

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

Dragoş-Sorin Fota, Lavinia Ştef, Dan Drinceanu, Izabella Fota, Rodica Căpriţă, Eliza Simiz

Banat's University of Agricultural Sciences and Veterinary Medicine, 300645, Timișoara, Calea Aradului Nr.119, Romania

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), Σ SFA, Σ MUFA, Σ PUFA of the chicken from the experimental groups, were determined. Fatty acids were determined using gaschromatography. 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, soy 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:

* Corresponding author: Dragoş-Sorin Fota, dragosfota@animalsci-tm.ro

- 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

Specification		L1	L2	L3			
Period	1 -21 days	BR1+ 2%SFO*	BR1+2%SBO*	BR1+2%LO*			
		23.05 CP%	23.05 CP%	23.05 CP%			
		ME 3245kcal/kg	ME 3245kcal/kg	ME 3245kcal/kg			
	22-42 days	BR 2+2%SFO*	BR 2+2% SBO*	BR 2+2% LO*			
		20.77 CP%	20.77 CP%	20.77 CP%			
		ME 3204kcal/kg	ME 3204kcal/kg	ME 3204kcal/kg			
Content of linoleic and linolenic ac. in the energy source /100kg CF							
Participation ratio of the energy source 2% (g)		Linoleic Ac.	Linolenic Ac.	Linoleic Ac.	Linolenic Ac.	Linoleic Ac.	Linolenic Ac.
		1.220	0.004	1.158	0.176	0.350	0.950
Linoleic:Linolenic Ratio in the BR	BR1	7.39		3.58		0.6	
	BR2	7.04		3.47		0.6	

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 gaschromography.

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 cancerigenous 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

Specification	L1- sunflower oil			
	Breast		Breast skin	
	$\bar{x} \pm SE$	CV%	$\bar{x} \pm SE$	CV%
EPA	0.0007 ± 0.0000	1.25	0.0008 ± 0.0000	6.79
DPA	0.0007 ± 0.0000	7.50	0.0007 ± 0.0000	11.25
DHA	0.0014 ± 0.0000	1.33	0.0007 ± 0.0000	2.50
L2- soybean oil				
EPA	0.0330 ± 0.0011	6.00	0.0552 ± 0.0007	2.50
DPA	0.0330 ± 0.0015	8.00	0.0690 ± 0.0079	20.00
DHA	0.0330 ± 0.0007	4.00	0.0966 ± 0.0007	1.43
L3- linseed oil				
EPA	0.0006 ± 0.0000	10.00	0.0976 ± 0.0106	18.75
DPA	0.0005 ± 0.0000	5.56	0.1098 ± 0.0106	16.67
DHA	0.0003 ± 0.0000	6.67	0.0549 ± 0.0021	6.67

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

Specification	L1- Sunflower oil g/100g product	
	Breast	Breast skin
EPA	0.0008	0.0552
DPA	0.0008	0.0690
DHA	0.0015	0.0966
L2- soybean oil g/100g product		
EPA	0.0008	0.0330
DPA	0.0007	0.0330
DHA	0.0007	0.0330
L3- linseed oil g/100g product		
EPA	0.0006	0.0976
DPA	0.0006	0.1098
DHA	0.0004	0.0549

Table 4 Values of the different ratios between SFA, MUFA and PUFA

Specificație	g/100g grăsime					
	L1		L2		L3	
	B	BS	B	BS	B	BS
(1)ΣSFA	35.69	37.08	45.32	47.29	40.70	26.54
(2)ΣMUFA	37.15	31.28	24.12	23.32	24.13	30.07
(3)ΣPUFA	23.14	24.13	20.30	20.07	26.52	32.14
(2:1)	1.04	0.84	0.53	0.49	0.59	1.13
(3:1)	0.64	0.65	0.44	0.42	0.65	1.20
(2+3:1)	1.68	1.49	0.98	0.91	1.24	2.34
(2+3)	60.29	55.41	44.43	43.39	50.66	62.22
(Ac. L ω-6:Ac. L ω-3)	2537	27.16	11.73	12.00	3.32	3.00

By analyzing the obtained values through summing saturated fatty acids (ΣSFA), monounsaturated fatty acids (ΣMUFA) and polyunsaturated fatty acids (ΣPUFA) 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/UFA ratio show 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/100 g product; DPA 0.0690g/100g product and DHA 0.966g/100g product) and L2 (BS EPA 0.0330g/100 g 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 B (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 lionoleic (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).

Acknowledgements

I would like to thank my wife, Izabella Fota and miss Miruna Dobândă for the support in translating this paper

References

1. Meluzzi, A., Siri, F., Functional eggs: Fortification with n-3 PUFA, CLA and antioxidants. *J. Food Sci.* 2004, 14, 159-166
2. Bourre, J. M., Where to find omega-3 fatty acids and how feeding animals with diet enriched in omega-3 fatty acids to increase nutritional value of derived products for human: what is actually useful?, *J. Nutr. Health Aging* 2005 Jul-Aug; 9 (4), 232-42
3. Haug, A., Eich-Greatorex, S., Bernhoft, A., Jens P Wold, Harald Hetland, Olav A Christophersen, and Trine Sogn; Effect of dietary selenium and omega-3 fatty acids on muscle composition and quality in broilers, *Lipids Health Dis* Norvegia 2007
4. Mierliță, D., Chereji, I., Maurescu, C., The effects of different fat sources on the performance of broiler chickens and on the fatty acid composition of selected tissues Vol 64, No 1-2: *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Animal Science and Biotechnologies USAMV-CN*, 2007, Vol 64, No 1-2
5. Simopoulos, A. P., The future direction of nutrition research: A nutrition and food sciences agency is the key to progress. *J. Nutr.* 1989, 119, 137-139
6. Simopoulos, A. P., Redefining dietary recommendations and food safety. *World Rev. Nutr. Diet.* 1998, 83, 219-222
7. Simopoulos, A. P., Human Requirement for n-3 Polyunsaturated Fatty Acids, *Poultry Science*, 2000, 79, 961-970
8. Simopoulos, A. P., and Visioli, F., ed., *Mediterranean Diets* Karger 2000 (S Karger, AG), Basel, Switzerland.
9. Fota, D. S., Drinceanu, D., Ștef L., Gergen, I, Alexa, E., Simiz, E., Baliga, I., Luca, I., The Effects of Different Fat Sources on Bioproductive Performances and Essential Fatty Acids Composition in Broiler Breast, *Animal Sciences and Biotechnologies*, 2010, 43 (1)
10. Fota, D. S., Ștef, L., Drinceanu, D., Fota, I., Căpriță, R., Simiz, E., The Effects of Different Fat sources on the Bioproductive Performances and the Essential Fatty Acids Composition of Tights and Abdominal Fat in Broilers, *Lucrari Stiintifice-Seria Zootehnie*, 2011, Vol. 56, in press
11. Palfy, T., Erdelyi, I., The Effects of Different Fat Sources on Broiler Performance and Fatty Acid Composition. *Sustainable Agriculture Across Borders in Europe*, 2005, pp.234-238