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# Domestic chicken omega 3 – a product for promoting human health

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**Abstract:** Literature data show that the relationship between two groups of polyunsaturated fatty acids in diet, omega 3 acids, whose basic representative is  $\alpha$ -linolenic acid (C18: 3 n-3), and omega 6 acids, whose basic representative is linoleic acid (C18: 2 n-6), has a significant role in development of cardiovascular diseases in humans. The optimal ratio of omega 6 to omega 3 fatty acids is around 4:1. In monogastric animals, the fatty acids in feed are absorbed in the gastrointestinal tract largely unchanged. This means the fatty acid profile of the animal's diet directly reflects the fatty acid profile of the tissue. The daily intake of unsaturated fatty acids can be increased by an adequate animal nutrition strategy. Flaxseed contains ten times more unsaturated (32.26%) than saturated (3.66%) fatty acids. 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, and which makes flaxseed an ideal raw material for the production of a wide range of omega 3 enriched products. In order to obtain chicken meat rich in omega 3, an experiment was organized with a specific diet for broilers at fattening. Thanks to the designed animal feed, it was possible to get products (meat, breast, drumstick, liver, subcutaneous fat) with significantly higher amounts of omega 3 fatty acids compared to the same products obtained from broilers fed with conventional mixtures, or with almost the ideal ratio between omega 6 and omega 3 fatty acids.

## 1. Introduction

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 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 is due to 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 [13]. 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 [5]. 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 can inhibit the conversion of alpha-linolenic acid to its derivatives [2]. 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 to omega 6 fatty acids in the body. Although the ratio of omega 6 to omega 3 fatty acids in humans who lived in the Paleolithic era was 1:1, modern ways of eating and living have 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 [13]. The production of omega 3 fortified poultry meat is very appealing 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 [6]. There are many examples in the literature showing the introduction of specific 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 an appropriate animal nutrition strategy is adopted, the results can be visible in a short period of time [11].

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 suitable animal nutrition strategy, but the source of omega 3 unsaturated fatty acids in the broiler diet could be different [3]. 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 [10]. 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 consisting predominantly of triacylglycerols, phospholipids and cholesterol [8]. As the composition of fatty acids in triacylglycerols changes primarily under the influence of feed/food, it is clear that also changes the composition of fatty acids in intramuscular adipose tissue [11].

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

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

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

Flaxseed contains an optimal fatty acid composition and, comparing it with other oilseeds, in terms of energy content, it is between soybean and sunflower, and in terms of crude protein content, it is similar to oilseed rape and cotton seed [3]. 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 [9]. 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 [1]. This distinguishes flaxseed from other conventional energy sources that are routinely used in broiler diets (corn,

soy, sunflower), which contain significantly higher amounts of omega 6 fatty acids than of omega 3 fatty acids (Table 2).

**Table 2.** Chemical composition of extruded flaxseed

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		
<b>Energetic value</b>			<b>Pigs</b>	<b>Sows</b>
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

## 2. Materials and Methods

In order to obtain products under the commercial name Domestic Chicken Omega 3, an study was organized with a specific diet for broilers at fattening, where the classic raw materials used in the diet of broilers in our area, rich in omega 6 fatty acids (soybean meal, and corn grain) were replaced with exuded flaxseed (source of omega 3 fatty acids), so producing broiler feed 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 flaxseed were subjected to detailed analyses 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.

## 3. Results and Discussion

Based on the performed analyses, the following results were obtained in Tables 3 and 4:

**Table 3.** Composition of meat from chickens fed with conventional feed

CHEMICAL ANALYSES	Method code	Unit of measure	Prescribed value	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	/	2.56
C18:3 n-3	02H.01.028	g/100g	/	0.174
C18:3 n-6	02H.01.028	g/100g	/	0.021
C20:3 n-3	02H.01.028	g/100g	/	0.000
C20:5 n-3	02H.01.028	g/100g	/	0.003
C22:6 n-3	02H.01.028	g/100g	/	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	/	0.01
Total monounsaturated fatty acids	02H.01.028	g/100g	/	3.76
Total n-3 fatty acids	02H.01.028	g/100g	/	0.18
Total n-6 fatty acids	02H.01.028	g/100g	/	2.59

Total polyunsaturated fatty acids	02H.01.028	g/100g	/	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	/	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 4.** The composition of meat from chickens fed with designed feed with the addition of extruded flaxseed

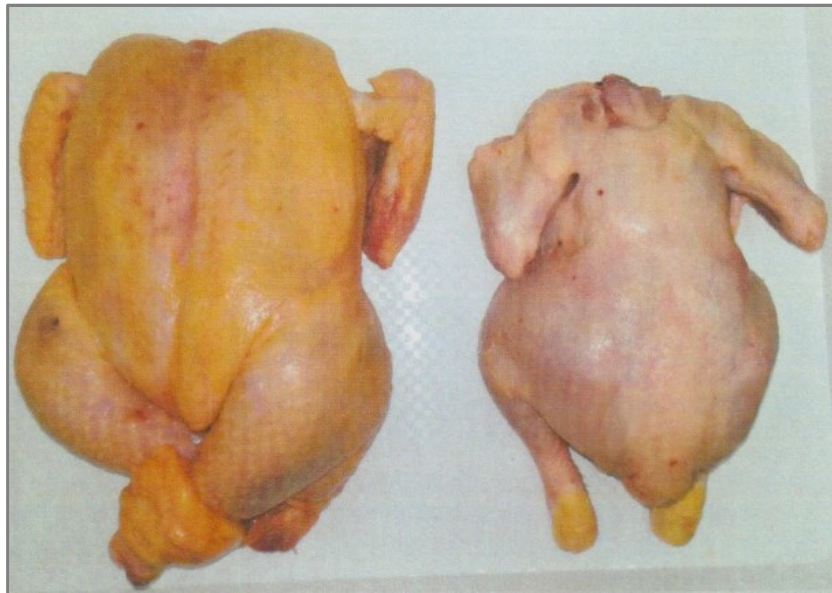
CHEMICAL ANALYSES	Method code	Unit of measure	Prescribed value	Result
Energetic value	/	kJ/100g	/	675.25
Energetic value	/	kcal/100g	/	161.75
Salt content	/	g/100g	/	0.18
Protein content	02H.01.012	%	/	18.56
Sugar content	02H.01.016	%	/	0.12
Carbohydrate content	02H.01.016	%	/	0.12
C18:2 n-6	02H.01.028	g/100g	/	3.24
C18:3 n-3	02H.01.028	g/100g	/	0.69
C18:3 n-6	02H.01.028	g/100g	/	0.022
C20:3 n-3	02H.01.028	g/100g	/	0.004
C20:5 n-3	02H.01.028	g/100g	/	0.007
C22:6 n-3	02H.01.028	g/100g	/	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	/	0.021
Total monounsaturated fatty acids	02H.01.028	g/100g	/	3.34
Total n-3 fatty acids	02H.01.028	g/100g	/	0.71
Total n-6 fatty acids	02H.01.028	g/100g	/	3.26
Total polyunsaturated fatty acids	02H.01.028	g/100g	/	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	/	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

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Lipid content	SRPS	ISO	%	/	9.67
	1444:1998				

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Thanks to the designed feed for broilers at fattening, the products (meat, breast, drumstick, liver, subcutaneous fat) had a significantly higher amount of omega 3 fatty acids compared to the same products obtained from broilers fed in the usual way, or they had an almost ideal ratio between omega 6 and omega 3 fatty acids (5-6:1). Figure 1 shows the carcass of broilers fed with designed feed, with the addition of extruded flaxseed (left), and broilers fed with conventional feed (right). Figure 2 shows drumstick plus thighs of broilers fed with designed feed, with the addition of extruded flaxseed (above), and broilers fed with conventional feed (below).



**Figure 1.** Carcass of broilers fed with designed feed, with the addition of extruded flaxseed, (left) and broilers fed with conventional feed (right)



**Figure 2.** Drumstick plus thighs of broilers fed with designed feed, with the addition of extruded flaxseed (above), and broilers fed with conventional feed (below)

The carcass fatty acid profile directly reflects the fatty acid profile in the animal's diet [4]. Since flaxseed has a desirable fatty acid composition, many producers are interested in using 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, soybean and sunflower are used, as well as other oilseeds that contain fatty acids from the n-3 series and fatty acids from the n-6 series [12].

Similar experiments on pigs were performed by [7], where the sources of fat in the diet of experimental groups were different in different fattening periods (from 30-60 kg and 60-115 kg), and accordingly after chemical analysis, the feeds were also of different fatty acid compositions. Thus, one experimental group received through feed 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 feed 10% flaxseed. Therefore, the content of total SFA, MUFA and PUFA differed between the experimental groups. Chemical analysis showed the experimental group that received flax had significantly less SFA (15.22%) and more PUFA (58.69%) than did the group that received SFA (75.02% and 13.13 %). In this experiment, the SFA/PUFA ratio was also influenced by feed components. Thus, the group receiving flaxseed had a significantly lower SFA/PUFA ratio (0.25) than the other group (5.71).

#### 4. Conclusion

It is shown that using designed feed for broilers produces meat with significantly higher amounts of omega 3 fatty acids compared to the same products obtained from broilers fed standard diet. The enhanced products had an ideal ratio between omega 6 and omega 3 fatty acids (5-6:1). Based on the results, we can



conclude that the use of flaxseed in feed mixtures for broilers at fattening is medically, nutritionally and economically justified.

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