The Influence of Different Vegetable Oils on Some ω-3 Polyunsaturated Fatty Acids in Broiler Chickens Breast

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Abstract
Taking into consideration that the vegetable oils added to the combined fodder can significantly modify the fatty acids profile in broiler food, through its redirection even the fatty acids profile of carcasses can be modified through enrichment in certain fatty acids and obtaining functional foods. Therefore an experiment was conducted on broilers, made up of three experimental groups, fed with a combined base fodder in which 2% of different fat sources have been incorporated (sunflower oil, soybean oil, linseed oil). After the 42 days growth period, the fatty acids profile, % of fatty acids in 100 g product (EPA, DPA, DHA), ∑ SFA, ∑ MUFA, ∑ PUFA of the chicken from the experimental groups, were determined. Fatty acids were determined using gas chromatography. The data obtained after statistic processing and interpretation have highlighted the fact that, concerning the fatty acids profile in the chickens breast, we can observe variations of the determined fatty acids content, what shows us that they can be influenced through dietary factors, but there quantity being determined by the participation % of the energy sources (vegetable oils), but also by the fatty acids content of the participating raw materials.

Keywords: essential fatty acids, ω-3 fatty acids, energetic sources, fatty acids profile, ω-3 enriched foods

1. Introduction
In order to satisfy the energy demand in different bird categories, and, especially, in broilers, different energy sources are used (animal fat, vegetable oils) without, though, taking into consideration the fatty acids content or profile. Thus, one can influence the fatty acids profile in broiler carcasses, unbalancing the omega-6 and omega-3 polyunsaturated fatty acids ratio (linoleic acid:linolenic acid) [1][2][3][4]. Taking into consideration that, in human consumption, chicken meat and chicken meat products have a great importance (50%), they insure a great deal of polyunsaturated omega-3 and omega-6 fatty acids in food. It is known that, at present, the modern man has unbalanced eating habits with an unbalanced ω-6:ω-3 ratio (20-25:1, compared to the recommended 1:2:1), thus a reduced content of ω-3 in food. [5][6][7][8]. By enriching different food stuff with ω-3 fatty acids, a new segment of functional products has appeared on the market, enriching food stuff with ω-3 fatty acids being preferred to nutritional supplements with this ingredient.

In the present paper we have presented a third set of results [9][10] regarding the possibilities of influencing the ω-6, ω-3 fatty acids profile and its ratio in broiler feed by using three energy sources (sunflower oil, soya bean oil, linseed oil) in a 2% ratio, as well as the fatty acids content in broiler breast meat.

2. Materials and methods
In order to study the effects of the added oils in broiler feed on the polyunsaturated fatty acids profile, we have conducted an experiment in accordance to the protocol presented in table 1 from which the following have been deduced:
The broilers from the three experimental groups have been fed with two types of combined fodder with the same basic components that insured in the period between 1 and 21 days, 9 % CP and 3235 kcal ME/kg respectively 20% CP and 3224 kcal ME/kg in the second growth period, 22 to 42 days.

The differentiation factor in fodder between the experimental groups was introduced, in a 2% ratio of sunflower oil in L1, soybean oil in L2 and linseed oil in L3.

Polyunsaturated fatty acids profile ω-3 (EPA eicosapentaenoic acid, DPA docosapentaenoic acid and DHA docosahexaenoic acid) in broiler breast meat was done using gas chromatography.

The primary experimental data were statistically processed using the international software SPSS 16. (ANOVA), the Mann-Whitney test, the student test, (MINITAB 15) in order to test the difference significance and, as for calculus, the Microsoft Office Excel program.

### Table 1 General organization scheme of the experiment

<table>
<thead>
<tr>
<th>Specification</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-21 days</td>
<td>BR1+ 2%SFO*</td>
<td>BR1+2%SBO*</td>
<td>BR1+2%LO*</td>
</tr>
<tr>
<td></td>
<td>23.05 CP%</td>
<td>23.05 CP%</td>
<td>23.05 CP%</td>
</tr>
<tr>
<td></td>
<td>ME 3245kcal/kg</td>
<td>ME 3245kcal/kg</td>
<td>ME 3245kcal/kg</td>
</tr>
<tr>
<td>22-42 days</td>
<td>BR 2+2%SFO*</td>
<td>BR 2+2% SBO*</td>
<td>BR 2+2% LO*</td>
</tr>
<tr>
<td></td>
<td>20.77 CP%</td>
<td>20.77 CP%</td>
<td>20.77 CP%</td>
</tr>
<tr>
<td></td>
<td>ME 3204kcal/kg</td>
<td>ME 3204kcal/kg</td>
<td>ME 3204kcal/kg</td>
</tr>
<tr>
<td>Participation ratio of the energy source 2% (g)</td>
<td>Linoleic</td>
<td>Linolenic</td>
<td>Linoleic</td>
</tr>
<tr>
<td>Linoleic:Linolenic Ratio in the BR</td>
<td>BR1</td>
<td>1.220</td>
<td>0.004</td>
</tr>
<tr>
<td>BR2</td>
<td>7.04</td>
<td>3.47</td>
<td>0.6</td>
</tr>
</tbody>
</table>

ESTABLISHED INDICATORS
- establishing and characterizing the fatty acids profile in the pieces taken into consideration (breast muscles and skin);
- establishing the saturated, monounsaturated and polyunsaturated fatty acids quantity.

### 3. Results and discussion

Introducing a 2% ration of sunflower, soybean and linseed oil in the combined fodder construction for broilers in the three experimental groups modify the polyunsaturated fatty acids ratio ω-6:ω-3 in food. Thus, the most unbalanced ratio, of 7.04:1 was registered for the experimental group L1, in which the lipid source was sunflower seed oil.

The most balanced ratio, of 0.60:1, was obtained for the experimental group L3, in which the lipid source was linseed oil.

**Fatty acids profile**

Regarding the fatty acids values determined in breast (muscle and skin), they were established at the end of the experimental period (42 days) with the help of gas chromatography.

After statistically processing the data, we have observed significant differences between the experimental groups regarding the EPA, DPA, DHA fatty acids content in breast muscles and skin, as shown in table2.

Regarding the essential polyunsaturated fatty acids (ω-3) **EPA** (eicosapentaenoic acid), **DPA** (docosapentaenoic acid) and **DHA** (docosahexaenoic acid), in light of recent studies, it was demonstrated that they have a special importance through their protection role of the heart and circulatory system, as well as in the protection of the brain, and an important role in the fight against cancerogenous cells.

Significant differences regarding the EPA content were registered between L1 and L2 for breast skin; there have been no registered differences
regarding this acid's content in breast muscles (p>0.005).
Also, there have been no significant differences (p>0.05) regarding the content of this acid by
comparing the data of L1 and L3, for breast muscles and breast skin.
By statistically processing the data obtained from
groups L2 and L3 we could not observe statistic
differences (p>0.05) in breast muscles.
By comparing the data obtained regarding DHA in
the experimental groups we can affirm that:
There have been significant differences (p<0.001)
between L1 and L2 for breast muscles and skin.
But, by comparing the data obtained from L1 and
L3, there are significant differences registered for
breast muscles (p<0.001) and breast skin (p<0.01).
Between the groups L2 and L3 there are statistic
differences for breast muscles (p<0.001) and
breast skin (p<0.05).

By comparing the obtained data regarding the
DPA acid in the experimental groups we can affirm that:
Regarding this acid, the statistic differences were
between the groups L1 and L2 for breast skin
(p<0.05) but there were no significant differences
registered for breast muscles (p>0.05).
The only statistic difference registered between
the groups L1 and L3, by comparing the pieces
taken into consideration was registered in breast
muscles (p<0.05).
Comparing the values obtained by statistically
comparing the groups L2 and L3, it can be said
that there are significant differences in abdominal
fat (p<0.001), thigh skin (p<0.01) and breast skin
(p<0.05).
The above mentioned data come to confirm the
results obtained by [11] that explains that different
fat sources significantly modify fat quality and
fatty acids structure, respectively.

Table 2. Statistical indicators of fatty acids (EPA, DPA, DHA) in the breast of the chicken from the
experimental groups

<table>
<thead>
<tr>
<th>Specification</th>
<th>L1- sunflower oil</th>
<th>Breast</th>
<th>CV%</th>
<th>Breast skin</th>
<th>CV%</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA</td>
<td>0.0007 ± 0.0000</td>
<td>1.25</td>
<td>0.0008 ± 0.0000</td>
<td>6.79</td>
<td></td>
</tr>
<tr>
<td>DPA</td>
<td>0.0007 ± 0.0000</td>
<td>7.50</td>
<td>0.0007 ± 0.0000</td>
<td>11.25</td>
<td></td>
</tr>
<tr>
<td>DHA</td>
<td>0.0014 ± 0.0000</td>
<td>1.33</td>
<td>0.0007 ± 0.0000</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>L2- soybean oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA</td>
<td>0.0330 ± 0.0011</td>
<td>6.00</td>
<td>0.0552 ± 0.0007</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>DPA</td>
<td>0.0330 ± 0.0015</td>
<td>8.00</td>
<td>0.0690 ± 0.0079</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>DHA</td>
<td>0.0330 ± 0.0007</td>
<td>4.00</td>
<td>0.0966 ± 0.0007</td>
<td>1.43</td>
<td></td>
</tr>
<tr>
<td>L3- linseed oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA</td>
<td>0.0006 ± 0.0000</td>
<td>10.00</td>
<td>0.0976 ± 0.0106</td>
<td>18.75</td>
<td></td>
</tr>
<tr>
<td>DPA</td>
<td>0.0005 ± 0.0000</td>
<td>5.56</td>
<td>0.1098 ± 0.0106</td>
<td>16.67</td>
<td></td>
</tr>
<tr>
<td>DHA</td>
<td>0.0003 ± 0.0000</td>
<td>6.67</td>
<td>0.0549 ± 0.0021</td>
<td>6.67</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Fatty acids content (EPA DPA DHA)/ 100 g product of chicken in the experimental groups

<table>
<thead>
<tr>
<th>Specification</th>
<th>L1- Sunflower oil</th>
<th>Breast</th>
<th>g/100g product</th>
<th>Breast skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA</td>
<td>0.0008</td>
<td>0.0552</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPA</td>
<td>0.0008</td>
<td>0.0690</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHA</td>
<td>0.0015</td>
<td>0.0966</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2- soybean oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA</td>
<td>0.0008</td>
<td>0.0330</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPA</td>
<td>0.0007</td>
<td>0.0330</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHA</td>
<td>0.0007</td>
<td>0.0330</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L3- linseed oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA</td>
<td>0.0006</td>
<td>0.0976</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPA</td>
<td>0.0006</td>
<td>0.1098</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHA</td>
<td>0.0004</td>
<td>0.0549</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
By analyzing the obtained values through summing saturated fatty acids ($\sum$SFA), monounsaturated fatty acids ($\sum$MUFA) and polyunsaturated fatty acids ($\sum$PUFA) in broiler breast from the experimental groups, the following conclusions can be expressed:

The MUFA/SFA ratio indicates that the highest values of this ratio have been registered by L3 (linseed oil) in breast skin BS (1.13:1), and the lowest value was registered by L2 (soybean seed oil) in breast skin BS (0.49:1).

The PUFA/SFA ratio shows that the highest value was registered by L3 (linseed oil) for BS (1.20:1), and the lowest value was registered by L2, still for BS (0.42:1).

Regarding the MUFA+PUFA/SFA ratio, the highest value was registered by L3, in BS (2.34:1), and the lowest value belonged to L2, in BS (0.91:1).

Regarding the linoleic (ω-6) and linolenic (ω-3) acids ratio, the most unbalanced ratio was registered by L1 (B 25.37:1; BS 27.16:1), followed by L2 for all the pieces taken into consideration. The closest values to the ones desired by nutritionists were registered for L3 (B 3.32:1; BS 3.00:1).

**Eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA).**

Are essential ω-3 fatty acids that are especially found in fish meat (salmon and shark) and, in small quantities, in chicken meat.

The highest values for these acids were registered by group L3 in breast skin (DPA 0.1098g/100g product), followed by L1 (BS EPA 0.0552g/100g product; DPA 0.0690g/100g product and DHA 0.966g/100g product) and L2 (BS EPA 0.0330g/100g product; DPA 0.0330g/100g product and DHA 0.0330g/100g product). The lowest values were registered by L3 in breast muscles (EPA 0.0006g/100 g product, DPA 0.0006g/100g product and DHA 0.0004g/100g product). The data are presented in table 3.

### 4. Conclusions

Regarding the fatty acids content taken into consideration for 100 g product, the following can be concluded:

- **EPA.** The highest quantity was determined (established) in L3 in Pp (0.976g/100g product) and the lowest value was also registered in L3, in P (0.0006g/100g product);
- **DPA.** The highest quantity was determined in L3 in Pp (0.1098/100g product) and the lowest value was also registered in L3, in P (0.0006g/100g product).
- **DHA.** The highest quantity was registered in L1 for Pp (0.0966g/100g product), and the lowest value was registered in L3, in P (0.0004g/100g product).

- The MUFA/SFA ratio show that the highest values of this ratio were registered by L3 in BS (1.13:1), and the lowest value was registered by L2 in BS (0.49:1).
- The PUFA/SFA ratio show that the highest value was registered by L3 in BS (1.20:1) and the lowest ratio was registered in BS (0.42:1) by L2.
- The MUFA+PUFA/SFA ratio show that the highest value was registered by L3 in BS (2.34:1) and the lowest value of this ratio was registered by L2 BS (0.91:1).

- Regarding the linoelic (ω-6) and linolenic (ω-3) acid ratio, it can be said that the most desired ratio was registered in L3 BS (3:1), at the other end being L1 BS (27.16:1).
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References

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