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Effect of replacing soy bean meal with maggot meal on the production performance and egg quality traits of commercial white leg horn layers

Abstract

Along with energy, quality protein is also essential for the health and production for poultry birds. Total 150 white leghorn layer birds, aged 25 weeks approx weight 1.5±0.5 were used in this study. The formulated ration contain control diet-1 (D-1)having 100% soybean meal and 0% maggot meal, Diet-2 (75% soybean meal and 25% maggot meal), Diet-3 (50%soybean meal and 50% maggot meal), Diet-4 (25% soybean meal and 75% maggot meal) and Diet-5 containing (0% soybean meal and 100% maggot meal). Egg shell thickness was determined after removing the shell membrane. The daily feed intake (g/day/bird), per/day egg production (%), weight (g) and feed conversion ratio (g feed/dozen egg production) did not differ ($P<0.05$) among the experimental groups (MD-2, MD-3, MD-4, MD-5), and MD-1 group. However MD-3 replacement diet had a better result on performance basis. The blood profile that is red blood cells (RBCs), white blood cells (WBCs), hemoglobin (HB), packed cell volume (PCV), albumin and total protein were not affected ($P<0.05$) by the different diets and no significant differences were found among the different treatment groups. The egg weight, egg shell weight, shell thickness, albumen height, yolk weight, yolk height and haugh unit were not affected ($P>0.05$) within dietary treatment. Finding of our result indicated cheap protein alternatives sources like maggot meal, help the resource poor farmers not only to cut down their production costs, but also to improve their production efficiency.

Keywords: additive feed ingredient, poultry, maggot meal, protein

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Introduction

The price of the poultry feed has been increased due to the shortage and high price of feed ingredients especially protein.[1,2] Due to the increase cost and high demand for conventional protein sources, it is very costly for the use for both human and animal population. This unremitting increase in the price of poultry feed items is a convincing factor to find out other alternatives for protein sources, which are not only have a good nutritional value but these must be cheaper and easily available than the other conventional protein sources.[3,4] Any effort towards finding cheap and easily available protein resources will definitely decrease the cost of livestock especially the cost of poultry production.[5] The main constituents of poultry feed includes proteins and energy. Cereal grains including barley, oats, corn, wheat and sorghum are used as source of energy in poultry ration. Along with energy, quality protein is also essential for the health of poultry birds. Soyabean meal and fish meal are the chief protein sources for poultry birds, but this meal fulfills the need and has increased environmental footprint and its mass scale production on sustainable bases is costly and leads toan increase poultry feed prices.[6] The level of soybean meal inclusion is 25% in chicks and 30-40% in breeders, laying hen and broilers depending upon the breed and type of birds as well as the ingredients availability.[7,8] In the last decade increased feed prices make poultry farming out of the reach for small holder farmers.[9] Thus, it is very important to search for local and easily available unconventional sources for protein to substitute soyabean meal in poultry ration. Finding a cheap and easy alternative to replace soyabean has become imperative. Identification of such cheap protein alternatives like maggot meal, earthworm meal, meal worm and other insects including fly larvae grasshoppers and crickets would help resource poor farmers not only to cut down their production costs, but also to improve their production efficiency.

In poultry production feed constitute almost 75% of the total cost[10] or 70% of the total production cost.[9] The demand for low cost poultry feed is high, due to the rising cost and limited supply of commercial feeds.[10] Hassan et al.[11] contended that due to establishment of new compounding feed mills and growing poultry farm the cost of poultry feed ingredient is increasing day by day. Maggot meal (MM) is a potential alternate source[12–14] and its use in poultry feed playing two major roles; (i) poultry waste recycling and (ii) environment friendly sustainable management of poultry wastes.[12] Efforts to prevail over this is to include reasonably inexpensive feed ingredients for example the costly soybean meal would be replaceable by the locally inexpensive available maggot meal (MGM) which has a reasonably similarity in the amino acid profile.[14] In this study the performance, feed digestibility, hematological parameters and egg quality trait reared on diets formulated by replacing soybean meal with maggot meal on equi-protein basis were used to find out the potential of this locally available raw material as protein resource in feeding.

Material and methods

Experimental birds and feeding regime

A total of one hundred and fifty (150) layer birds, with aged 25 weeks approx weight 1.5±0.5 were purchased from the local market. All birds were provided with proper lighting and feeding regime throughout the experimental period. The study was carried out at the University Poultry Farm, The University of Agriculture Peshawar-Pakistan.

Feeding trials

Feeding trial was conducted on commercially available white leghorn layer at peak egg production stage. The experimental rations were weight according to the recommendations of National Research Council (NRC)-Islamabad-Pakistan. These rations were compared with control ration in each trial containing soybean as the main source of proteins. The formulated layer rations were offered to the birds during the study. The formulated ration contained control diet-1 (D-1)having 100% soybean meal and 0% maggot meal, Diet-2 (75% soybean meal and 25% maggot meal), Diet-3 (50% soybean meal and 50% maggot meal), Diet-4 (25% soybean meal and 75% maggot meal) and Diet-5 containing (0% soybean meal and 100% maggot meal).

Recorded production parameters

Daily feed intake, eggs production and combined weight of each group was recorded. Weight of the layers birds were recorded at the end of each experimental week and three eggs from each replicate (total 45 egg samples from 15 replicates) were collected randomly to record the following egg quality parameters. Weight of individual egg was determined with the help of analytical balance. Shell thickness was determined by using screw gauge after removing the shell membrane. After evacuation of egg albumin and yolk was dried off with help of tissue paper to determine its weight by using analytical balance. Egg yolk color was determined by using Roche fan color paper. Yolk weight was determined by pouring it into Petri dish then weight. Albumin height was determined with Spherometer. Egg albumin weight was calculated by subtracting egg shell and egg yolk from the total volume. For recording Hough unit, the egg from the collected sample were broken in a Petri dish and albumen height was recorded. The Hough unit was calculated using the following formula.

HU=100*log (albumin height-7.57-1.7*egg weight 0.37)

Statistical analysis

All data were expressed as means ± standard deviation. Data analysis was performed with a commercially available software program (SPSS version 18, SPSS Inc, Chicago, IL, USA), while using analysis of a variance (ANOVA), followed by Bonferroni test for differences between treatment groups. The value of $P<0.05$ was considered to be significant.

Results

The replacement of maggot meal in layer diets did not have harmful effect on the performance of laying hen when compared to control group (MD-1). The daily feed intake (g/day/bird), per/day egg production (%), weight (g) and feed conversion ratio (g feed/dozen egg production) did not differ ($P<0.05$) among the experimental groups (MD-2, MD-3, MD-4, MD-5) and MD-1 group. Numerical variation among the groups were recorded, although no differences ($P<0.05$) in the feed conversion ratio and other performance parameters of the birds were recorded among the groups. However MD-3 replacement diet had a better result on performance basis. No mortality was documented during our research observation period (Table 1).

Table 1 Effect of varying replacement levels of maggots meal for soybean meal on performance parameters of laying hens

Performance parameters				
Diets (soybean: maggots)	**Feedintake (g/day/bird)**	**Hen weight(g)**	**Hen day production(%)**	**FCR (Feed/ dozen of egg**
MD-1	117.1	1324	67.88	2.18
MD-2	116.8	1297	64.8	2.23
MD-3	118.8	1356	68.11	2.07
MD-4	117.9	1372	67.98	2.28
MD-5	118.4	1379	65.22	2.26
P. value	0.695	0.38	0.532	0.241

Diets D-1(0%) used as control diet, D-2(25%), D-3 (50%), D-4 (75%) and D-5 (100%) of the soybean meal was replaced with maggot meal. SBM, soybean meal; MM, maggot meal. P. value, non-significant

Effect of varying replacement levels of maggots meal for soybean meal on hematological parameter of laying hens

Maggot meal replacement in ration had no adverse effect on hematological parameters of the birds. The blood profile that is red blood cells (RBCs), white blood cells (WBCs), hemoglobin (HB), packed cell volume (PCV), albumin and total protein were not affected by the different diets and no significant differences were found among treatment groups. Arithmetical variation was found in the values for blood parameters when compared to that of MD-1 group and other dietary supplement groups (Table 2).

Effect of varying replacement levels of maggot meal for soy bean meal on egg quality parameters of laying hens

The physical parameters of the collected eggs, showed no significant differences among the treatment groups (Table 3). The egg weight, egg shell weight, shell thickness albumen height, yolk weight, yolk height and haugh unit were not affected ($P>0.05$) within dietary treatment. The Haugh units increased numerically in dietary treatment MD-3, when compared to D-1 group.

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Table 2 Effect of varying replacement levels of maggotsmeal for soybean meal on hematological parameters of laying hens

Haematological parameters					
Diets (soybean: Maggots)	**RBCs (103/mm³)**	**WBCs (103/mm³)**	**HB(g/dl)**	**PCV %**	**Albumin (mg/dl)**
MD-1	2.14	3.85	8.18	2.23	5.74
MD-2	2.27	3.96	7.84	2.35	5.66
MD-3	2.16	3.83	8.22	2.31	5.69
MD-4	2.31	3.9	8.39	2.42	5.64
MD-5	2.19	3.91	8.77	2.38	5.7
P. value	0.9	0.458	0.493	0.812	0.786

D-1 is control diet, whereas in the other diets D-2 (25%), D-3 (50%), D-4 (75%) and D-5 (100%) of the soybean meal was replaced with maggot meal. SBM, soybean meal; MM, maggot meal. Red blood cells (RBCs), White blood cells (WBCs), hemoglobin (HB), Packed cell volume (PCV)

Table 3 Effect of varying replacement levels of maggot meal for soybean meal on egg quality parameters of laying hens

	Diets (soybean: maggots)					
Parameters	**D1 (100:0)**	**D2(75:25)**	**D3 (50:50)**	**D4 (25:75)**	**D5 (0:100)**	**P. value**
Egg weight (g)	60.11	59.4	60.05	62.23	61.01	0.685
Egg shell weight (g)	8.54	6.98	8.15	7.49	7.46	0.456
Shell thickness (mm)	0.32	0.34	0.35	0.34	0.36	0.216
Albumin weight (g)	36.21	35.83	37.85	38.32	38.07	0.536
Albumin height (mm)	6.85	6.52	7.08	7.1	6.91	0.149
Yolk weight (g)	15.86	15.72	15.82	15.38	15.74	0.549
Yolk height (mm)	17.43	18.05	18.91	18.21	18.56	0.2
Haugh unit	82.49	80.87	83.94	82.89	84.61	0.959

D-1 is control diet, whereas in the other diets D-2 (25%), D-3 (50%), D-4 (75%) and D-5(100%) of the soybean meal was replaced with maggot meal. SBM, soybean meal; MM, maggot meal

Discussion

The egg production over the trial period endorses that maggot meal as protein supplement was better for laying hen. The obtained results are in line with findings of[15] and found that egg production increases with increase in maggot meal replacement up to 70% and then decreases beyond this limit, may be due to some digestibility factors, which may affect further utilization of maggot meal. Similarly Cadag et al.[16] study supported the present study finding that the egg production of the pullets progressively declined with increasing level of insect source proteins ingredients replacing in a diet. Ernst et al.[17] has also replaced animal source protein with maggot meal in the diet of laying hens and observed an increase in egg yield. Assessment of laying performance is very vital important factor on percent hen-day egg production.[18] Hence our observation on this parameter showed a numerical improvement in birds fed maggot meal, when compared to control group. The results of this parameter agrees with earlier findings of Parshikova et al.,[13,17,19] which showed increases in egg yield when housefly larvae (maggots) was provided to the laying chickens. Moreover, the highest hen-day egg production at level of D-2 (75:25) were observed in our study, may suggest an optimum complementarity of nutrient profile at ratio 3:1. This hypothesis may be sufficiently explained the earlier reports of Molchanova et al.[20] and,[21] and also the current trend observed for hen-day egg production. Similarly the results of[5] evaluated the performance of finisher broilers fed maggot meal as a replacement for fish meal in a 35 day trial. Diets were formulated such that maggot meal replaced fish meal at 0, 20, 30, 40 and 50%. The results showed that feed intake and feed conversion ratio of birds on maggot meal were superior to commercial diet. The authors found that the replacement of a 4.0% dietary fish meal in finisher broiler chicken's diet with 50% maggot meal gave superior performance characteristics to the basal diet, and was a more economical option. The present results are also in line with findings of,[22] who found that insect meal (caterpillar) has no significant adverse effect on the production performance of layer birds. Maurer et al.[23] resulted found that feed intake was not affected by adding maggot meal in poultryration. Current results were supported by Makkar et al.[24] who found that no deleterious effect on egg production, weight gain and feed consumption ratio in poultry birds were observed.

Feed conversion ratio was expressed as feed required in kg/dozen of eggs production was affected by addition of maggot supplement in layer diet. Numerical reduction in feed intake and high weight gain of the birds was observed with increased levels of replacement in the ration of the birds, while there was no significant difference found among the treatment groups. Atteh[14] had also observed reduction in feed consumption, which may be due to high energy content of the maggot meal. The findings of the obtained results were also in the line with the results obtained of Atteh[14] that increasing the concentration of maggot meal in layers' diet resulted in a significant reduction in feed intake and a consequent increase in weight gain. Similarly Okah[5] conducted experiment and found that no significant differences

in different treatment groups with different levels of maggot meal replacing (50%) fish meal in the poultry diet, however significantly lower feed intake and weight gain was recorded, which may be due to high energy content in the diet.

Hematological parameters showed no significant differences among the different treatment groups, although numerical variations exist among the different treatment groups. In general hematology and serum protein analysis showed that replacement level of (MM 75%: SBM25%) has reasonably better hematocrit indices. Similar findings were also observed by Bovera et al.[19] who conducted his research study on yellow mealworm larvae replacing soybean meal in ration, which is also derivative of insect meal, and found that 100% soybean meal can be replaced with mealworm larvae, while the findings of our research study showed that maggot meal upto 75% supplement has positive impact on the hematological parameters. Moreover it is also noted that increased in maggot meal replacement beyond 75% have no significantly negative effect, which may be due to some factors in the maggot meal impairing the hematocrit indices. The present results are in line with the findings of Duwa et al.,[25] who performed his experiments in rabbits and replaced soybean meal with maggot meal (5%) in the whole diet and found no adverse effects on the serum biochemical profile, as well on hematological indices. White blood cells, packed cell volume, hemoglobin concentration, mean corpuscular volume, albumin and globulin concentration all are in the acceptable range, which indicate no harmful effects of maggot meal on the health status of the birds. A slight non-significant ($P\geq0.05$) increase in the white blood cells with increasing the level of maggot meal in the poultry ration may be due to some recent infection in that group. Similar findings were also observed by Stephen et al.[26] and Uchewa[27] who found no significant increase or decrease in the serum biochemical profile and hematological parameters.The erythrocyte values (PCV, MCHC, MCV and Hb) obtained from our study, have the same range as obtained by Mitruka et al.[28] As the with increasing the level of replacement there is numerical decrease in albumin/globulin level, state that high globulin concentrations and low albumin/globulin ratios indicate better disease resistance and immune response of birds. The mean values for haematocrit, plasma, and glucose were not significantly different ($P<0.05$) among the feeding groups. This shows that no physiological stressful condition was introduced in the birds by feeding maggot meal diets. It has been shown that nutritional deficiency is one of the main causes of stress in poultry birds.[29]

The egg weight, egg shell weight, egg shell thickness, albumen height, yolk weight, height and haugh unit were not affected ($P>0.05$) with dietary treatment. The Haugh units increased numerically in dietary treatment MD-3 compared to D-1.Our results are in line with the findings of Akpodite et al. who conducted a 56-day experiment to determine the replacement value of maggot meal in diet of laying chicken and found that egg weight, egg production, shell and yolk weight as well as yolk color were not affected ($P\geq0.05$), however albumin weight was affected ($P\leq0.05$), which may be due to the different in age of bird groups, as we have 30 weeks old age birds in our trial. Current study was supported by the report of Awoyini et al., (2000),that egg weight and Hough unit was not affected ($P\geq0.05$) by offering insect meal in the ration. Similarly Khatun et al.,[30] found no significant ($P\geq0.05$) result for egg weight and hen day egg production. Our results are indirectly supported by the Margareta et al.,[31] report that insect meal product have no significant effect on egg weight, albumin height and Haugh unit. Similar results were also observed by the report of Atteh[14] that different egg quality parameters were not affected significantly ($P\geq0.05$) using maggot meal in layers diet. Our results are also in line with the results of Bovera et al.[19] who found that egg production, egg weight, albumin and yolk weight were reduced ($P\geq0.05$) with increasing the level of maggot meal. Our findings showed that maggot meal at the ratio of 75:25 showed best performance of layer birds.[32–35]

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None.

Conflicts of interest

The author declares there is no conflict of interest.

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