INTRODUCTION

The oil seed meals are important sources of protein in the diet of chickens. At present, the requirement of protein sources in India is 4.72 million MT and it will increase to 19.83 million MT by 2015 (Chadda, 1998). Apart from animal protein sources, various oil meals prepared from groundnut, sunflower and rapeseed-mustard meals are available for animal and poultry feeding in South Asian countries including India. Only groundnut meal has been used as conventional vegetable protein supplement in the preparation of mixed feeds for various classes of poultry. Rapeseed-mustard meal contains glucosinolate (Tripathi et al. 2001), whereas sunflower meal contain more fiber (Gracia-Fernandez et al., 1999) and cause lipids peroxidation (Senkoylu and Dale, 1999), hence not used in poultry feeds. Groundnut meal, however, is not balanced in amino acids pattern desirable for poultry. It is deficient in methionine, tryptophan and tyrosine (Singh et al., 1981). Its keeping quality is poor as it may develop aflatoxins during storage (Mishra, 1993). The presence of aflatoxins in the feed leads to a deadly condition due to aflatoxicosis. In comparison to groundnut meal, the amino acid pattern of soybean meal approximates more to dietary requirement of poultry and methionine, which is a relatively deficient amino acid may be supplemented easily. Soybean meal availability in India has been increased markedly. It is also superior to groundnut meal. Soybean meal contains higher crude protein and methionine (Lesson and Summers, 1991) than groundnut meal and with less crude fiber and silica among all vegetable protein supplements (Uma, 2000). The occurrence (possibility) of aflatoxin contamination is also least in soybean.

Fish meal is an important animal protein supplement in poultry diets, which could be also contaminated with higher level of sand, silica, salt and contains gizzerosin (Okazaki et al., 1983) and another limiting factor is its high cost. The objective of this study was to assess the effect of replacing groundnut meal with soybean meal at varying levels of fish meal and protein levels on performance and egg quality of layer chickens.

MATERIALS AND METHODS

Study site

The present experiment was conducted at Poultry Research Center of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, India. The Research Center is located in the Tarai region at 29.3°N latitude, 79.3°E longitude and 243.84 meters above mean sea level. The climate of Pantnagar is humid and subtropical in nature. The temperature exceeds 40°C in summer and falls below 5°C in winter. The annual rainfall is approximately 125 cm. The experiment was conducted in 1999 from mid January to mid April and average ambient temperature was 22°C.

ABSTRACT

Two hundred and sixteen single comb white egg layers of the White Leghorn hens of 24 weeks of age were randomly allocated to 12 groups with three replications of six hens in each. Hens were fed in a factorial arrangement 2×3×2, on diets containing either 16 or 18% crude protein with 0, 3 or 6% fish meal, replacing groundnut meal with soybean meal. Soybean meal incorporation improved (p<0.05) egg production, feed intake, feed conversion efficiency and egg weights. Egg quality traits of specific gravity, shape index, albumen index, yolk index and shell thickness remained unchanged. Laying performance was significantly (p<0.05) better at 18% than on 16% dietary protein level. Use of fish meal linearly improved egg production and feed conversion efficiency on diets supplemented with groundnut meal and fish meal incorporation showed quadratic improvement on feed conversion efficiency with SBM diets at 16% dietary protein level. Therefore, use of soybean meal as substitute of groundnut meal is recommended in layer diets, at 16% dietary protein level and fish meal incorporation could be beneficial for layers. (Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 11 : 1617-1621)

Key Words: Groundnut Meal, Soybean Meal, Layer Performance, Egg Quality
Experimental protocol

Birds and experimental design: Two hundred and sixteen single comb white egg layers of the White Leghorn strain were obtained at 24 weeks of age from Poultry Research Center and placed individually in cages (32×33 cm). They were obtained in January after being reared in an open sided house and thus may have been adapted to heat stress conditions. After all birds entered in production (96% had laid), they were arranged according to egg laid during a 2 week pre-experimental period prior to feeding with different diets. One hen was housed per cage and three replications of six hens each were fed on each experimental diet. The experiment was conducted in a completely randomized design.

Diets and feeding: Twelve experimental layer diets were prepared containing either 16 or 18% crude protein with 0, 3 and 6% fish meal, replacing groundnut with soybean meal on a crude protein basis. The composition of diets is given in Table 1. Diets were analysed for proximate principles and calcium content following the procedures of AOAC (1984). All birds were fed 2-3 weeks for an adaptation period. The birds were fed at 8:30 am daily and records of feed intake were maintained on a week basis for 90 days. Diet and water were provided ad. libitum. The birds were allowed 10% diet refusals. Mortality and egg production were recorded twice daily at 10:00 h and 17:00 h. Hens were weighed individually at 30 day intervals to assess the change in body weight.

Egg quality measurements: All eggs from each treatment were weighed for 4 consecutive days at 30 days intervals. Specific gravity was determined by the eggs flotation method using eight salt (NaCl) solutions varying in specific gravity by increment of 0.005 from 1.065 to 1.100. The shape index was measured by dividing the transverse diameter of egg by the length (Shape index=(width of egg/length)×100). The eggs were then broken on a glass sheet (30×30 cm), albumen index (height of dense albumen/average width) and yolk index (height of yolk/width of yolk) were determined. The shell thickness was measured with shell membranes intact using a micrometer at equatorial parts of the egg.

Statistical analysis

The data obtained on a cage basis for all parameters except feed intake which was on pen basis were statistically analyzed using a linear model (Harvey, 1975).

\[ Y_{ijk} = \mu + P_i + F_j + S_k + e_{ijk} \]

where: \( \mu \) = General mean  
\( P_i \) = Effect of ith protein level (i=1, 2)  
\( F_j \) = Effect of jth fish meal level (j=1, 3)  
\( S_k \) = Effect of kth vegetable protein source (k=1,2)  
\( e_{ijk} \) = Random error

Regression analysis was also carried out using the level of fish meal as factor, separately with 16 or 18% protein level utilizing a polynomial design which tested linear and quadratic relationship (Snedecor and Cochran, 1982).

Table 1. Ingredient and chemical composition of experimental diets

<table>
<thead>
<tr>
<th>Protein level (%)</th>
<th>16 % crude protein diet</th>
<th>18 % crude protein diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal level</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Vegetable protein source</td>
<td>GNM*a</td>
<td>SBMb</td>
</tr>
<tr>
<td>Ingredients (g/100 g)</td>
<td>Wheat</td>
<td>53.69</td>
</tr>
<tr>
<td>Groundnut meal</td>
<td>16.95</td>
<td>-</td>
</tr>
<tr>
<td>Ricebran*c</td>
<td>20.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Fishmeal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Analysed chemical composition (% in DM)</td>
<td>Dry matter</td>
<td>94.52</td>
</tr>
<tr>
<td>Crude protein</td>
<td>16.00</td>
<td>16.00</td>
</tr>
<tr>
<td>Ether extract</td>
<td>0.79</td>
<td>0.88</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>5.67</td>
<td>3.68</td>
</tr>
<tr>
<td>Calcium</td>
<td>3.00</td>
<td>3.00</td>
</tr>
</tbody>
</table>

*a GN Ma: Groundnut meal.

*b SBM: Soybean meal.

*c Ricebran: It was deoiled and contained 2 g oil per kg DM.

*d Premix provides: 1. Mineral mixture 2 kg; contained (g/kg) calcium 315.8, phosphorus 60.5, copper 0.3, manganese 1.8, cobalt 0.5, zinc 2.4, potassium iodide 0.3 and fluoride <0.3. 2. Shell grit 7 kg. 3. Vitamin supplement 30 g, contained: Vitamin A 82,500 IU, Vitamin D, 12,000 IU, Vitamin E 10 mg, Vitamin B12 40 mg. 4. Nifmit-200, 25 g [contained furazolidone 20% (W/W)]. 5. Dinitolmide 50 g. 6. NaCl 250 g.
RESULTS

Chemical composition

The diets of two protein groups were isonitrogenous and contained 16 to 16.03% protein in 16% group, whereas 18 % diets contained 17.99 to 18.02% protein. Ether extract ranged from 0.71 to 0.99 %, crude fiber varied from 3.45 to 7.16 % and calcium 3.0 to 3.58% either of 16 or 18 % diets (Table 1).

Hen performance

Rate of laying was constantly better (p<0.05) on SBM diets to that of GNM diets. Fish meal level linearly increased rate of lay in GNM diet at 16% protein level, however, egg production remained unaffected in SBM diets. Fish meal level quadraticly increased egg production at 18% protein diets containing SBM. The highest (p<0.05) egg production was recorded at 18% protein level with 6% fishmeal in SBM diet, which was (p<0.05) higher to the diets containing GNM at 16% dietary protein with either of 0, 3 or 6 % fish meal.

Feed intake of layers was higher (p<0.05) on diets containing 18% protein with SBM and 3 or 6% fish meal to that on 16% protein diet contained GNM and 3 or 6% fish meal, respectively. Dietary protein levels and vegetable protein sources showed significant effect on feed intake, which was better at 18% protein with SBM diets. The quadratic depression on feed intake was observed with GNM diet at 16% protein with 6% fish meal level.

Feed conversion ratio was not different between GNM or SBM diet at various fish meal levels but fish meal inclusion improved feed conversion ratio. The FCR showed

| Table 2. Effect of experimental diets on hen performance and egg quality |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Protein level              | 16 % crude protein diet     | 18 % crude protein diet     |
| Fish meal (%)              | GNMb                        | SBMb                        | GNMb                        | SBMb                        | GNMb                        | SBMb                        | GNMb                        | SBMb                        |
| Vegetable protein source   | 0                           | 3                           | 6                           | 0                           | 3                           | 6                           | 0                           | 3                           | 6                           |
| Hen performance            |                              |                              |                              |                              |                              |                              |                              |                              |                              |
| Rate of laying (%)         | 83.1a 92.4bc 86.0b 93.0bc 87.2ab 93.9bc 91.7bc 91.0bc 91.2bc 93.4bc 93.0bc 96.7c 2.04 |
| Feed consumption (g per hen day) | 127ab 132bc 127ab 135bc 118a 130b 133bc 136bc 134bc 143c 132bc 134bc 3.78 |
| Feed conversion ratio (g feed per egg) | 142b 137ab 136ab 131ab 133ah 131ab 135ab 133ab 134ab 134ab 134ab 135ab 3.02 |
| Egg quality measurements   |                              |                              |                              |                              |                              |                              |                              |                              |                              |
| Egg weight (g)             | 50.3ab 52.2b 49.3b 54.6b 50.2b 52.5b 51.6b 51.9b 50.7b 52.8b 51.8ab 54.0b 0.62 |
| Specific gravity           | 1.11 1.06 1.10 1.09 1.09 1.08 1.10 1.09 1.10 1.10 1.10 1.10 0.010 |
| Shape index                | 77.40 76.22 77.28 75.63 76.83 76.83 77.67 77.58 75.86 75.36 78.05 76.50 0.68 |
| Yolk index                 | 0.463 0.473 0.463 0.470 0.480 0.473 0.460 0.457 0.470 0.480 0.467 0.473 0.065 |
| Albumen index              | 0.104 0.099 0.101 0.097 0.107 0.113 0.099 0.107 0.099 0.099 0.114 0.103 0.056 |
| Shell thickness            | 3.3 3.4 3.5 3.5 3.6 3.4 3.5 3.5 3.5 3.5 3.6 3.6 0.65 |

Values having different letters in a row differ significantly p<0.05.

| Table 3. Regression effects of protein level, source of protein and fish meal levels on hen performance |
|---------------------------------------------------|---------------------------------------------------|---------------------------------------------------|---------------------------------------------------|
| Protein levels                                   | Protein Source | Protein levels                                   | Protein Source |
|                                                   | 16 % protein   | 18 % protein                                     | 16 % protein   |
|                                                   | GNMb                        | SBMb                        | GNMb                        | SBMb                        |
| Rate of lay *                                     * * NS NS NS NS NS NS NS NS NS NS NS * |
| Feed intake *                                     * NS NS NS NS NS NS NS NS NS NS NS NS NS |
| Feed conversion ratio                            * NS NS NS NS NS NS NS NS NS NS NS NS NS |
| Egg weight NS                                     NS * NS NS NS NS NS NS NS NS NS NS NS |

* GNM: Groundnut meal.
* SBM: Soybean meal.
* Lin: Linear effects of dietary protein and fish meal levels or vegetable protein source on performance.
* Quad: Quadratic effects of dietary protein and fish meal levels or vegetable protein source on performance.
* NS: Not significant.
* p<0.05.
increasing soybean meal in diet increased egg weight and
Gavrish (1994). Scholtyssek et al. (1991) reported that
incorporation is in agreement with Svezhentsov and
meal approximates more to dietary requirement of poultry
1986) for poultry, whereas amino acid pattern of soybean
level or dietary protein levels. Egg weight was higher
unaffected due to source of vegetable protein, fish meal
index, albumen index and shell thickness remained
egg quality traits of specific gravity, shape index, yolk
index, albumen index and shell thickness remained
unsupplemented due to source of vegetable protein, fish meal
level or dietary protein levels. Egg weight was higher
(p<0.05) on SBM diets to that of GNM diets.

Egg quality

Egg quality traits of specific gravity, shape index, yolk
index, albumen index and shell thickness remained
unaffected due to source of vegetable protein, fish meal
level or dietary protein levels. Egg weight was higher
higher (p<0.05) on SBM diets to that of GNM diets.

DISCUSSION

The methionine, tryptophan and lysine are deficient in
groundnut meal (Singh et al., 1981; Singh and Zombade,
1986) for poultry, whereas amino acid pattern of soybean
meal approximates more to dietary requirement of poultry
(Lesson and Summers, 1991). The SBM contain higher
Crude protein, better amino acid pattern and bioavailability
(Park et al., 2002). Dry extruded soybean meal was used in
the present experiment, which contained minute trypsin
inhibitor (Baier et al., 1989). Substitution of soybean meal
improved hen performance which agreed favorably with
previous reports (Ekpenyong and Agkwunobi, 1988; Rybina,
1979; Vodolazhchenko and Vedyakina, 1987 and Mandlekar
and Thatte, 1993), who reported increased egg production
and improved feed conversion ratio on soybean meal
incorporated diets in comparison to other vegetable protein
supplements such as groundnut, sunflower and rapeseed
meal etc. Improved supply of lysine and methionine on
soybean meal could have increased hen performance on
SBM incorporated diets. Lysine is generally deficient in
poultry diets and higher arginine content of groundnut meal
create lysine- arginine antagonism and excess arginine
promotes biosynthesis of creatinine which require methyl
protein. Fish meal increased egg production on groundnut
meal diets, whereas response of fish meal with SBM diets
was lower (Mandlekar, 1992). Soybean oil meal could
replace fish meal up to some extent in poultry diet
(Vodolazhchenko and Vedyakina, 1987). Results of the
reported experiment are in agreement with previous reports
(Thakur et al., 1987; Skorupinska, 1985; Yin and Han,
1995; Kulikov and Sarda, 1987) who reported that
gardless of energy concentration, the dietary protein
levels have a positive relation with laying performance.

CONCLUSION

It is concluded that vegetable protein source and level of
dietary protein have significant effect on layer performance.
Soybean meal incorporation improved rate of laying, feed
consumption, feed conversion ratio and egg weight. Use of
fish meal with GNM diets improves rate of laying and feed
conversion. Hence, substitution of groundnut meal with
soybean meal is recommended in layer diets. It is concluded
that the dietary level of 16% CP may be adequate for laying
hens and an increase over this level (up to 18%) lead to a
waste of protein.

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