)
CSRM % Replacement Level (YC:SB)	40:10	1.52^{b}	170^{b}	0.44	0.86	1.41^{a}	1.79
	80:20	1.59^{a}	180^{a}	0.44	0.82	1.31^{b}	1.72
AGPs	With	1.57	170	0.43	0.85	1.37	1.75
	Without	1.55	180	0.45	0.83	1.35	1.75

Means within column (per factor) with different superscripts are different (P≤0.05).

In terms of FCR, chickens fed basal diet without CSRM and with AGPs were more efficient (P<0.05) than chickens fed diets with CSRM replacing 80% YC and 20% SBOM in the diets (T4 and T5). This could be due to the growth promoter effects of antibiotics used in T1.

Mortality rate

The recorded mortality rate (0.05%) is very low throughout the experiment. The cause of death is also not related to the dietary treatments. Low mortality rate can be attributed to good management practice and well balanced diets.

Carcass characteristics

In broiler production, the dressing percentage usually ranges from 70 to 72%. This information can be used to set prices and calculate profitability (Schweihofer, 2011). The average dressing percentage of 76.83% in the experiment is higher compared to known standards (Table 5). In general, the animals that are heavier muscled have higher dressing percentage than animals that are lighter muscled (Schweihofer, 2011).

Table 4. Production performance and dressing percentage of broiler chickens fed diets with varying inclusion levels of corn-soya replacer meal (CSRM).

Parameter	T1	T2	T3	T4	T5	CV,%
Feed consumption (kg)						
Booster[ns]	0.25	0.26	0.26	0.26	0.26	7.69
Starter[ns]	1.17	1.18	1.16	1.17	1.17	1.71
Finisher[ns]	1.26	1.29	1.28	1.31	1.28	3.91
Body weight (kg)						
28 days	1.47^{a}	1.43^{a}	1.38^{ab}	1.30^{b}	1.32^{b}	6.52
35 days	1.87^{a}	1.79^{a}	1.78^{ab}	1.71^{b}	1.72^{b}	6.17
Feed conversion ratio	1.43^{b}	1.52^{ab}	1.52^{ab}	1.61^{a}	1.58^{a}	5.88
35-day dressing percentage[ns]	77.14	77.29	77.57	75.51	76.66	76.83

Means within same row with different superscripts are different (P≤0.05)
ns- not significant
T1-basal diet without CSRM with AGPs; T2 and T3-diets replacing 40% and 10% of YC and SBOM inclusions, with and without AGPs, respectively; and T4 and T5- diets replacing 80% and 20% of YC and SBOM inclusions, with and without AGPs, respectively.

Table 5. Growth performance of growing-finishing pigs fed diets with varying inclusion levels of corn-soya replacer meal (CSRM).

Parameter	T1	T2	T3	T4	T5	CV,%	
Feed consumption (kg)							
Booster^{ns}	0.25	0.26	0.26	0.26	0.26	7.69	
Starter^{ns}	1.17	1.18	1.16	1.17	1.17	1.71	
Finisher^{ns}	1.26	1.29	1.28	1.31	1.28	3.91	
Body weight (kg)							
28 days	1.47^{a}	1.43^{a}	1.38^{ab}	1.30^{b}	1.32^{b}	6.52	
35 days	1.87^{a}	1.79^{a}	1.78^{ab}	1.71^{b}	1.72^{b}	6.17	
Feed conversion ratio	1.43^{b}	1.52^{ab}	1.52^{ab}	1.61^{a}	1.58^{a}	5.88	
35-day dressing percentage^{ns}	77.14	77.29	77.57	75.51	76.66	76.83	
Body weight, kg ^{ns}							
Starter	43.30	44.24	43.70	44.7	42.17	4.33	
Grower	68.77	68.84	68.33	69.17	66.43	3.99	
Finisher	93.27	93.33	93.97	92.87	90.13	9.87	
Body weight gain, kg ^{ns}							
Starter	22.60	22.98	22.91	24.02	21.42	8.25	
Grower	25.47	24.60	24.63	24.47	24.27	7.35	
Finisher	24.50	25.10	25.63	23.7	23.7	7.46	
Overall	72.57	72.06	73.18	72.18	69.39	4.87	
Average daily gain, kg ^{ns}							
Starter	0.81	0.82	0.82	0.86	0.77	8.17	
Grower	0.91	0.88	0.88	0.87	0.87	7.42	
Finisher	0.88	0.90	0.92	0.85	0.85	7.52	
Overall	0.86	0.86	0.87	0.86	0.83	4.77	
Average daily feed intake, kg ^{ns}							
Starter	1.65	1.70	1.66	1.63	1.62	12.59	
Grower	2.47	2.45	2.35	2.47	2.45	3.29	
Finisher	2.76	2.77	2.79	2.78	2.79	7.93	
Overall	2.29	2.32	2.26	2.29	2.29	3.10	
Feed conversion ratio ^{ns}	2.65	2.67	2.71	2.62	2.67	2.77	
Mortality, % ^{ns}	0.00	0.00	0.00	16.67	0.00		

ns - not significant (P>0.05)
T1-basal diet without CSRM with AGPs; T2 and T3-diets replacing 40% and 10% of YC and SBOM inclusions, with and without AGPs, respectively; and T4 and T5- diets replacing 80% and 20% of YC and SBOM inclusions, with and without AGPs, respectively.

Table 6. Carcass characteristics of pigs fed diets with varying inclusion levels of corn-soya replacer meal (CSRM).

Parameter	T1	T2	T3	T4	T5	CV, %
Hot Carcass Weight, kg ^{ns}	67.03	65.63	70.70	65.30	64.03	3.93
Carcass Length, cm ^{ns}	74.17	74.00	76.87	75.60	73.33	2.78
Backfat Thickness, cm ^{ns}	2.79	2.59	2.56	2.54	2.28	18.80
Fat Depth, cm ^{ns}	2.00	1.60	1.50	1.73	1.47	21.94
Loin Eye Area, in$^{2\ ns}$	6.52	5.48	6.47	5.92	5.70	10.89

ns - not significant (P>0.05)
T1-basal diet without CSRM with AGPs; T2 and T3-diets replacing 40% and 10% of YC and SBOM inclusions, with and without AGPs, respectively; and T4 and T5- diets replacing 80% and 20% of YC and SBOM inclusions, with and without AGPs, respectively.

Growing-finishing pig trial

Interaction and main effects of CSRM and AGPs on FC, BW and FCR

The performance parameters measured in this experiment are presented in Table 5. There were no interaction effects observed between CSRM replacement rates (40:10 or 80:20) and level of AGPs (with and without). For the main effects, no significant differences were observed among factors for all the parameters measured. This suggests that CSRM can be used to replace YC and SBOM even at a high replacement ratio and even without AGP. Since the pigs that fed on diet with CSRM replacing 80% and 20% of YC and SBOM inclusions, respectively, without AGP, had the same performance with the pigs that received the control diet, it can be suggested to use CSRM as partial replacement for YC and SBOM. Results showed that the amount and digestibility of nutrients in CSRM at the given replacement rate for YC and SBOM are possibly equivalent, resulting in similar growth performance of the pigs. CSRM being a formulated product, composed of by-product materials from several industry such as ethanol manufacturing plants, may have adequate levels of nutrients enough to substitute YC and SBOM at 40-80% and 10-20% replacement rates.

The result of the current study was the same on the experiment conducted by Kwak and Kang (2006) on feeding food waste-broiler litter and bakery by-product mixture to pigs which resulted to same ADG when pigs were offered corn-soy diet with 25% replacement of the mixture. The bakery by-product was a source of energy for the pigs. The study of Mwesigwa *et al.* (2009) on pigs fed diets with by-products from corn and wheat processing resulted to better BW, ADG and FCR (P<0.05) compared with pigs offered corn-based diet. The improvement was attributed to higher digestibility of nutrients of the diets containing by-products from corn and wheat processing which were corn bran and wheat bran. Dehydrated *Aspergillus niger* products such as non-starch polysaccharidases (NSPase) were tested by Ao *et al.* (2010) and found out that pigs fed diets with 0.1% NSPase had ADG and FCR significantly better than pigs fed diets without NSPase (P<0.05). However, other studies failed to observe a positive effect of NSPase supplementation on growth performance (Olukosi *et al.*, 2007). The contradictions in the impact of multi-enzyme supplementation on growth performance may be due to the differences in the diet composition or age of pigs used. In addition, the enzyme source, the situations under which the specific ingredient was grown, the storage and process of feed, the interactions among dietary compositions and health status may also exert significant effects on growth performance (Kim *et al.*, 2003).

Since the product being tested in the current study was a mixture of different products, results may be different with other studies that used individual or combination of ingredients present in CSRM. AGP supplementation in all of the diet did not give superior performance over other treatments with AGPs supplementation. Antibiotics suppress populations of bacteria in the intestines. With this, there is decreased competition for nutrients between the host animal and the microorganisms and reduction in microbial metabolites that depress growth (Gunal *et al*., 2006). It has been estimated that as much as 6% of the net energy in the pig diet could be lost due to microbial fermentation in the intestine. If the microbial population could be better controlled, it is possible that the lost energy could be diverted to growth (Hughes and Heritage, 2002). Moreover, the experimental set which utilized individually caged pigs was too ideal causing no apparent gastro-intestinal challenge which could affect performance. According to Dibner and Richards (2005), antibiotics do not have growth-promoting effects in germ-free animals, and that the mechanisms for growth promotion have focused on interactions between the antibiotic and the gut microbiota.

Carcass characteristics

Table 6 shows the data gathered from the evaluation of the carcass quality. There were no significant differences among treatments in the parameters measured. Similarly, AGP supplementation did not affect the carcass quality of the pigs in the current study. This is in agreement with the study of Kwak and Kang (2006) wherein pigs given diets with food waste-broiler litter and bakery by-product mixture had the same carcass weight and backfat thickness with the pigs fed basal diet. However, when given by-products from corn and wheat processing, pigs had heavier carcass but carcass length and backfat thickness were the same with the control group (Mwesiga *et al*., 2009).

CONCLUSION

Based on the results of the broiler chicken experiment, CSRM can be used as partial replacement for YC and SBOM up to 40% and 10%, respectively, without negatively affecting the performance of broiler chickens. On the other hand, partial replacement for YC and SBOM up to 80% and 20%, respectively, by CSRM had no effect on the performance of growing-finishing pigs. Hot carcass weight, carcass length, back fat thickness, fat depth, and loin eye area were also not affected by inclusion of CSRM in growing-finishing diets. Therefore, it can be concluded that partial replacement of YC and SBOM in growing-finishing diets of pigs could be up to 80% and 20%, respectively.

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