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# Chemical Evaluation and Nutrient Digestibility of Shrimp Waste Meal in Broilers

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## ABSTRACT

This experiment was conducted to study the nutrient utilization in broilers fed shrimp waste meal (SWM) at various levels supplemented with or without amino acids as a substitute for fish meal in broiler diets. The percent dry matter, crude protein, ether extract, crude fibre, total ash, nitrogen free extract of shrimp waste meal (SWM) were 94.17, 50.5, 8.2, 15.2, 19.1, and 7.0, respectively. The calcium and phosphorous content of the SWM was 6.0, and 1.2 %, respectively. The percent lysine and methionine were 1.66, and 0.88, respectively. Metabolizable energy content of SWM was calculated as 1515 kcal/kg diet. The experimental diets in pre-starter phase were prepared by replacing fish meal protein of the basal diet with the shrimp waste meal protein at 20% level ($T_2$), 30% level ($T_3$); and $T_{4,}$ $T_5$ diets were prepared by adding synthetic lysine and methionine to $T_2$ and $T_3$ diets. In starter and finisher phases, five experimental diets were prepared by replacing fish meal protein of the basal diet with the shrimp waste meal protein at 50% level ($T_2$), 100% level ($T_3$); and $T_{4,}$ $T_5$ diets were prepared by adding synthetic lysine and methionine to $T_2$ and $T_3$ diets. The basal diet $T_1$ was used as control containing maize, SBM, DORB and 10 % fish meal. All diets were iso-nitrogenous and iso-caloric. Metabolism trials were conducted to study the digestibility of nutrients during starter (0-28 days) and finisher (29-42 days) phases. The nutrient digestibility of DM and CF was found to be non-significant among treatments during starter and finisher phase. However, during starter and finisher phases CP and EE digestibilities were significantly ($P<0.01$) higher in birds fed $T_4$ diet when compared to birds fed other diets ($T_1$, $T_{2,}$ $T_3$ and $T_5$). The results of the present study conclude that the protein from fishmeal can be safely substituted up to 30% with the SWM protein in pre-starter and up to 50% in starter and finisher broiler diets along with the supplementation of synthetic lysine and methionine.

**Key words:** Amino acids, Broilers, Chemical composition, Fish meal, Nutrient digestibility, Shrimp waste meal

## INTRODUCTION

Escalating cost of poultry feed has promoted the use of alternative feed sources, especially agro-industrial by-products. To avoid the problem of disposal of agro-industrial wastes, which pose threat to the environment, can be better utilized as potential feed resources. Shrimp waste meal is one of such unconventional protein source that has the potential of being an alternative source of protein in broiler rations, partially or totally replacing conventional protein sources like fish meal. Shrimp waste meal is the dried and milled waste of the shrimp industry which consists of heads, shells and appendages of shrimp (Ingweye *et al.,* 2008). Shrimp waste contains high CP content and reasonably good balance of essential amino acids (Ngoan *et al.,* 2000a). It is particularly rich in lysine which makes it an ideal supplement for cereals (Fanimo *et al.,* 1996). It is palatable and has a pleasant aroma. This study was therefore designed to provide an insight into the chemical composition and the nutrient utilization potential of diets containing various levels of SWM with or without amino acids supplementation.

## MATERIALS AND METHODS

Shrimp waste meal used in the preparation of experimental diets was procured from Om Sai Aqua Industry, Venkateswarapuram, Nellore district. Feed ingredients like maize, soybean meal, fish meal and de-oiled rice bran (DORB) for preparation of experimental diets were procured from the local market. Representative samples of feed ingredients were analyzed for their proximate composition (AOAC, 2005). The ME values for all feed ingredients except fish meal

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was estimated using equation suggested by NRC (1994), while for fish meal the ME value was derived as per equation suggested by Leeson and Summers (2008). Representative samples of feed ingredients and broiler diets were analyzed for calcium and phosphorous as per the method of Talapatra *et al.* (1940).

Three hundred and seventy-five, day old commercial broiler chicks were distributed randomly to five treatments with three replicates of twenty five birds each. Experimental diets were formulated for pre-starter (0-14 days), starter (15-28 days) and finisher (29-42 days) phases. The experimental diets in pre-starter phase were prepared by replacing fish meal protein of the basal diet with the SWM protein at 20% level ($T_2$), 30% level ($T_3$); and $T_{4,}$ $T_5$ diets were prepared by adding synthetic lysine and methionine to $T_2$ and $T_3$ diets. In starter and finisher phases five experimental diets were prepared by replacing fish meal protein of the basal diet with the SWM protein at 50% level ($T_2$), 100% level ($T_3$) and $T_{4,}$ $T_5$ diets were prepared by adding synthetic lysine and methionine to $T_2$ and $T_3$ diets. The basal diet $T_1$ was used as control containing maize, SBM, DORB and 10 % fish meal.

All the five diets during each phase were made iso-nitrogenous and iso-caloric and other ingredients like palm oil, L-Lysine and DL-Methionine were also used to meet the dietary concentration for energy, protein, lysine and methionine as per ICAR (2013) specifications for broiler diets. The CF and AIA content of the basal diets was within the permissible limits of BIS (1992). The synthetic lysine and methionine were added to the $T_4$ and $T_5$ diets as the SWM was having these amino acids in lesser amounts as compared to FM.

Metabolism trials were conducted during the starter and finisher phases of the biological trial. Two birds from each replicate, thus a total of six birds per treatment were kept separately in six metabolic cages. Birds in the cages were fed with the respective experimental diets consecutively for 3 days and the total feed offered was weighed and recorded for each cage. Similarly feces voided and feed left over in each cage was carefully collected, weighed and recorded. The representative samples of experimental diets offered and fecal samples from each cage were collected separately and analyzed for dry matter, crude protein, ether extract and crude fiber as per AOAC (2005). All the data obtained in this experiment were subjected to analysis of variance (Snedecor and Cochran, 1994).

## RESULTS AND DISCUSSION

The proximate composition of shrimp waste meal revealed that it contained 94.17% DM, on a dry matter basis it contained 50.5 % CP, 8.2 % EE, 15.2 % CF, 19.1 % TA, 7.0 % NFE, 6.0% Ca, 1.2 % P, 1.6 % lysine, 0.88% methionine and 1515 kcal ME /kg diet. The nutrient content (%DM) of feed ingredients, ingredient composition and nutrient content (%DM) of experimental diets are presented in the Tables 1,2,3 and 4.

The CP content of SWM in the present study was 50.5 % which is similar to the values reported by Rosenfeld *et al.* (1997). On the contrary lower, CP values were reported by Okonkwo *et al.* (2012) and Mahata *et al.* (2008). The EE, CF, TA values of SWM used in the present study were higher than those reported by Rosenfeld *et al.* (1997). This variation among different studies may be due to the difference in shrimp species (Ngoan *et al.,* 2000; Heu *et al.,* 2003), source of shrimp meal (head/shell) (Meyers, 1986) and/or processing method, as these can affect the nutritional values of SWM. Shrimp waste meal made from heads contains more CP and EE, less CF and TA than shrimp shells (Meyers *et al.,* 1973).

During starter phase and finisher phases no significant differences were noticed regarding the digestibility of DM and CF among treatments (Table 5 and 6). These findings were on line with Khempaka *et al.* (2011) who reported that DM, OM and ash digestibility values and nitrogen retention did not change significantly when SWM was added in the ration at or below 15% level. Ojewola and Annah (2006) also reported non-significant differences regarding fat, ash, crude fibre digestibility and nitrogen retention among treatment groups fed with SWM.

During starter and finisher phases the digestibility

**Table 1. Chemical composition of feed ingredients used in the experiment**

| Constituents | Ingredients | | | | |
|---|---|---|---|---|---|
| | Maize | Soybean meal | Fish meal | De-oiled rice Bran | Shrimp waste meal |
| Dry matter (%) | 90.2 | 90.8 | 91.17 | 93.6 | 94.17 |
| | | | %DM | | |
| Crude protein | 10.5 | 45.00 | 55.00 | 13.0 | 50.5 |
| Ether extract | 1.50 | 1.02 | 2.5 | 0.80 | 8.20 |
| Crude fibre | 6.7 | 9.46 | 2.4 | 16.8 | 15.2 |
| Nitrogen free extract | 75 | 36.28 | 19.6 | 53.9 | 7.0 |
| Total ash | 6.30 | 8.24 | 20.50 | 15.5 | 19.1 |
| Calcium | 0.01 | 0.20 | 6.50 | 0.06 | 6.0 |
| Phosphorus | 0.13 | 0.3 | 3.50 | 0.80 | 1.2 |
| Lysine* | 0.2 | 1.28 | 3.5 | 0.51 | 1.66 |
| Methionine* | 0.2 | 0.33 | 1.19 | 0.29 | 0.80 |
| ME (k.cal /kg)** | 3300 | 2300 | 2200 | 1400 | 1515 |

*Calculated as per Panda *et al.* (1984); **Calculated as per Leeson and Summer (2008).

of CP and EE was significantly (P<0.01) higher in birds fed $T_4$ ration (50% SWM protein + amino acids) and lower values were observed with the rations in which fish meal protein was completely substituted with SWM protein. Similar findings were reported by Mahata *et al.* (2008) that there was a significant decrease in the

**Table 2. Ingredient composition (%) and chemical composition (%) of broiler pre-starter diets**

| Ingredients | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
|---|---|---|---|---|---|
| Maize | 58 | 57.9 | 58 | 57.9 | 58 |
| Soybean meal | 20.55 | 20.4 | 20.3 | 20.34 | 20.21 |
| Fish meal | 10 | 8 | 7 | 8 | 7.0 |
| Shrimp waste meal | 0 | 2.18 | 3.27 | 2.18 | 3.27 |
| De-oiled rice bran | 5 | 5 | 4.83 | 5 | 4.83 |
| Palm oil | 3.7 | 3.77 | 3.85 | 3.77 | 3.85 |
| Mineral mixture* | 2 | 2.0 | 2.0 | 2.0 | 2.0 |
| DL-methionine | 0.2 | 0.2 | 0.2 | 0.21 | 0.21 |
| L-lysine | 0.55 | 0.55 | 0.55 | 0.6 | 0.63 |
| Feed additives** | + | + | + | + | + |
| Total | 100 | 100 | 100 | 100 | 10 |
| **Chemical composition** | | | | | |
| CP (%) | 22.1 | 22.05 | 22.0 | 22.08 | 22.04 |
| ME (kcal/kg) | 3002 | 2998 | 2999 | 2997 | 3000 |
| Lysine (%) | 1.18 | 1.15 | 1.13 | 1.20 | 1.19 |
| Methionine (%) | 0.51 | 0.51 | 0.50 | 0.52 | 0.51 |
| Ca (%) | 1.01 | 1.02 | 1.02 | 1.02 | 1.02 |
| Available P (%) | 0.7 | 0.66 | 0.63 | 0.66 | 0.63 |
| Cost (₹/kg) | 28.7 | 28.96 | 28.89 | 29.04 | 29.04 |

*Contained Ca, 25; P, 15; NaCl, 2.5; Fe, 0.35% and Cu, 100; Mn, 200; Co, 50; I, 100 ppm; **All diets contained Meriplex® – FDS @ 10g/100 kg : (Each gram contains: Vit-$B_1$, 8mg; Vit-$B_6$, 16 mg Vit-$B_{12}$, 80µg; Vit-$E_{50}$, 80 mg; Niacin, 120 mg; Folic acid, 8 mg; Calcium D Pantothenate, 80 mg, Merivite®-$AB_2D_3K$@10g/100kg :(Each gram contains: Vit-A 82,500 IU, Vit-$B_2$ 52mg, Vit-$D_3$ 1200 IU, Vit-K 10mg, Calcium 166 mg, Phosphate 395 mg) and Cosmodot @ 50g/100 kg: (3-5, Dinitro-O-Toluamide:25 percent W/W)

**Table 3. Composition of broiler starter and finisher diets**

| Ingredient | $T_1$ | | $T_2$ | | $T_3$ | | $T_4$ | | $T_5$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Starter | Finisher | Starter | Finisher | Starter | Finisher | Starter | Finisher | Starter | Finisher |
| **Ingredient composition (%)** | | | | | | | | | | |
| Maize | 59 | 65 | 60.25 | 65 | 59.51 | 64.81 | 60.25 | 65 | 59.77 | 65.24 |
| Soybean meal | 19.3 | 14 | 19.5 | 14.2 | 19.8 | 14.7 | 19.39 | 14.06 | 19.3 | 14 |
| Fish meal | 10 | 10 | 5 | 5 | 0 | 0 | 5 | 5 | 0 | 0 |
| Shrimp | 0 | 0 | 5.45 | 5.45 | 10.89 | 10.89 | 5.45 | 5.45 | 10.89 | 10.89 |
| De-oiled rice bran | 5 | 4.8 | 3 | 3.65 | 2.5 | 2.5 | 3.0 | 3.65 | 2.5 | 2.5 |
| Palm oil | 4.1 | 3.8 | 4.2 | 4.3 | 4.7 | 4.7 | 4.2 | 4.3 | 4.7 | 4.7 |
| Mineral mixture* | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DL-methionine | 0.17 | 0.1 | 0.17 | 0.1 | 0.17 | 0.1 | 0.18 | 0.11 | 0.2 | 0.13 |
| L-lysine | 0.43 | 0.3 | 0.43 | 0.3 | 0.43 | 0.3 | 0.53 | 0.43 | 0.64 | 0.54 |
| Feed additives** | + | + | + | + | + | + | + | + | + | + |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Chemical composition (%) DM Basis** | | | | | | | | | | |
| CP | 21.5 | 19.55 | 21.49 | 19.5 | 21.5 | 19.5 | 21.5 | 19.6 | 21.5 | 19.5 |
| ME (kcal/kg) | 3049 | 3096 | 3049.3 | 3102 | 3048 | 3099 | 3047 | 3099 | 3049.2 | 3098 |
| Lysine | 1.09 | 0.92 | 0.99 | 0.83 | 0.99 | 0.74 | 1.01 | 0.93 | 1.01 | 0.92 |
| Methionine | 0.48 | 0.4 | 0.46 | 0.39 | 0.4 | 0.37 | 0.47 | 0.4 | 0.47 | 0.4 |
| Ca | 1.01 | 1.07 | 1.01 | 1.09 | 1.02 | 1.01 | 1.01 | 1.08 | 1.01 | 1.09 |
| Available P | 0.7 | 0.69 | 0.58 | 0.57 | 0.46 | 0.45 | 0.58 | 0.57 | 0.46 | 0.45 |
| Cost (₹/kg) | 28.39 | 26.39 | 28.30 | 26.53 | 28.49 | 26.71 | 28.53 | 26.82 | 29.06 | 27.56 |

*Contained Ca, 25; P, 15; NaCl, 2.5; Fe, 0.35% and Cu, 100; Mn, 200; Co, 50; I, 100 ppm; ** ll diets contained Meriplex® – FDS @ 10g/100 kg : (Each gram contains: Vit-$B_{1,}$ 8mg; Vit-$B_{6,}$ 16 mg Vit-$B_{12,}$ 80µg; Vit-$E_{50,}$ 80 mg; Niacin, 120 mg; Folic acid, 8 mg; Calcium D Pantothenate, 80 mg, Merivite®-$AB_2D_3K$@10g/100kg :(Each gram contains: Vit-A 82,500 IU, Vit-$B_2$ 52mg, Vit-$D_3$ 1200 IU, Vit-K 10mg, Calcium 166 mg, Phosphate 395 mg) and Cosmodot @ 50g/100 kg: (3-5, Dinitro-O-Toluamide:25 percent W/W)

**Table 4. Chemical composition (%) of broiler basal experimental diets on dry matter basis**

| Nutrient | Basal diets | | |
|---|---|---|---|
| | Pre-Starter | Starter | Finisher |
| Dry matter | 90.1 | 90.36 | 91.06 |
| Crude protein | 22.04 | 21.50 | 19.57 |
| Crude fat | 5.37 | 5.12 | 5.18 |
| Crude fibre | 6.16 | 6.98 | 6.96 |
| Total ash | 10.40 | 10.43 | 10.56 |
| Acid insoluble ash | 2.08 | 2.15 | 2.16 |
| Nitrogen free extract | 56.03 | 55.97 | 57.73 |
| Calcium | 0.97 | 1.0 | 0.94 |
| Phosphorus | 0.57 | 0.55 | 0.56 |
| Lysine* | 1.20 | 1.09 | 0.97 |
| Methionine* | 0.52 | 0.48 | 0.47 |
| ME (k.cal/kg)* | 3000 | 3049 | 3099 |

*calculated values

**Table 5. Effect of supplementation of shrimp waste meal on digestibility of nutrients during starter phase**

| Treatment | Digestibility % | | | |
|---|---|---|---|---|
| | $DM^{NS}$ | $CP^{**}$ | $EE^{**}$ | $CF^{NS}$ |
| $T_1$ | 66.70±0.32 | 68.23$^{c}$±0.10 | 79.02$^{ab}$±0.13 | 30.45±0.09 |
| $T_2$ | 66.90±0.17 | 69.06$^{b}$±0.36 | 79.23$^{a}$±0.23 | 30.24±0.15 |
| $T_3$ | 66.70±0.1 | 66.78$^{d}$±0.09 | 78.49$^{b}$±0.32 | 29.94±0.23 |
| $T_4$ | 67.60±0.25 | 70.25$^{a}$±0.1 | 79.72$^{a}$±0.35 | 30.70±0.06 |
| $T_5$ | 66.78±0.26 | 67.05$^{d}$±0.07 | 79.11$^{ab}$±0.12 | 30.15±0.28 |

$^{abcd}$Values in a column not sharing common superscripts differ significantly $^{**}$(P<0.01), NS- Non-significant

**Table 6. Effect of supplementation of shrimp waste meal on digestibility of nutrients during Finisher phase**

| Treatment | Digestibility % | | | |
|---|---|---|---|---|
| | $DM^{NS}$ | $CP^{**}$ | $EE^{**}$ | $CF^{NS}$ |
| $T_1$ | 70.77±0.2 | 68.58$^{b}$±0.22 | 77.9$^{b}$±0.21 | 31.49±0.02 |
| $T_2$ | 70.64±0.04 | 68.99$^{ab}$±0.29 | 77.79$^{b}$±0.28 | 31.61±0.06 |
| $T_3$ | 70.47±0.27 | 67.22$^{c}$±0.25 | 77.08$^{c}$±0.27 | 31.39±0.09 |
| $T_4$ | 71.22±0.23 | 69.51$^{a}$±0.19 | 78.6$^{a}$±0.10 | 31.01±0.33 |
| $T_5$ | 70.41±0.14 | 67.84$^{c}$±0.17 | 77.33$^{bc}$±0.21 | 31.19±0.25 |

$^{abc}$Values in a column not sharing common superscripts differ significantly $^{**}$(P<0.01), NS- Non-significant

nitrogen retention when SWM was used beyond 8% level of inclusion in the diet. The enhanced nutrient digestibility in birds fed $T_4$ ration may be due to reduced number of pathogenic bacteria *Escherichia coli, Salmonella typhimurium* (Choi *et al.,* 1994; Le M ieux *et al.,* 2003; Wang *et al.,* 2003), increased immune function (Gibson and Roberfroid, 1995; Patterson and Burkholder, 2003), better secretion of digestive enzymes (Hou and Gao, 2001) and better absorption of nutrients (Wu, 1998; Huang *et al.,* 2005; Li *et al.,* 2007; Khambualai *et al.,* 2008, 2009).

The exoskeleton of the shrimp is composed mainly of chitin, an N-acetylated glucosamine polysaccharide that forms part of the protein complex, and is considered to have low digestibility when fed to animals (Austin *et al.,* 1981). Inclusion of SWM at higher levels in broiler diets caused impairment of digestion due to increase in chitin levels as it physically blocks the access of digestive enzymes to lipids and proteins, thus affecting the utilization of these nutrients (Castro *et al.,* 1989; Karasov, 1990).

## CONCLUSION

Results indicates that shrimp waste meal can be utilized as a potential alternative protein source to fish meal in broiler diets. Along with the supplementation of synthetic lysine and methionine, the protein from FM can be safely substituted up to 30% with the SWM protein in pre-starter and up to 50% in starter and finisher broiler diets.

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