NUTRITIONAL STRATEGIES IN CHANGING FATTY ACID PROFILE OF FEED FOR BROILERS IN ORDER TO PRODUCE FUNCTIONAL FOOD OF ANIMAL ORIGIN

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Abstract

Numerous medical findings show that in development of cardiovascular and other chronic diseases in humans, the relationship between two groups of polyunsaturated fatty acids in diet plays a significant role: omega 6 acids whose basic representative is linoleic acid (C18: 2 n-6) and omega 3 acids whose basic representative of α-linolenic acid (C18: 3 n-3). Human needs are approximately two to six times higher in omega 6 than in omega 3 fatty acids, so the optimal ratio of omega 6 and omega 3 fatty acids would be 4: 1. In monogastric animals such as poultry and pigs, the fatty acids in feed are absorbed in the gastrointestinal tract largely unchanged, which means that the fatty acid profile of the tissue directly reflects the fatty acid profile in the animal's diet. The daily intake of unsaturated fatty acids can be increased by an adequate animal nutrition strategy. The largest amount of unsaturated fatty acids in flax seeds (about 70%) is α-linolenic acid (ALA), which is a precursor of the entire omega 3 series of fatty acids, which makes flax seed an ideal raw material for the production of a wide range of omega 3 enriched food of animal origin. In order to obtain products under the commercial name Domestic chicken omega 3, an experiment was organized with a specific diet for broilers in fattening, with the replacement of classic raw materials rich in omega 6 fatty acids, with exuded flax seed, obtained feed for broilers with an ideal fatty acid profile. Thanks to such a designed meal for broilers, it is possible to get products with a significantly higher amount of omega 3 fatty acids.

Key words: *broilers, feed, fatty acid profile, homemade omega 3 chicken, flax seeds*

1. INTRODUCTION

Meat and meat products are high quality food, and have pronounced nutritional and biological properties. In addition to the quantitative increase in meat production in the world, it is necessary that the meat has impeccable quality and long-term sustainability. Numerous medical findings show that in the development of cardiovascular and other chronic diseases in humans a significant role have the relationship between two groups of polyunsaturated fatty acids in the diet: omega 6 acids whose basic representative is linoleic acid (C18:2 n-6) and omega 3 acids whose basic representative is alpha linolenic acid (C18: 3 n-3). Due to the many potential benefits of the presence of omega 3 fatty acids in the diet, consumer demands for omega 3 enriched foods of animal origin are also growing (Sanders, 2000). The reaction of desaturation and elongation of the chain of alpha-linolenic and linoleic acids, in which their derivatives, polyunsaturated fatty acids, are formed, is catalyzed by the same enzyme - desaturase (Gabiana, 2005). Since the reaction is catalyzed by the same enzyme, there is competition between these essential fatty acids for this enzyme, so that increasing the concentration of linoleic acid may inhibit the conversion of alpha-linolenic acid to its derivatives (Daun et al., 2003). On the other hand, a diet rich in alpha-linolenic acid can reduce the production of linoleic or arachidonic acid derivatives, which disrupts the ratio of omega 3 and omega 6 fatty acids in the body. Although the ratio of omega 6 and omega 3 fatty acids in humans who lived in the Paleolithic was 1: 1, the modern way of eating and living has disrupted this ratio, which is often higher than 25: 1 today. It is believed that in a proper diet, humans should have approximately two to six times more omega 6 than omega 3 fatty acids,

so that the optimal ratio of omega 6 and omega 3 fatty acids would be 4: 1 (Sanders, 2000). The ability to produce omega 3 fortified poultry meat is very interesting for many producers and consumers. In monogastric animals such as poultry and pigs, the fatty acids present in feed are absorbed in the gastrointestinal tract largely unchanged, meaning that the tissue fatty acid profile directly reflects the fatty acid profile present in the animal's diet (Gunstone, 2001). There are many examples in the literature that the introduction of certain practices in the diet and breeding of production animals can increase the content of omega 3 unsaturated and other desirable fatty acids in meat. If a certain animal nutrition strategy is adopted, the results may be visible in a shorter period of time (Maddock et al., 2005).

2. FLAX SEEDS AS A SOURCE OF UNSATURATED FATTY ACIDS

The daily intake of unsaturated fatty acids can be increased directly, by enriching food of animal origin with omega 3 unsaturated fatty acids or indirectly with a certain animal nutrition strategy, but the source of omega 3 unsaturated fatty acids in the broiler diet may be different (Dimić, 2005). If we use only supplements of plant origin (flaxseed or oil), the amount of omega 3 fatty acids in the intramuscular adipose tissue will increase, while the amount of omega 6 unsaturated fatty acids will decrease (Krčmar, 2008). It is important to note that fat and fatty acids in muscle tissue are located within and between muscle fibers, with fat within muscle fibers being concentrated in fat cells that are isolated or located in clusters along muscle fibers and consist predominantly of triacylglycerols, phospholipids and cholesterol (Ivanov et al., 2002) As the composition of fatty acids in triacylglycerols changes primarily under the influence of food, it is clear that in that case the composition of fatty acids in intramuscular adipose tissue also changes (Maddock et al., 2005).

In the diet of broilers, soybeans, sunflowers are used as fat sources, but also other oilseeds that are a source of fatty acids from the omega 3 and omega 6 series (Table 1).

Omega 3	Omega 6
Linseed oil	Sunflower oil
Rapeseed oil	Corn oil
Walnuts	Pumpkin seed oil
	Nuts

Table 1. The most important plant sources of omega 3 and omega 6 fatty acids

Flax seeds contain an optimal fatty acid composition and, comparing it with other oilseeds, in terms of energy content, they are between soybeans and sunflowers, and in terms of crude protein content, they are similar to oilseed rape and cotton seeds (Dimić, 2005). Due to all these characteristics, flax has become an important part of animal feed. What makes it a nutritionally valuable feed is the fact that in addition to a large percentage of dietary fiber, it also contains ten times more unsaturated (32.26%) fatty acids compared to the amount of saturated (3.66%) fatty acids present (Kišgeci, 2002). The largest amount of unsaturated fatty acids (about 70%) is alpha-linolenic acid (ALA), which is a precursor of the entire omega 3 series of fatty acids, which makes flaxseed an ideal raw material for the production of a wide range of omega 3 fortified food of animal origin (Damn and Przybylski, 2000). The mentioned fact distinguishes flax seeds in relation to other conventional energy sources that are routinely used in the diet of broilers (corn, soy, sunflower) which contain a significantly higher amount of omega 6 fatty acids compared to the content of omega 3 fatty acids (Table 2).

Dry matter, %	90,0
Crude proteins, %	26,0
Crude fiber, %	9,0
Crude lipid, %	25,0
Crude ash, %	5,0
NDF, %	22,38
ADF, %	12,36
ADL, %	5,65
Starch, %	4,0
Sugars, %	5,0
Calcium, g/kg	5,0
Phosphorus, g/kg	8,0
Magnesium, g/kg	4,0
Potassium, g/kg	11,0
Sodium, g/kg	0,58
Chlorine, g/kg	0,64
Sulfur, g/kg	3,86
Manganese, mg/kg	38,20
Zinc, mg/kg	53,0
Copper, mg/kg	10,0
Iron, mg/kg	157,60
Selenium, mg/kg	0,44
Cobalt, mg/kg	0,04
Molybdenum, mg/kg	0,76
Iodine, mg/kg	0,28
C14:0, g/kg	0,2
C16:0, g/kg	14,0
C16:1, g/kg	0,3
C18:0, g/kg	10,0
C18:1, g/kg	44,0
C18:2, g/kg	38,0
C18:3, g/kg	136,0

Energetic value		Pigs	Sows	Poultry
DE	kcal/kg	4015	4210	
ME	kcal/kg	3845	3966	3390
NE	kcal/kg	2861	2927	

Vitamin E	mg/kg	5,60
Vitamin B1	mg/kg	2,16

Vitamin B2	mg/kg	2,50
Vitamin B6	mg/kg	4,40
Vitamin B12	mg/kg	--
Niacin	mg/kg	74,2
Pantothenic acid	mg/kg	3,60
Folic acid	mg/kg	0,33
Biotin	mg/kg	0,36
Choline	mg/kg	2615

Table 2. Chemical composition of extruded flax seed

3. MATERIAL AND METHODS

In order to obtain products under the commercial name Domestic chicken omega 3, an experiment was organized with a specific diet of broilers in fattening, where the replacement of classic raw materials used in the diet of broilers in our area, rich in omega 6 fatty acids (soybean meal, and corn grain) with exuded flax seed (source of omega 3 fatty acids) obtained feed for broilers with an ideal fatty acid profile. After slaughter, the meat, breast, drumstick, liver and subcutaneous adipose tissue of free-range chickens fed conventional feed and chickens fed with the feed with addition of extruded flax seeds were subjected to detailed analyzes which determined: average nutritional value, energy value expressed in kJ and kcal, protein content, polyunsaturated and monounsaturated fatty acid content, carbohydrate content, salt content, fatty acid profile, cholesterol, water / dry matter ratio, instrumental skin color determination, comparative sensory analysis and saturated fatty acid content.

4. RESULTS

Based on the performed analyzes, the following results were obtained:

Chemical analyzes	Method code	Unit of measure	Prescribed value	The result
Energetic value	/	kJ/100g	/	664.25
Energetic value	/	kcal/100g	/	158.99
Salt content	/	g/100g	/	0.15
Protein content	02H.01.012	%	/	19.11
Sugar content	02H.01.016	%	/	0.14
Carbohydrate content	02H.01.016	%	/	0.14
C18:2 n-6	02H.01.028	g/100g sample	/	2,56
C18:3 n-3	02H.01.028	g/100g sample	/	0,174
C18:3 n-6	02H.01.028	g/100g sample	/	0,021
C20:3 n-3	02H.01.028	g/100g sample	/	0,000
C20:5 n-3	02H.01.028	g/100g sample	/	0,003

C22:6 n-3	02H.01.028	g/100g sample	/	0,006
Ratio n-6/n-3 fatty acids	02H.01.028	/	/	14,38
Eicosapentaenoic (EPA) and docosahexaenoic (DHA) acid content	02H.01.028	g/100g sample	/	0,01
Total monounsaturated fatty acids	02H.01.028	g/100g sample	/	3,76
Total n-3 fatty acids	02H.01.028	g/100g sample	/	0,18
Total n-6 fatty acids	02H.01.028	g/100g sample	/	2,59
Total polyunsaturated fatty acids	02H.01.028	g/100g sample	/	2,78
Total saturated fatty acids (C14:0, C15:0, C16:0, C17:0, C18:0, C20:0, C24:0)	02H.01.028	g/100g sample	/	2,57
Cholesterol content	02H.01.029	mg/100g	/	38,04
Sodium	02R.01.214	g/100g	/	0.06
Dry matter content	SRPS ISO 1442:1998	%	/	28.72
Water content	SRPS ISO 1442:1998	%	/	71.28
Lipid content	SRPS ISO 1444:1998	%	/	9,11

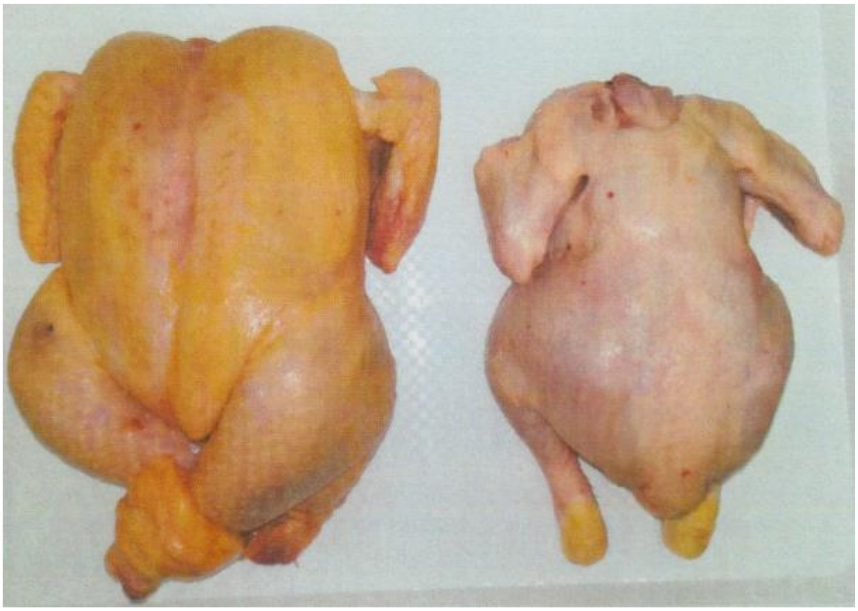
Table 3. Composition of chicken meat fed with conventional feed

Chemical analyzes	Method code	Unit of measure	Prescribed value	The result
Energetic value	/	kJ/100g	/	675,25
Energetic value	/	kcal/100g	/	161,75
Salt content	/	g/100g	/	0.18
Protein content	02H.01.012	%	/	18,56
Sugar content	02H.01.016	%	/	0,12
Carbohydrate content	02H.01.016	%	/	0,12
C18:2 n-6	02H.01.028	g/100g sample	/	3,24
C18:3 n-3	02H.01.028	g/100g sample	/	0,69
C18:3 n-6	02H.01.028	g/100g sample	/	0,022
C20:3 n-3	02H.01.028	g/100g sample	/	0,004
C20:5 n-3	02H.01.028	g/100g sample	/	0,007
C22:6 n-3	02H.01.028	g/100g sample	/	0,000
Ratio n-6/n-3 fatty acids	02H.01.028	/	/	4,57
Eicosapentaenoic (EPA) and docosahexaenoic (DHA) acid content	02H.01.028	g/100g sample	/	0,021
Total monounsaturated fatty acids	02H.01.028	g/100g sample	/	3,34
Total n-3 fatty acids	02H.01.028	g/100g sample	/	0,71
Total n-6 fatty acids	02H.01.028	g/100g sample	/	3,26

Total polyunsaturated fatty acids	02H.01.028	g/100g sample	/	4,00
Total saturated fatty acids (C14:0, C15:0, C16:0, C17:0, C18:0, C20:0, C24:0)	02H.01.028	g/100g sample	/	2,33
Cholesterol content	02H.01.029	mg/100g	/	25,41
Sodium	02R.01.214	g/100g	/	0.07
Dry matter content	SRPS ISO 1442:1998	%	/	28,70
Water content	SRPS ISO 1442:1998	%	/	71,30
Lipid content	SRPS ISO 1444:1998	%	/	9,67

Table 4. The composition of the meat of chickens fed with designed feed with the addition of extruded flax seeds

Thanks to the designed meal for broilers in fattening, we also got products (meat, breast, drumstick, liver, subcutaneous fat) with a significantly higher amount of omega 3 fatty acids compared to the same products obtained from broilers fed in the usual way, or almost ideally achieved ratio between omega 6 and omega 3 fatty acids in the tested products (5-6: 1). Picture 1 shows the carcass of broilers fed with designed feed with the addition of extruded flax seeds (left) and broilers fed with conventional feed (right). Picture 2 shows a drumstick with a carabat of broilers fed with designed feed with the addition of extruded flax seeds (above) and broilers fed with conventional feed (below).



Picture 1. Carcass of broilers fed with designed feed with the addition of extruded flax seeds (left) and broilers fed with conventional feed (right)

Picture 2. Drum with carabat of broilers fed with designed feed with the addition of extruded flax seeds (above) and broilers fed with conventional feed (below)

5. DISCUSSION

The carcass fatty acid profile directly reflects the fatty acid profile in the animal's diet (Eastwood, 1993). Since flaxseed has a desirable fatty acid composition, many producers are interested in improving it in the final fattening of pigs and poultry, to improve the fatty acid composition of adipose tissue and pig meat. In the diet of pigs, soybeans, sunflowers are used, as well as other oilseeds that contain fatty acids from the n-3 series and fatty acids from the n-6 series (Marković et al., 2011).

Similar experiments on pigs were performed by Huang et al., (2008) where the sources of fat in the diet of experimental groups were different in different periods of fattening (from 30-60 kg and 60-115 kg), and accordingly after chemical analysis of that food was also a different fatty acid composition of these meals. Thus, one experimental group received through food received saturated fatty acids (palmitic C16: 0 70-80%; stearic C18: 0 5-10% and oleic C18: 1 8-15%) in powder, and the other experimental group received through food 10% flax. Therefore, the content of total SFA, MUFA and PUFA differed between the experimental groups. After the chemical analysis, the experimental group that received flax had significantly less SFA (15.22%) and more PUFA (58.69%) compared to the group that received saturated fatty acids (75.02% and 13.13 %). In this experiment, the SFA / PUFA ratio was also influenced by feed components. Thus, the group receiving flax had a significantly lower SFA / PUFA ratio (0.25) compared to the other group (5.71).

6. CONCLUSIONS

It is shown that using designed meal for broilers, we got products with a significantly higher amount of omega 3 fatty acids compared to the same products obtained from broilers fed in the usual way. In these products, we get ideally achieved ratio between omega 6 and omega 3 fatty acids (5-6: 1). Based on the test results, we can conclude that the use of flax seeds in feed mixtures for broilers in fattening has its medical, nutritional and economic justification.

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