**Effect of feeding flaxseed to laying hens on the performance and egg quality and fatty acid composition of egg yolk**

Einfluß des Einsatzes von Leinsaat im Legehennenfutter auf die Leistung, die Eiqualität und das Fettsäuremuster im Dotter

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**Introduction**

The use of flaxseed as well as menhaden oil and golden marine algae, alone or in combination, in diets for egg laying hens has previously shown to be very effective in manipulation the fatty acid composition of the yolk, especially the ω-3 fatty acid (FA), which have health benefits for the consumer (HARGIS et al., 1991; HARGIS and VAN ELSWYK, 1993; HAMMERSHOJ, 1995). In addition, according to YANNAKOPOULOS et al. (1997) dietary natural zeolite increases both egg weight and albumen weight, while yolk weight was not significantly affected. Tserveni-Gousi et al. (1997) reported that a positive response — especially in egg weight, albumen and yolk weight — can be achieved by feeding the hens with natural zeolite.

The ω-3 FA eicosapentaenoic acid (C_{20:5} ω-3-EPA) and docosahexanoic acid (C_{22:6}ω-3-DHA) have been associated with a decreased risk of heart related diseases (FARR, 1995). Linseed can be an attractive ingredient for animal feed because of the high crude protein (22%) and fat content (35%); however, its use can lead to a lower deposition of EPA and DHA in egg yolk.

The aim of this experiment was to examine the effects of feeding a mixture of ground or whole flaxseed with other fiber ingredients on the hen performance and egg quality as well as the fatty acid composition of egg yolk.

**Materials and Methods**

In one experiment thirty six laying hens (Lohmann LSL) forty three weeks old were randomly housed in 12 cages (three birds/cage) and assigned to four groups A, B, C and D (3 replicates/group). The experimental diets in the four treatment groups were similar in chemical composition except the fat (Table 1) and were given for 12 weeks.

Body weight/hen was taken at the start and the end of experiment. Feed consumption and egg production was recorded daily. Three times within each treatment 10 eggs were collected and the egg quality was evaluated by egg weight, shell color, Haugh units, specific gravity, albumen-yolk-shell weight, yolk color and shell thick-

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Table 2. Dietary effect on feed consumption, body weight and egg production

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Feed consumption (g/hen/d)</th>
<th>Average body weight (kg)</th>
<th>Hen day egg production (%)</th>
<th>Total egg number/hen</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>99.1 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.970</td>
<td>78.5</td>
<td>49.6</td>
</tr>
<tr>
<td>B</td>
<td>93.1 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.028</td>
<td>81.5</td>
<td>51.3</td>
</tr>
<tr>
<td>C</td>
<td>105.9 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.953</td>
<td>79.5</td>
<td>50.1</td>
</tr>
<tr>
<td>D</td>
<td>99.7 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.968</td>
<td>78.1</td>
<td>49.2</td>
</tr>
</tbody>
</table>

SE of difference 2.7 F-value 7.82

Table 3. Dietary effect on egg quality characteristics

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Egg weight (g)</th>
<th>Shell color</th>
<th>Haugh units</th>
<th>Specific gravity</th>
<th>Albumen weight (g)</th>
<th>Yolk weight (g)</th>
<th>Shell weight (g)</th>
<th>Yolk color</th>
<th>Shell thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>62.10 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>30.09</td>
<td>61.82</td>
<td>1.080</td>
<td>39.79</td>
<td>15.41 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.89</td>
<td>11.46 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.374</td>
</tr>
<tr>
<td>B</td>
<td>63.81 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.10</td>
<td>66.90</td>
<td>1.082</td>
<td>39.91</td>
<td>16.53 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.36</td>
<td>10.40 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.365</td>
</tr>
<tr>
<td>C</td>
<td>66.53 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.70</td>
<td>70.40</td>
<td>1.084</td>
<td>40.71</td>
<td>18.44 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.34</td>
<td>9.90 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.379</td>
</tr>
<tr>
<td>D</td>
<td>63.97 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.80</td>
<td>64.30</td>
<td>1.089</td>
<td>39.22</td>
<td>17.63 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.16</td>
<td>10.00 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.371</td>
</tr>
</tbody>
</table>

SE difference 2.62 F-value 2.88

Table 4. Dietary effect on yolk fatty acid composition

<table>
<thead>
<tr>
<th>Fatty acid (%)</th>
<th>Treatments</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&lt;sub&gt;16:0&lt;/sub&gt; (palmitic)</td>
<td>24.15 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.43 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>18.43 &lt;sup&gt;c&lt;/sup&gt;</td>
<td>20.50 &lt;sup&gt;bc&lt;/sup&gt;</td>
<td>8.40</td>
</tr>
<tr>
<td>C&lt;sub&gt;18:1&lt;/sub&gt; (oleic)</td>
<td>49.62 &lt;sup&gt;ab&lt;/sup&gt;</td>
<td>42.79 &lt;sup&gt;c&lt;/sup&gt;</td>
<td>46.92 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>43.63 &lt;sup&gt;bc&lt;/sup&gt;</td>
<td>4.22</td>
</tr>
<tr>
<td>C&lt;sub&gt;18:2&lt;/sub&gt; (linoleic)</td>
<td>13.73 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.14 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>15.50 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.40 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.69</td>
</tr>
<tr>
<td>C&lt;sub&gt;18:3&lt;/sub&gt; (linolenic)</td>
<td>0.40 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.87 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.86 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.17 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.89</td>
</tr>
<tr>
<td>C&lt;sub&gt;22:6n-3&lt;/sub&gt; (DHA)</td>
<td>1.33 &lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.72 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.53 &lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.54 &lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Discussion

Among the hen performance variables studied in this experiment, daily feed consumption differed between groups. Hens of group B (10% whole flaxseed) fed less (P < 0.05) whereas hens of group C (10% ground flaxseed + 2% zeolite) fed more (P < 0.05) than those of the other groups. Previous reports of flaxseed use in laying hen diets used whole or ground flaxseed (SCHEIDLER and FRÖNING, 1996) showed no significant difference between two forms for daily feed consumption. According to this.
finding the increased feed consumption reported in our study may be due to the effect of zeolite consumption, combined with flaxseed or alone.

Egg weight (Table 3) differed between groups (62.10, 63.81, 66.53 and 63.97 g for group A, B, C and D, respectively) being higher (P < 0.05) in hens fed 10% ground flaxseed (group C) and corresponded with the increased feed consumption of these hens (Table 2). According to the findings of SCHEIDELER et al. (1994) the effect of flax on egg size was not consistent. CASTON et al. (1994) have reported 2.8 and 3.6 g declines in egg weight after feeding 10% and 20% ground flaxseed, respectively, whereas FERRIER et al. (1995) found that egg weight was not significantly affected by the addition of 0%, 10% and 20% ground flaxseed in the hen diet.

The results of this study (Table 3) demonstrate a positive effect of ground flaxseed on yolk weight, the differences between whole vs ground flaxseed at 10% level showing an improvement (P < 0.05) with the ground type (16.53 vs 18.44 g). Different concentration (5% or 10%) of ground flaxseed did not affect (P > 0.05) the yolk weight (18.44 g and 17.63 g for group C and D, respectively). This finding does not support the report of SCHEIDELER and FRONING (1996) that there is a decrease in the average percentage of yolk in eggs produced by hens fed flaxseed diets and in the overall yolk size of eggs fed ground vs whole flaxseed. In our study the observed increased yolk size of hens fed flaxseed was accompanied by an increase in yolk linoleic acid (Table 4) supporting the suggestion of MARCH and Mc MILLAN (1990) that linoleic acid enhances synthesis of lipoproteins taken up by the developing yolk.

The effect of flaxseed on yolk color (Table 3) as it was determined by using a Roche fan was consistent. Eggs from hens fed ground or whole flaxseed had lighter (P < 0.05) yolk color than those of the control hens (11.46, 10.40, 9.90 and 10.00 for group A, B, C and D, respectively). It appears that the flaxseed pigments were not capable of incorporation into the egg yolks providing them with darker color. According the findings of SCHEIDELER and FRONING (1997) the degree of lightness/darkness of yolk was significantly affected by variety of flaxseed.

Linolenic acid (C 18: 3) was higher (P < 0.05 - Table 4) in the yolk egg of hens fed flaxseed regardless of the level or form of flaxseed (4.87, 4.86 and 3.17% for group B, C, D, respectively, against 0.40% for control group). According to the findings of CASTON and LEESON (1990) the linolenic acid of yolk egg from hens fed 10% flaxseed was 4.6%. A significant increase (P < 0.05 - Table 4) of DHA by 1.90–2.70 times higher in all eggs from hens fed flaxseed was found. DHA is synthesized by hens from LNA and EPA following the chain elongation and desaturation processes (FARRellar, 1994, VAN ELSWYK (1997) supports that the metabolic derivatives of LNA, EPA and DHA are deposited only in limited amounts regardless of the level or form of flaxseed fed. The high amounts of DHA found in our study as is possibly as to due to differences in utilization of dietary fat and in a potential fiber interaction with fat utilization. In groups B and C, especially, a combination of more fat and slightly more soluble fiber (flaxseed, alfameal and middlings) probably increased the DHA deposition in yolk. Palmitic acid was significantly (P < 0.05) decreased with dietary flaxseed inclusion (8.9, 23.6 and 8.5% for group B, C and D, respectively). FERRIER et al. (1995) found 3.5% decrease in the yolk palmitic acid of hens fed 10% ground flaxseed.

Linolenic acid was positively (P < 0.05) related with linoleic acid and negatively (P < 0.01) with palmitic acid of the yolk (Table 5). Regression analysis indicated that LNA increased by 0.6541 for every unit decrease of palmitic acid. The experimental findings of this study demonstrated that the flaxseed can be a valuable additive to the layer diet, since it modifies the fatty acid composition of egg yolk and thus increases the nutritional value of eggs.

Summary

In 36 laying hens (Lohmann LSL) forty three weeks old an experiment was conducted to examine for 12 weeks the effect of feeding a mixture of ground or whole flaxseed (5% and 10%) with other fiber ingredients on the hen performance and egg quality as well as the fatty acid composition of egg yolk. The diets varied especially in linolenic acid.

Results of this study indicated that body weight and hen day production was not affected (P > 0.05) by the type of diet whereas daily feed consumption was affected (P < 0.05).

Egg weight was higher (P < 0.05) in eggs of hens fed diet C (10% ground linseed). Also, the type of diet affected (P < 0.05) yolk weight and yolk color whereas the other egg quality parameters were similar between groups. Dietary flaxseed affected the egg fatty acid composition. A negative relationship between linolenic and palmitic acid was observed.

In conclusion, the dietary flaxseed can be a valuable additive to the layers diet, since modifies the fatty acid composition of egg yolk increasing the nutritional value of eggs with health benefits to humans.

Key words

Layers, nutrition, flaxseed, fatty acid composition, performance, egg quality

Zusammenfassung

Einfluß des Einsatzes von Leinsaat im Legehennenfutter auf die Leistung, die Eiqualität und das Fettsäuremuster im Dotter

In einer Untersuchung bei 36 Legehennen (Lohmann LSL) im Alter von 30 Wochen wurde über eine Versuchsdauer von 12 Wochen der Einfluß einer Fütterung mit ganzer oder geschroteter Leinsaat (5 und 10%) in Kombination mit anderen Rohfasersubstanzen auf die Leistung, die Eiqualität und das Fettsäuremuster im
Dotter überprüft. Die Versuchsrationen variierten in erster Linie im Hinblick auf den Gehalt an Linolensäure.

Die Untersuchung ergab, daß weder das Lebendgewicht noch die Legeleistung über die Fütterung beeinflußt wurde (P > 0.05). Demgegenüber haben sich die Futterrationen signifikant auf die Futteraufnahme ausgewirkt (P < 0.05). Die höchsten Eiweißwerte wurden beim Einsatz der Futterration C (10% geschrotete Leinsaat) erzielt (P < 0.05). Die Futterrationen hatten einen signifikanten Einfluß auf das Dottergewicht und die Dotterfarbe, während die anderen Kriterien der Eiqualität nicht durch die Behandlung beeinflußt waren. Die Leinsaat im Futter hatte einen deutlichen Einfluß auf das Fettsäuremuster des Dotter in dem Dotter verbessert den Nährwert des Eies für den Menschen und wirkt sich positiv auf seine Gesundheit aus.

Stichworte
Legehennen, Fütterung, Leinsaat, Fettsäuremuster, Leistung, Eiqualität

References

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