# Maggot meal as a substitute for fish meal in laying chicken diet

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SUMMARY

A 56-day experiment was conducted to determine the replacement value of maggot meal for fish meal in diet of laying chicken. Fish meal was included at 30 g $kg^{-1}$ of the control diet. Maggot meal incrementally replaced fish meal at 250, 500, 750, and 1000 g $kg^{-1}$ on crude protein basis. The five diets were fed to a total of 120 36-week-old Nera breed-laying chickens. Inclusion of various amounts of maggot meal in laying chicken diets had no significant impact on daily feed intake, hen-day egg production, egg weight, feed efficiency, and liveability. Aspects of egg external and internal quality characteristics measured were identical ($P>0.05$); however, albumen weight (as percent of egg weight) was significantly ($P<0.05$) high in birds fed with diet which contained equiprotein inclusion of both fish and maggot meal. Egg yolk cholesterol and calcium concentration were significantly reduced ($P<0.05$) with increased inclusion of maggot meal in laying chickens' diet. The use of maggot meal in poultry rations may reduce cholesterol intake through consumption of eggs. It is concluded that maggot meal can nutritionally and productively replace fish meal in layer diet without adverse consequences on performance and egg quality characteristics.

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RÉSUMÉ

AKPODIETE, O. J., OLOGHOBO, A. D. & ONIFADE, A. A.: *Guano d'asticot comme un remplaçant de guano de poisson dans le régime de poulette pondeuse.* Une expérience de 56 jours était conduite pour déterminer la valeur du remplacement de guano d'asticot par guano de poisson dans le régime de poulette pondeuse. Le guano de poisson était inclus au niveau de 30 g $kg^{-1}$ du régime de contrôle. Le guano d'asticot remplaçait progressivement le guano de piosson à 250, 500, 750 et 1000g $kg^{-1}$ en prenant pour base la protéine brute. Les cinq régimes étaient nourris aux 120 de poulette pondeuse de l'espéce Nera ayant l' âge de 36 semaines. Inclusion des quantités variables de guano d' asticot dans les régimes de poulette pondeuse n'avaient aucun effet considérable sur la consommation quotidienne de ration, la production d' œuf de poule pendant la journée, le poids d'œuf, l' efficacité et la supportabilité de ration. Les aspects des caractéristiques de la qualité externe et interne d'œuf mesurés étaient identiques ($P>0.05$); toutefois, le poids d' albumen (comme le pourcentage du poids d'œuf) était considérablement ($P<0.05$) plus élevé dans les oiseaux nourris de ration qui contenait l'inclusion équiprotéine de guano de piosson et guano d'asticot à la fois. Le cholestérol du jaune d'œuf et la concentration de calcium étaient considérablement réduites ($P<0.05$) avec l'inclusion augmentée de guano d'asticot dans le régime de poulette pondeuse. L' utilisation de guano d'asticot dans les rations de volaille pourrait être un moyen de réduire la consommation de cholestérol par la consommation des œufs. La conclusion est tirée que le guano d'asticot peut nutritionnellement et productivement remplacer le guano de poisson dans le régime d' une pondeuse sans des conséquences défavorables sur la performance et les caractéristiques de la qualité d'œuf.

## Introduction

The influence of adequate diets on the performance and egg quality characteristics of laying chickens has been widely reported (Reddy, Reddy & Reddy, 1988; Leeson & Summers, 1989; Helena-Straznicka, 1990; NRC, 1994). In protein

studies with laying birds, the amino acid balance is more important than the total dietary protein (Oluyemi & Roberts, 1979). Thus, in spite of the high protein content of feather meal, its inclusion in poultry diets is limited. On the other hand, because of the high protein quality of fish meal (FM), it has remained a prominent animal protein supplement in poultry feed. However, its prohibitive cost has stimulated the quest for alternatives.

Maggot meal (MM) is a potential substitute (El Boushy, 1991; Akpodiete, 1992; Atteh & Adeyoyin, 1993) and its use in poultry nutrition serves two major advantages: (i) recycling of poultry waste (Calvert, Martins & Morgan, 1969; El Boushy,1991), and (ii) a sustainable environmentally friendly management of poultry wastes.

This study aimed to evaluate the replacement value of MM for FM in laying chicken diets using performance indices, egg quality characteristics, and egg yolk biochemistry as response criteria.

## Materials and methods

Maggots were harvested from layer droppings enriched with palm oil as energy booster after a growing period of 6 days. The technique used as described by Akpodiete, Ologhobo & Oluyemi (1997), involved collecting fresh layer droppings into plastic bowls (1 kg per fowl), mixed with 100 ml of palm oil, and placing the bowls in open shed. Houseflies oviposited on them and the cultures were sufficiently moistened by sprinkling with water daily to support larvae growth for 6 days before the larvae were harvested. At harvest, sufficient water was added to each bowl to completely submerge the droppings which allowed the maggots to float. The maggots were harvested, sieved, rinsed, and freed of debris. The harvested maggots were roasted dry on fire and milled in a laboratory hammer mill before being incorporated into the diet. A control diet was formulated to contain 30 g fish meal $kg^{-1}$ MM incrementally replaced FM at 250, 500, 750, and 1000 g $kg^{-1}$ on crude protein equivalent in Diets 2, 3, 4, and 5, respectively. The five diets were isonitrogenous (17.0 g $kg^{-1}$ of crude protein) and isocaloric (10.88 MJ $kg^{-1}$ of metabolizable energy) (Table 1).

One hundred and twenty 36-week-old laying chicken (Nera breed) were randomly allocated to the five dietary treatments with three replicates. Two replicate birds were kept per cage. Birds were offered diets and water *ad libitum* during the experiment. The birds were individually weighed at initiation and completion of the experiment at 56 days. Daily feed intake (FI), hen-day production (HDP), egg weight (EW), and feed efficiency (FE) were calculated on replicate basis. Egg quality characteristics were determined bi-weekly with the methods described by Oluyemi & Roberts (1979). Egg yolk colour was scored by the Roche Colour Fan subjectively; shell surface area (SSA) was calculated according to Lewis & Perry (1987); and egg shape index (ESI) was determined as outlined by Allen & Young (1980). Egg yolk was analyzed for cholesterol, triglyceride, calcium, and phosphorus concentrations. according to the procedure in Technicon method (SE4-0016F H4 ((1974). Proximate analysis of the diets was according to AOAC (1990), and data accruing from the results were statistically analysed as described by Steel & Torie (1980) for completely randomized design.

## Results and discussion

Table 2 shows the results of the performance characteristics of the laying chickens. Feed intake, hen-egg production, egg weight, and feed efficiency were not significantly different ($P>0.05$) among treatment groups. The similarity in the general performance of layers and the lack of significant ($P>0.05$) differences in body weight gain among experimental birds (Table 2) indicates that MM compared nutritionally with FM. This is consistent with the observations of Molchanova *et al.* (1983), Akpodiete (1992), and Atteh & Adedoyin (1993). However, Atteh & Adedoyin (1993) reported a significant decrease in feed intake when MM was included in the diet

TABLE 1

*Composition of Layer Diet (g kg$^{-1}$)*

| *Diet component* | *Diet* 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Maggot meal (54.30 per cent CP) | - | 09.20 | 18.40 | 27.20 | 36.40 |
| Fish meal (65 per cent CP) | 30.00 | 22.50 | 15.00 | 07.50 | - |
| Maize | 433.00 | 433.00 | 433.00 | 433.00 | 433.00 |
| Maize offal | 145.00 | 143.30 | 141.60 | 140.30 | 138.60 |
| Wheat offal | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Soyabean meal | 180.00 | 180.00 | 180.00 | 180.00 | 180.00 |
| Bone meal | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| Oyster shell | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| Salt | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Premix[1] | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| Methionine | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| *Chemical analysis* | | | | | |
| Dry matter | 89.67 | 89.63 | 89.65 | 89.61 | 89.57 |
| Crude protein(CP) | 17.05 | 17.12 | 17.04 | 17.01 | 17.15 |
| Ether extract | 3.70 | 3.69 | 3.59 | 3.63 | 3.61 |
| Crude fibre | 6.04 | 5.97 | 5.95 | 5.96 | 5.93 |
| Metabolizable energy (MJ kg$^{-1}$)[2] | 10.88 | 10.88 | 10.87 | 10.87 | 10.87 |

1. Premix provided per kg diet: Vit A, 10,000 IU; D3 2,000 IU; Vit E 75 IU; Vit K, 2.00 mg; Vit B2, 45 mg; Vit. B6 3 mg; Niacin 250 mg; Pantothenic acid 8.0 mg; Vit B12 0.01 mg; Folic acid 0.05 mg; Choline chloride 300 mg; Chlortetracycline 20 mg; Dinitro-ortholol namides 125 mg; Mn 100 mg; Fe 50 mg; Zn 40 mg; Cu 2.40 gm; Iodine 1.40 mg; Co 0.20 mg; and Se 0.08 mg.
2. Calculated based on values given in *Nutrient Plan Master*, Pfizer (1990).

TABLE 2

*Effect of Maggot Meal Substitution for Fish Meal on the Performance of Laying Chickens*

| *Performance index* | *Diet* 1 | 2 | 3 | 4 | 5 | *SE* |
|---|---|---|---|---|---|---|
| Feed intake (g/bird/day) | 99.57 | 98.43 | 102.43 | 101.57 | 102.86 | 0.50 |
| Body weight gain (g/bird/day) | 252.00 | 237.00 | 200.00 | 255.00 | 187 | 1.90 |
| Hen-day egg production (g) | 82.36 | 81.37 | 83.15 | 86.33 | 83.59 | 0.35 |
| Egg weight (g) | 61.66 | 61.12 | 59.08 | 59.69 | 61.97 | 0.63 |
| Feed efficiency (kg egg/kg feed) | 0.46 | 0.45 | 0.48 | 0.46 | 0.46 | 0.01 |

at 60 per cent kg$^{-1}$ and above, and this was attributed to the high fat content of the MM used.

Percent hen-day egg production remains vital in assessing laying performance (Leeson & Summers, 1989). Hence a closer look at this parameter showed a numerical improvement in birds fed MM compared to control. This finding agrees with earlier reports (Parshikova *et al.*, 1981; Molchanova *et al.*, 1983; Akpodiete, 1992) which showed increases in egg yield when housefly larvae (maggots) replaced fish meal in the diet of laying chickens, although no explanation was offered for this trend. However, the highest hen-day egg production at penultimate level of MM observed in the study may suggest an optimum complimentarity of nutrient in FM and MM at ratio 1 : 3. This hypothesis may sufficiently explain the earlier reports of Molchanova *et al.* (1983) and Akpodiete (1992), and also the current trend observed for hen-day egg production.

The synopsis of the egg quality characteristics (Table 3) did not show significant differences

TABLE 3

*Effect of Maggot Meal Substitution for Fish Meal on Some Egg Quality Characteristics of Laying Chickens*

| | Diet | | | | | |
|---|---|---|---|---|---|---|
| *Egg quality characteristics* | *1* | *2* | *3* | *4* | *5* | *SE* |
| Egg weight (g) | 61.66 | 61.12 | 59.08 | 59.69 | 61.97 | 0.61 |
| Albumin weight (% egg weight) | 57.13 | 59.39 | 61.72 | 59.01 | 56.85 | 0.29 |
| Yolk weight (% egg weight) | 27.91 | 27.57 | 26.29 | 28.16 | 27.89 | 0.41 |
| Egg shell weight (% egg weight) | 8.70 | 8.20 | 8.76 | 8.67 | 8.07 | 0.19 |
| Haugh unit | 90.87 | 91.74 | 89.81 | 90.60 | 90.85 | 0.55 |
| Yolk index | 0.50 | 0.50 | 0.49 | 0.48 | 0.50 | 0.01 |
| Shell thickness (mm) | 0.35 | 0.35 | 0.33 | 0.32 | 0.34 | 0.06 |
| Shell surface area | 72.23 | 72.23 | 70.09 | 71.65 | 73.74 | 0.55 |
| Egg shape index | 0.75 | 0.77 | 0.76 | 0.76 | 0.76 | 0.01 |
| Yolk colour score | 5.50 | 5.30 | 5.25 | 5.30 | 5.60 | 0.06 |
| Blood/meat spots (%) | 13.23 | 14.20 | 11.89 | 12.90 | 12.90 | 0.53 |
| Cracked eggs (%) | 0.52 | 0.67 | 0.00 | 0.00 | 0.16 | 0.32 |
| Soft-shelled eggs (%) | 0.33 | 0.00 | 0.00 | 0.00 | 0.50 | 0.28 |

($P>0.05$) in all parameters measured, except albumen weight, which was significantly higher ($P<0.05$) in eggs laid by birds fed Diet 3 compared with others fed Diet 1 and Diet 5. The external qualities of the egg, namely shell thickness, shell surface area, egg shape index, cracks (percent), and soft-shelledness (percent) were uninfluenced by the dietary treatments (Table 3). These observations suggest, albeit indirectly, the adequate metabolism of calcium and phosphorus, the major minerals essential for egg shell formation. The adequate shell thickness, low percentage cracks, and soft-shelled eggs, are of economic importance. However, the somewhat numerically higher percentage cracks, soft-shelled eggs, and shell thickness of eggs laid by birds fed diet containing only MM (Diet 5) appear fortuitous. The current data on external characteristics of eggs are similar to those reported earlier (Oluyemi & Roberts, 1979; Akpodiete, 1992; Kaminska & Skraba, 1992). The internal qualities of egg: haugh unit, an index of protein use, was uniformly ($P>0.05$) high; yolk colour, a criterion of commercial importance (Belyavin & Marangos, 1989), was similar ($P>0.05$) in eggs laid by birds on various treatments. The similarities in the characteristics of eggs laid by birds on the treatments further attested to the comparable nutritional quality of maggot meal with fish meal.

The occurrence of blood spots might not be nutritionally related. It might be due to stresses of various forms according to Gordon (1979). Albumen weight peaked ($P>0.05$) at equi-protein (50:50) inclusion of MM and FM; however, no reason could be advanced for this observation.

Table 4 shows the results of the cholesterol, triglyceride, calcium, and phophorus concentrations of the egg yolk. The

TABLE 4

*Effect of Maggot Meal Inclusion in Laying Chickens' Diet on Concentration of Egg Yolk Cholesterol, Triglyceride, Calcium and Phosphorus*

| | Diet | | | | | |
|---|---|---|---|---|---|---|
| *Diet* | *1* | *2* | *3* | *4* | *5* | *SE* |
| Cholesterol (mg/g) | 13.520 | 12.550 | 12.490 | 12.440 | 12.290 | 0.40 |
| Triglyceride (mg/g) | 39.600 | 39.470 | 38.780 | 38.320 | 38.270 | 0.46 |
| Calcium (mg/g) | 0.446 | 0.414 | 0.358 | 0.347 | 0.342 | 0.12 |
| Phosphorus (mg/g) | 0.236 | 0.239 | 0.241 | 0.261 | 0.247 | 0.06 |

concentrations of yolk cholesterol, triglyceride and calcium generally decreased with increasing inclusion of MM. This was significant ($P<0.05$) for cholesterol and calcium concentrations. Phosphorus concentration, on the other hand, tended to increase ($P<0.05$) with increasing levels of maggot meal.

The significant reduction in cholesterol concentration of yolk of eggs laid by birds fed on MM diets compared to those on the control diet, may be of nutritional interest in the dietetic treatment of patients with artheriosclerosis and other cardiovascular diseases. The excessive cholesterol intake is implicated for the aetiology of artheriosclerosis and other cardiovascular disorders. The fatty acid composition of oils in MM might be responsible for the modifying effect on the cholesterol content of egg. This supposition is consistent with the observation of Herbert, Perez-Buriel & Berrio (1987) who found that egg yolk cholesterol was reduced from 224 ± 27 to 197 ± 25 mg when 8 per cent sunflower oil was fed to laying birds as compared to olive oil at the same level of inclusion.

In addition, maggots were reported to be rich in essential fatty acids, especially linoleic and oleic acids (El Boushy, 1991). According to Herbert, Perez-Buriel & Berrio (1987), these two fatty acids in the diet of laying chicken do not act to increase egg yolk cholesterol content. However, the addition of 1 per cent cholesterol to either oleic or linoleic acid rations of laying chickens increased yolk cholesterol. The reduction in yolk cholesterol in treatment groups fed MM diets tended to confirm the assertion of Schmidt-Nielson (1993) that insect proteint source contains little or no cholesterol.

The reduction in yolk calcium concentration and the slight increases in yolk phosphorus with increasing concentrations of MM in the diets confirm the work of Oladeji (1990) who reported low calcium and high phosphorus contents in maggots. These two minerals in MM may not have any implication on table eggs as the external characteristics of eggs in this study did not show significant variations.

Finally, the study suggests that MM could completely replace FM in a layer diet with no adverse consequences on performance and egg quality characteristics. Its use in poultry diets may be of health importance in artheriosclerosis and other cardiovascular diseases associated with excessive cholesterol intake.

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