# The Production Performance of Broiler Birds as Affected by the Replacement of Fish Meal by Maggot Meal in the Starter and Finisher Diets

A.Téguia[1], M. Mpoame[2] & J.A. Okourou Mba[1]

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## Summary

*The effect of replacing fish meal with maggot meal in the starter and grower-finisher diets on the production performances of broiler chickens was studied. For both the starter and the grower-finisher periods, total weight gain in the control group receiving exclusively fish meal was significantly (P< 0.05) lower than that of birds receiving the diet containing the largest amount of maggot meal. No significant difference (P> 0.05) was detected among treatment groups for feed conversion ratio for both the starter and grower-finisher periods. No significant difference was detected among treatment groups for either hot carcass yield or proportion of different parts of the carcass, although increasing the amount of maggot meal in the diet tended to increased proportion of liver and gizzard. Although no significant difference was recorded among treatment groups for the feed cost for the production of one kg of live weight, there was a 4 to 16% reduction in cost of production as compared to the control group for both the starter and the grower-finisher periods. It was concluded that from the technical and economic point of view, maggot meal could replace fish meal, but that the earlier should be analysed for toxicity before it could be widely used for broiler chicken feeding.*

## Résumé

**Effet de la substitution de la farine de poisson par de la farine d'asticot dans les rations démarrage et finition sur les performances de production des poulets de chair**

*L'effet de substitution de la farine de poisson par de la farine d'asticot dans les aliments démarrage et finition sur les performances de production des poulets de chair a été étudié. Aussi bien au démarrage qu'en finition, le gain de poids des oiseaux du lot témoin nourri exclusivement à la farine de poisson a été significativement (P< 0,05) moins élevé que celui de ceux recevant de la farine d'asticot. Pendant les deux périodes de production, aucune différence significative (P> 0,05) n'a été détectée entre les différents lots pour l'indice de consommation. Bien que le foie et le gésier avaient tendance à grossir avec des taux croissants de farine d'asticot, il n'y avait aucune différence significative entre les différents lots pour le rendement carcasse et la proportion des différentes parties. L'utilisation de la farine d'asticot a permis de réduire le coût de production du poulet même si aucune différence significative n'existait entre les lots pour le coût alimentaire de production d'un kg de poulet. Du point de vue technique et économique, la farine d'asticot pourrait remplacer celle de poisson dans les aliments de poulets de chair. Il est cependant nécessaire d'analyser la farine d'asticot pour la détermination de facteurs anti-nutritionnels avant que son utilisation à grande échelle ne soit envisagée.*


## Introduction

The development of poultry industry in developing countries in general and Africa south of Sahara in particular has been very rapid during the past two decades. Although rural poultry continues to supply about 60% of the consumption in some countries (2), the importance of broiler meat from modern farms is increasing very rapidly. However, the major constraint of the young industry is feeding that represents up to 60-70% of costs of production (12). Adopting an intensive poultry production supposes the used of protein sources of high biological value such as meat meal, fish meal and soybean meal that are usually imported. Due to the economic crisis affecting developing countries in general and Africa in particular, it becomes more advisable to envisage the utilisation of non conventional sources of protein, not suitable for human consumption but that are widely available (6). This could save some of the limited hard currencies for other development priorities. Such sources of protein have successfully been used (4, 6).

[1] Faculty of Agriculture and Agricultural Sciences, University of Dschang, Cameroon.
[2] Faculty of Sciences , University of Dschang, Cameroon.
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In rural Africa, maggots have always constituted part of the daily diet of scavenging poultry. In modern poultry production farms, manure disposal is increasingly becoming a serious environmental problem and it is not uncommon to see huge amount of manure stocked in open air and readily invaded by flies. Chicken manure has been found to be a good environment for the development of common flies (11). While solving an environmental problem, the production of maggots could provide an excellent source of animal proteins for local poultry farms. The crude protein content of maggots is high (7) and comparable to that of fish meal. Reports were made that maggots were being produced in Ghana (12) and Burkina Faso (5) for the feeding of birds. However, the product there was fed fresh. For intensive farming, if maggots are to be used as a source of proteins for poultry, they would be more interesting in a dry form.

The objective of this study was therefore, to evaluate the nutritive value of maggots and analyse the effect of maggot meal on the production performances of broiler chickens.

## Material and methods

The study took place in the experimental farm of the University of Dschang. Dschang is located in the Western Highlands of Cameroon at an altitude of 1450 m. The climate is characterised by a long rainy season running from mid March to mid November and a short dry season from mid November to mid March. The mean daily temperature varies from 16 to 27 °C and a relative humidity from 40 to 100% depending to the season.

### Animals

One hundred and sixty unsexed day old Arbor Acres broiler chicks were used. For the brooding period, the birds were randomly distributed into 16 groups of 10 and raised on litter under similar environmental and management conditions. For the grower-finisher period, the birds were housed in pairs in Californian type cages. The chicks were immunised against Newcastle disease, infectious bronchitis, and Gumboro disease. Coccidiostatics were distributed three consecutive days per week as from 15 to 30 days of age. The birds received vitamins every 15 days and were dewormed at 30 days before they were transferred into cages.

### Feeding

Maggots were collected fresh from a commercial layer farm. They were thoroughly washed using tap water and dried on aluminium sheets set 1.5 m above wood flame. After about 1.5 hour, the maggots were completely dry and were then milled and added to the experimental diets. The cost of production of maggot meal was estimated at FCFA 434/kg as compared to FCFA 550/kg for fish meal (1 euro = FCFA 657.56)

Samples of maggot meal were analysed for crude protein, crude fibre and phosphorus (3), dry matter (105 °C for 24 h) and ash (500 °C over night).

For the brooding period, 0 (control diet), 5 (S1), 10 (S2) or 15% (S3) of the fish meal were replaced by maggot meal. Each of the 4 experimental diets was given to 4 groups of 10 chicks. At the end of the brooding period, all the birds fed on each starter diet were randomly distributed into the three groups corresponding to the three experimental grower-finisher diets where 0 (control diet), 50 (F1) or 100% (F2) of the fish meal were replaced by maggot meal with 25 replicates per treatment. The composition and determined analysis of experimental diets are given in table 1 for the starter period and table 2 for the grower-finisher period.

**Table 1**

**Composition and determined analysis of starter broiler chicks diets containing maggot meal (g.kg$^{-1}$)**

| | Control diet | S1 | S2 | S3 |
|---|---|---|---|---|
| Composition | | | | |
| Maize | 625.000 | 625.000 | 625.000 | 625.000 |
| Soybean meal | 120.000 | 120.000 | 120.000 | 120.000 |
| Cotton seed cake | 100.000 | 100.000 | 100.000 | 100.000 |
| Fish meal | 45.000 | 42.750 | 40.500 | 38.250 |
| Maggot meal | 0.000 | 2.250 | 4.500 | 6.750 |
| Vitamin/Mineral premix[a] | 100.000 | 100.000 | 100.000 | 100.000 |
| NaCl | 10.000 | 10.000 | 10.000 | 10.000 |
| Determined analysis | | | | |
| Dry matter | 896.000 | 903.110 | 920.230 | 915.300 |
| Crude protein | 207.810 | 213.230 | 208.400 | 211.000 |
| Crude fibre | 40.520 | 40.731 | 40.861 | 41.010 |
| Ash | 24.620 | 34.620 | 34.010 | 34.310 |
| M.E* | 2725.9 | 2726.7 | 2727.4 | 2728.2 |

[a] Vitamin/Mineral premix composition (g.kg$^{-1}$): dry matter (920), protein (520), fat (35), ash (350), Ca (92.6), P (35.2) lysine (30.5), methionine (24.1) methionine + cystine (28.9), vitamin A (15 x $10^6$ IU/100 kg), Vitamin D (3 x $10^6$ IU/100 kg), vitamin E (35000 mg/100 kg), vitamin (mg.kg$^{-1}$) K3 (26), B1 (26), B2 (66), B3 (193), B6 (20) B10 (0.26), folic acid (19), choline (21), biotine (0.2), trace mineral (mg.kg$^{-1}$) Fe (1600) Cu (200), Zn (1320), Mg (800), Se (3.3).

* Calculated metabolizable energy (Kcal.kg$^{-1}$)

### Data collection statistical analysis

During the seven-week experimental period, weekly live body weight and weekly feed consumption were collected. The weekly weight gain and feed efficiency ratio were then calculated. At the end of the production period, 4 broiler birds from each of the three treatments including 2 males and 2 females were processed for carcass analysis (9). For the economic evaluation of diets, the feed cost of producing 1 kg of live weight was calculated by multiplying the feed conversion ratio by the cost of 1 kg of diet.

Data were analysed using a completely randomised design. The least significant difference test was used for mean separation in case of significant difference (13).

**Table 2**

**Composition and determined analysis of grower-finisher broiler diets containing maggot meal (g.kg-1)**

| | Control diet | F1 | F2 |
|---|---|---|---|
| Composition | | | |
| Maize | 560.0 | 560.0 | 560.0 |
| Wheat middlings | 200.0 | 200.0 | 200.0 |
| Soybean meal | 70.0 | 70.0 | 70.0 |
| Cotton seed cake | 40.0 | 40.0 | 40.0 |
| Fish meal | 20.0 | 10.0 | 00.0 |
| Maggot meal | 00.0 | 10.0 | 20.0 |
| Vitamin/mineral premix[a] | 100.0 | 100.0 | 100.0 |
| NaCl | 10.0 | 10.0 | 10.0 |
| Determined analysis | | | |
| Dry matter | 896.2 | 886.5 | 892.9 |
| Crude protein | 187.1 | 188.2 | 187.4 |
| Crude fibre | 43.6 | 44.3 | 44.2 |
| Ash | 76.2 | 74.6 | 75.3 |
| M.E* | 2574.9 | 2578.3 | 2581.7 |

[a] Vitamin/Mineral premix composition ($g.kg^{-1}$): dry matter (920), protein (520), fat (35), ash (350), Ca (92.6), P (35.2) lysine (30.5), methionine (24.1) methionine + cystine (28.9), vitamin A ($15 \times 10^6$ IU/100 kg), Vitamin D ($3 \times 10^6$ IU/100 kg), vitamin E (35000 mg/100 kg), vitamin ($mg.kg^{-1}$) K3 (26), B1 (26), B2 (66), B3 (193), B6 (20) B10 (0.26), folic acid (19), choline (21), biotine (0.2), trace mineral ($mg.kg^{-1}$) Fe (1600) Cu (200), Zn (1320), Mg (800), Se (3.3).

* Calculated metabolizable energy ($Kcal.kg^{-1}$)

**Table 3**

**Chemical composition of maggot meal (% DM)**

| Chemical characteristic | % DM |
|---|---|
| Dry matter | 93.50 |
| Crude protein | 61.25 |
| Ash | 19.12 |
| Crude fibre | 3.58 |
| Phosphorus | 5.21 |
| M.E* | 3060.6 |

* calculated according to Sibbald (1980) quoted by INRA (1989)

## Results

The chemical composition of maggot meal is summarised in table 3. Crude fibre content and total ash are comparable to those of fish meal (9). However, fish meal has lower crude fibre and total phosphorus content (7). Metabolisable energy content of maggot meal is higher than that of fish meal.

### Weight gain

From day old to four-weeks of age, the lowest weight gain was recorded with the control group of chicks, while the birds fed with the S3 diet obtained the highest (Table 4). Except for week 2, using maggot meal always yielded higher weight gain as compared to the control (Figure 1). Statistical analysis showed that the treatment effect was significant ($P< 0.05$).Total weight gain in the S3 group was significantly higher than that of the control group, but not significantly different from the S1 group of birds. However, no significant difference was found between the control group and the S2 group of birds and between S1 and S2 broiler chicks for total weight gain during the starter period.

During the grower-finisher period, weight gain ranged from 1062.2 ± 59.9 g for the control group, to 1209.4 ± 73.3 g for the birds fed with the diet in which all the fish meal was replaced with maggot meal (F2). Except for the F0 group of birds, the increase in weight gain was linear (Figure 2)

Statistical analysis revealed that there was no significant difference among the birds fed with maggot meal (F1 and F2), while those fed the F2 recorded significantly ($P< 0.05$) higher weight gain as compared to the control. There was however, no significant difference between the birds on the control diet and those fed the F1 diet.

### Feed consumption

Feed consumption during the starter period varied from 1356.50 ± 106.12 g for the birds fed with the control diet to 1456.58 ± 110.16 g for those fed with the S3 (Table 4). The broiler birds fed with the S3 diet consumed significantly ($P< 0.05$) more feed than those fed with the control or the S2 diets. No significant difference was however recorded among the control, the S1 and the S2 groups for feed consumption. Replacing 5%

**Table 4**

**Weight gain (g), feed consumption (g), feed conversion ratio and feed cost of production of one kg live weight (FCFA)* of broiler chicks fed with maggot meal from day old to 4 weeks of age**

| Diet | Weight gain ± SEM | Feed consumption ± SEM | Feed conversion ± SEM | Feed cost for the production of 1kg of live weight |
|---|---|---|---|---|
| Control | 678.25 ± 96.46[c] | 1356.50 ± 106.12[b] | 2.00 ± 0.19[a] | 419.54[a] |
| S1 | 795.38 ± 125.28[ab] | 1415.77 ± 102.60[ab] | 1.78 ± 0.37[a] | 371.49[a] |
| S2 | 717.50 ± 107.50[bc] | 1377.60 ± 98.78[b] | 1.92 ± 0.20[a] | 401.06[a] |
| S3 | 837.12 ± 138.87[a] | 1456.58 ± 110.16[a] | 1.74 ± 0.07[a] | 363.26[a] |

[abc] A treatment is not significantly different ($P> 0.05$) from the control group when means of both groups carry the same letter.

* 1 euro= 657.56 FCFA.

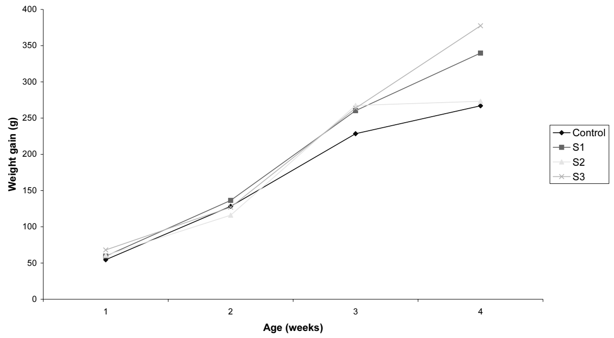


Figure 1: Weight gain of broiler chicks fed with maggot meal from day old to 4 weeks of age

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Control | 54.5 | 128.25 | 228.5 | 267 |
| S1 | 59.5 | 136.38 | 260.25 | 339.75 |
| S2 | 60.75 | 116 | 267.5 | 273.25 |
| S3 | 68 | 127 | 263.75 | 377,5 |

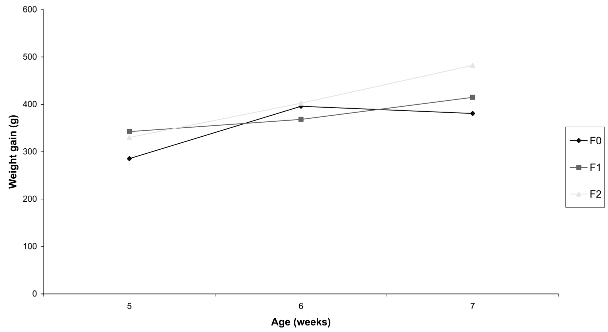


Figure 2: Weight gain (g) of broiler chickens fed with maggot meal during the grower-finisher period

| | 5 | 6 | 7 |
|---|---|---|---|
| F0 | 285.47 | 395.94 | 380.78 |
| F1 | 342.50 | 368.29 | 414.84 |
| F2 | 330.15 | 402.50 | 482.35 |

(S1) or 15% (S3) of the fish meal with maggot meal did not significantly (P> 0.05) affect feed consumption.

For the last three weeks of production (Table 5), feed consumption was lower in the group of birds fed with the diet containing only maggot meal (F2) and higher in the F1 group of birds fed with the diet containing equal amount of both fish meal and maggot meal. There was no significant difference (P> 0.05) between the control birds and those fed on the F2 diet in which 100% of the fish meal was replaced with maggot meal.

Feed consumption in the group of birds fed with the diet containing equal amounts of fish and maggot meals was significantly (P< 0.05) higher than that of the other two groups.

## Feed conversion efficiency

Feed conversion was 1.74 ± 0.07 for the S3 group of birds and 2.00 ± 0.19 for the control group during the starter period (Table 4). From table 5, it appears that

**Table 5**

**Weight gain (g), feed consumption (g), feed conversion ratio and feed cost for the production of one kg of live weight (FCFA)* of broiler chicks fed with maggot meal from 30 to 49 days of age**

| Diet | Weight gain ± SEM | Feed consumption ± SEM | Feed conversion ± SEM | Feed cost for the production of 1 kg of live weight |
|---|---|---|---|---|
| Control | 1062.19 ± 59.88[b] | 2718.59 ± 202.46[b] | 2.63 ± 0.30[a] | 458.01[a] |
| F1 | 1125.63 ± 36.66[ab] | 2972.81 ± 249.09[a] | 2.65 ± 0.39[a] | 457.87[a] |
| F2 | 1209.38 ± 73.28[a] | 2668.28 ± 241.50[b] | 2.23 ± 0.28[a] | 383.80[a] |

[abc] A treatment is not significantly different (P> 0.05) from the control group when means of both groups carry the same letter.

* 1 euro= 657.56 FCFA.

**Table 6**

**Carcass yield and proportion of different parts of the carcasses (%) of 49 days old broiler chicken birds fed with diet containing maggot meal**

| Diet | Hot carcass yield | Heart | Liver | Gizzard | Legs | Abdominal fat |
|---|---|---|---|---|---|---|
| | As a percentage of live weight | | | | | |
| Control | 64.23[a] | 0.45[a] | 1.75[a] | 1.80[a] | 4.38[a] | 1.35[a] |
| F1 | 63.62[a] | 0.43[a] | 1.80[a] | 1.86[a] | 4.97[a] | 0.88[a] |
| F2 | 64.90[a] | 0.48[a] | 1.83[a] | 2.15[a] | 5.43[a] | 0.81[a] |

[a] Percentages carrying the same letter in the same column are not significantly different (P> 0.05).

during the grower-finisher period, the F1 group of birds recorded a feed conversion ratio of 2.65 ± 0.39 while the F2 group of birds had 2.23 ± 0.28. For both the starter and grower-finisher periods, no significant difference (P> 0.05) was recorded among groups of birds for feed conversion ratio.

### Carcass quality

Data on carcass yield and proportion of different parts of the carcass are summarised in table 6. Carcass yield varied from 63.92% for the control group to 64.9% for the F2 birds. Percent legs, percent gizzard and percent liver increased from the control group to the F2 group. There was a decreased in the proportion of abdominal fat with increased amounts of maggot meal in the diet. There was however, no significant difference (P> 0.05) among treatment groups for carcass yield and proportion of heart, gizzard, liver, legs and abdominal fat.

### Feed cost for the production of one kilogram of live broiler chicken weight

The feed cost for the production of one kg of live broiler chick varied from FCFA 363 for the group of birds fed with the S3 diet to FCFA 419 for the birds under the control diet (Table 4). During the grower-finisher period, the feed cost for the production of one kg of live broiler decreased from FCFA 458 for the birds under the F0 diet to FCFA 383 for those fed on the F2 diet (Table 5). However, there was no significant difference (P> 0.05) among treatment groups either during the starter or the grower-finisher periods for the feed cost for the production of one kg of live broiler chicken weight.

## Discussion

Weight gain for both the starter and the grower-finisher periods have been significantly higher for the group of birds fed with the feed containing the highest amount of maggot meal as compared with the control group. In general, adding maggot meal to the diet resulted to a higher weight gain as compared with the control (Figures 1 and 2), although the difference between the control birds and some diets containing maggot meal was not significant. Weight gain of all birds used in this experiment either for the starter or grower-finisher periods was lower than suggested for Arbor Acres broiler birds, 1069 g and 1408 g from day old to 4 weeks and from 5 to 7 weeks respectively. This difference in weight gain could be related to the quality of feed but also to the environment as this birds are initially selected for temperate regions.

During the starter period, feed consumption has been significantly higher for the birds fed with the diet containing the largest amount of maggot meal as compared with the control group, however, no difference was detected between the later and the two other groups for feed consumption. The grower-finisher ration was significantly more consumed by birds on F1 diet as compared to the control and F2 groups. No clear treatment effect was detected. Also, in general, all birds used in this experiment consumed less feed than suggested for Arbor Acres broiler birds. This could be related to the relatively low energy to protein ratios recorded for the diets used in this experiment that were between 128 and 131 for the starter diets and around 137 for the grower-finisher diets as compared to values between 138 and 145 and between 157 and 190 as suggested (10) respectively for starter and grower-finisher diets.

Although no significant difference was detected among treatment groups for feed conversion either for the starter or the grower-finisher, a better feed utilisation was observed for birds fed with feeds containing maggot meal, particularly during the 4 first weeks of life. However, all birds used in this experiment recorded poorer feed efficiency than suggested by the breeder except for the F2 group of birds fed with the feed containing exclusively maggot meal in replacement of fish meal in the grower-finisher diet. With the control group also giving lower performance, the poor feed utilisation could not be totally attributed to the introduction of maggot meal in the diet. This could rather be related to the quality of the feed used, particularly to the lower energy concentration as previously noticed (8) for poultry diets in the tropics.

The carcass yield and proportion of heart were in the range previously suggested (9) 63.92% and 0.43% respectively, however, proportions of legs and gizzard were higher than the suggested 4.0% and 1.15% respectively. All the birds in this experiment recorded lower proportion of abdominal fat than the 2.0% suggested (9). While the inclusion of increased amount of maggot meal resulted in a proportional increase in the percent legs, liver and gizzard, the proportion of abdominal fat decreased with increased amount of maggot meal in the grower-finisher diet. An increase in the proportion of the gizzard and liver could be an indication of a more intensive activity of these organs and a possible toxicity of maggot meal, although no clinical sign of toxicity was observed in birds fed with maggot meal. The relative decrease in the abdominal fat deposit with increased amount of maggot meal could be due to the better utilisation of feed containing maggot meal.

Although no significant difference was detected among treatment groups for the feed cost for the production of 1 kg of live weight, there was a net decrease in cost ranging from 4.4% to 13.4% and from 0.03% to 16.2% as compared to the control group respectively for the starter and the grower-finisher periods. The reduction in cost of feeding in treatment groups as compared to the controls is probably related to the lowest cost of maggot meal as compared to fish meal, but also to better utilisation of feed particularly in groups fed with the highest amount of maggot meal both during starter and grower-finisher periods. The difference between the control group and the one fed with maggot meal could be of prime practical importance as this could mean a sensible reduction in the cost of production, particularly in large production units.

## Conclusion

The replacement of fish meal with maggot meal in broiler chicken starter and grower finisher diet resulted in higher weight gain as compared to control diets. Carcass yield was comparable for birds fed with control diets and those containing maggot meal. From the technical point of view, the substitution was a success.

Under commercial conditions, using maggot meal could also be justified by a reduction in cost of feeding broiler chicken to market weight.

However, with the increased size of gizzard and liver, it is advisable that maggot meal should be analysed for toxicity before it could be widely used for broiler chicken feeding.

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A.Téguia, Cameroonian, M.Sc., Animal Scientist, Senior lecturer, Department of Animal Science, Faculty of Agronomy and Agricultural Sciences, University of Dschang, P.O.B; 70 Dschang, Cameroon.

M. Mpoame, Cameroonian, Ph.D., Zoologist, Associate professor, Faculty of Science, University of Dschang, Cameroon.

J.A. Okourou Mba, Cameroonian, Agricultural engineer, Department of Animal Science, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon.