Increasing ω-3-fatty acids in quail meat

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Abstract: During the last decade, dietologists all over the world have focused their studies on ω-3 fatty acids that are known for their ability of inhibiting platelet aggregation. Therefore the possibilities of enriching regular foodstuffs with ω-3 fatty acids are being studied worldwide.
In Estonia, the possibilities of enriching the poultry meat and eggs with ω-3 fatty acids have been studied since 1997. The preliminary studies have shown the very good ability of quails to assimilate ω-3 fatty acids from feed. The 4% linseed oil supplementation to quail diet appeared to be the minimum quantity required to produce so-called healthy eggs. Moreover, it increased the content of α-linolenic acids in total lipids of leg muscles of quails from 2.6 to 7.8%, and in total lipids of breast muscles from 2.3% to 5.7%. As linseed oil is relatively expensive, it was necessary to determine the ω-3 fatty acid content in quail meat in case of the minimum concentration of linseed oil in feed.
In 2003, the fatty acid composition of quail meat and fat in case of 3% linseed oil supplementation to feed was studied on the Järveotsa quail farm. The quails of the trial and control group were fed different diets from the 31st to the 45th day of age. At the age of 45 days, ten male quails from both groups were slaughtered for analysis. In the trial group, the sum of ω-3 fatty acids from total lipids was 14.0% in leg muscles; 11.1% in breast muscles and 9.1% in abdominal fat. The relevant data in the control group were 8.7, 4.6 and 1.6% respectively. The differences were statistically significant.

Keywords: ω-3 fatty acids; quail meat; linseed oil.

Introduction

Data on the change of ω-3 fatty acids content of quail meat in case of 4% linseed oil content has been published in authors' former works (Tikk *et al*., 1999; Tikk *et al*., 2002). The 4% linseed oil content of the feed used in the test was due to the fact that the 4% linseed oil content of feed was the minimum necessary quantity to produce "ω-health eggs". The 4% linseed oil content of feed increased the α-linolenic acid content of leg meat from 2.6% to 7.8%, of breast meat from 2.3% to 5.7% and of abdominal fat from 3.0% to 10.2%. The figures indicate α-linolenic acid as percentage of total lipids.

Initial results indicated quails' very good capability for ω-3 fatty acids intake from feed. The positive effect of those fatty acids on the prevention of cardiovascular diseases has been proved in several respects (Siguel, 1996; Simopoulos, 1991; Sardesai, Detroit, 1992). The tests run in Estonia have indicated the positive impact of the consumption of ω-3 fatty acids-enriched quail eggs on the blood indicators of men moderately suffering from hyperlipidaemia (Tikk *et al*., 2001).

Considering the above mentioned, Järveotsa quail farm started to investigate the opportunities to produce the so called ω-3-health meat. The price of linseed oil was relatively high and therefore, the ω-2 fatty acids content of quail meat in case of lower linseed oil content of feed needed to be clarified.

Material and methods

The trial was run in Järveotsa quail farm in 2000. Both trial and control group included 100 30 days old male quails, which were fed differently in 2 weeks.

The trial group quails were fed compound feed which met recommended feeding standards but contained neither linseed nor rape oil. In trial group, young quail feed contained 3% of linseed oil.

Former investigations of quail eggs have indicated that 2% of linseed oil in quail feed was not sufficient to get the expected result (Hämmal *et al*., 1998). The compound feed fed to young quails in the middle of the trial contained 1.22 MJ of metabolic energy, 24.0% of crude protein, 1.0% of calcium and 0.7% of total phosphorus on an average. The young quails of control and trial group were kept in similar conditions on the middle floor of a battery cage and they were fed by hand according to their wish.

On day 45, 10 male quails of each group were slaughtered and samples were taken from their carcase (leg and breast meat, skin plus subcutaneous fat and abdominal fat) for chemical analysis, which was made in the ecochemical laboratory of the Estonian University of Life Sciences.

Test results

The anatomical-morphological analysis of quails' bodies and carcases did not show any differences between the birds of two groups. The fatty acids content of quails' meat, skin and fat is given in tables 1 and 2.

In the comparison of tables 1 and 2 it becomes evident that 3% of linseed oil in feed had the strongest effect on ω-3 fatty acids content of quails' skin and subcutaneous fat and on abdominal fat (on an average, it increased 5.4–5.7 times). The ω-3 fatty acids content of breast and leg meat increased relatively less (1.6–2.4 times). Thus, contrary to general opinion, quail skin and subcutaneous fat and abdominal fat are the healthiest parts regarding human diet.

ω-6- and ω-3 fatty acids ratio was ideal in enriched quail meat and fat (1.65–2.13), as the up to 5 ratio of those acids in food for human consumption should be optimal. At the same time it becomes clear that in control group quails' abdominal fat this ratio exceeded 10. This is not bad as in food for normal consumption ω-6- and ω-3 fatty acids ratio tends to be within 25.

Due to the impact of linseed oil, the saturated fatty acids content of quail meat and fat decreased (by 6% on an average), which can be regarded as positive. The saturated fatty acids content mainly decreased due to the lower palmitic acid content of the samples taken from the trial group.

Table 1. Fatty acids composition (% of total lipids) of trial group quails' meat and fat

Fatty acid	Leg meat	Breast meat	Skin+subcutaneous fat	Abdominal fat
Myristic acid C14:0	0.9	0.8	1.0	0.9
Palmitic acid C16:0	15.9	16.8	15.8	15.6
Palmitoleic acid C16:1	4.8	5.6	6.0	5.8
Stearic acid C18:0	12.9	7.6	4.9	5.0
Oleic acid C18:1	28.3	37.1	43.6	43.5
Linoleic acid C18:2ω-6	18.5	18.2	18.3	19.3
α-linolenic acid C18:3ω-3	6.7	8.1	9.6	9.6
Eicosenic acid C20:1	0.3	0.5	0.5	0.8
Arachidonic acid C20:4ω-6	4.6	2.3	0.1	0.1
Eicosapentaenoic acid C20:5ω-3	1.1	0.6	0	0
Docosapentaenoic acid C22:5ω-3	0.6	0.3	0	0
Docosahexaenoic acid C22:6ω-3	5.6	2.1	0.1	0.1
Fat content of the object, %	0.69	1.6	48.2	71.2
In fat, % :				
Σ saturated fatty acids	29.7	25.2	21.7	21.5
Σ monosaturated fatty acids	33.4	43.2	50.1	49.7
Σ ω-3 fatty acids	14.0	11.1	9.7	9.1
Σ ω-6 fatty acids	23.1	20.5	18.4	19.4
Σ ω-6 : Σ ω-3	1.65	1.85	1.90	2.13

Table 2. Fatty acids composition (% of total lipids) of control group quails' meat and fat

Fatty acid	Leg meat	Breast meat	Skin+subcutaneous fat	Abdominal fat
Myristic acid C14:0	1.0	1.0	1.2	1.1
Palmitic acid C16:0	19.2	20.6	20.2	19.7
Palmitoleic acid C16:1	4.0	5.6	6.3	6.6
Stearic acid C18:0	16.0	10.6	6.9	6.7
Oleic acid C18:1	26.0	36.3	46.5	47.2
Linoleic acid C18:2ω-6	16.5	15.9	16.3	16.1
α-linolenic acid C18:3ω-3	1.3	1.4	1.7	1.5
Eicosenic acid C20:1	0.2	0.5	0.6	0.9
Arachidonic acid C20:4ω-6	8.5	4.9	0.2	0.1
Eicosapentaenoic acid C20:5ω-3	0.5	0.3	0	0
Docosapentaenoic acid C22:5ω-3	0.8	0.4	0	0
Docosahexaenoic acid C22:6ω-3	6.1	2.5	0.1	0.1
Fat content of the object, %	0.46	1.42	49.2	61.7
In fat, %:				
Σ saturated fatty acids	36.2*	32.2*	28.3*	27.5*
Σ monosaturated fatty acids	30.2	42.4	53.4	54.7
Σ ω-3 fatty acids	8.7*	4.6*	1.8**	1.6**
Σ ω-6 fatty acids	25.0	20.8	16.5	16.2
Σ ω-6 : Σ ω-3	2.87	4.52	9.17	10.13

* significant change ($P<0.05$)
** significant change ($P<0.01$)

Conclusions

Usage of 3% linseed oil in young quail diet

- increased the ω-3 fatty acids content of quail meat 1.6–2.4 times ($P<0.05$) and that of skin+subcutaneous fat and abdominal fat 5.4–5.7 times ($P<0.001$);
- considerably improved the fat ω-6- and ω-3 fatty acids ratio in quail meat (1.7–2.4 times) and particularly in fat (4.8 times), compared with the respective data of the control group;
- decreased the saturated fatty acids content of quail meat and fat by 6% ($P<0.05$) on an average. The palmitic acid content of trial group samples decreased more.

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