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SPECIES PECULIARITIES OF LIPID AND FATTY ACID COMPOSITION OF LIVER AND EGG YOLK IN JAPANESE QUAILS AND LAYING HENS

V. Kystsiv[1],I. Ratych[1], F. Borowiec[2], B. Kyryliv[1], L. Andrejeva[1]

[1]Institute of Animal biology of NAAS Ukraine
[2]Agricultural Academy, Animal Nutrition department, Krakow

Species peculiarities of lipid and fatty acid composition of liver and egg yolk in Japanese quails and laying hens have been studied. In results of our study was determined that total lipids content in liver of Japanese quails and laying hens was almost same, but in egg yolk less by 20,96 %.It was established less level of phospholipides, mono- and diacylglycerols and higher content of triacylglycerols in total lipids composition in liver of Japanese quails, as compared with liver of hens. In egg yolk of Japanese quails was observed higher triacylglicerols level and less free cholesterol content. It was established higher palmitic acid level among saturated fatty acids anh higher content of oleic and linolenic acids among unsaturated fatty acids in composition of liver total lipids of Japanese quails. In liver of laying hens was observed higher level of stearic, linoleic and arachidonic acids. It was shown higher relative content of saturated and polyunsaturated fatty acids in egg yolks lipids of Japanese quails. Oleic acid level was higher in egg yolk of laying hens.

Key words: TOTAL LIPIDS, FATTY ACIDS, JAPANESE QUAILS, LAYING HENS.

Advisability of lipid metabolism study of animals and poultry is determined by its significant role of lipids in organism. In particularly, lipids are membrane structure components, served as form, in which metabolizable energy is deposed, lipids also have defensive and regulatory action, are fatty acid vitamins solvents, take part in tissue permeability processes (Borchman D. et al.,1999). In animal and avian tissues lipids are partly containing in free status, but mainly as compounds with proteins and carbohydrates. In base of all tissue membranes are compounds of lipids with proteins (He S.Y. et al., 2005; Salaün C. et al., 2004).

Lipid synthesis in animal tissues is depending firstly from free fatty acids pool in cell. Fatty acids partly going in animal organism with feed lipids and partly are syntesized de novo. Liver and adipose have central state in fatty acid synthesis in organism, and polyene fatty acid synthesis is depending on linoleic and linolenic acids intake from feed (Budowsky P., 1989). Avian egg contain 61, 51% essential fatty acids. All lipid classes of avian eggs contain fatty acids. Egg contains only 14 fatty acids in relatively significant values (Fisinin V.I. et al., 1990).

Egg fatty acid profile can depend to some degree on feeding factors, keeping conditions and breed (Fuhrmann H. et al., 1996; Raes K. et al., 2002).

Numerous authors have reported data devoted to study of lipid and fatty acid composition of different avian species, but in available literature it is little comparative data, in particularly, about poultry different by its metabolism intensity and growth rate, hence by organism need in nutritive and biologic active substances. In this connection is essential to study poultry species peculiarities for research of metabolism intensity and its regulation.

Materials and methods

The studies were conducted with Japanese quails aged 125 days and Tetra SL hybrid laying hens aged 300 days. Both poultry species were fed ration balanced by nutritive and biologically active compounds. Quails and hens were in cage kept, feed and water were available *ad libitum.*

Japanese quails were fed ration containing 287,7 ccal metabolizable energy, 19,2 % protein; 3,36 % fat; 3,78 % fibre; 2,88 % calcium; 0,97 % phosphorus; 0,32 % sodium; 0,90 % lysine; 0,67 % methionine+cyctine; 0,24 % triptophan.

Hens were fed ration containing 269,9 ccal metabolizable energy, 17,33 % protein; 4,42 % fat; 4,40 % fibre; 3,01 % calcium; 0,7 % phosphorus; 0,40 % sodium; 0,69 % lysine; 0,49 % methionine+cyctine; 0,21 % tryptophan.

Material for study was sampled liver tissue and egg yolks.

Total lipids content was analyzed by weight method after extraction with chlorophorm-methanol mixture 2:1and by Folch procedure in liver and egg yolks (*Folch J.* et al., 1957). Total lipids were separated into classes by method of thin-layer chromatography on silicagel in system haexan-diethyl ether-ice acetic acid 70:30:1 with its following determination by bichromate method (Stefanik M.B et

Fatty acid	Species

al., 1985). Fatty acid composition was determined using gas chromatography (Stefanik M.B et al., 1985).Results were statistically analized.

Results and discussion

Our results concerning total lipid contents and its class ratio are shown in table 1.

Table 1

Indices	Liver		Egg yolk	
	Japanese quails (M±m, n=6)	Hens (M±m, n=5)	Japanese quails (n=3)	Hens(n=5)
Total lipids,gr%	9,83±0,48	8,52±0,56	28,25±0,55A	34,17±1,42B
Lipid class:				
Phospholipids, %	27,54±0,36A	35,22±0,75B	24,97±0,70	24,63±0,61
Mono- and diacylglicerols ,%	6,69±0,43a	8,57±0,60b	8,83±0,25	7,72±0,49
Free cholesterol, %	10,95±0,49	10,35±0,21	9,87±0,27A	14,30±0,75B
Free fatty acids, %	8,54±0,75	10,98±0,79	9,60±0,33	11,30±0,80
Triacylglycerolsи, %	34,01±0,92A	19,08±0,69B	36,43±0,88A	31,62±0,92B
Cholesterol ethers,%	12,28±0,35A	15,95±0,68B	10,30±0,36	10,51±0,65

Total lipid content and some lipid class interrelation in liver and egg yolk of Japanese quails and laying hens; (M±m, n=3-6)

A, B – P<0,01; a, b – P<0,05.

Data given in table showed that total lipids content in liver of Japanese quails and hens were almost the same, but level of some lipid class was significantly different. Relative phospholipid content was higher by 7, 68 % (p<0,001) in hen liver, than in same tissue of Japanese quails. Hen liver also contain higher relative content of mono- and diacylglycerols (p<0,05) and cholesterol ethers (p<0,001).

By that triacylglicerols content was by 1,78 times greater in liver of Japanese quails, than in same tissue of hens (p<0,001). Total lipids content in egg yolk of japanese quails was less by 20, 96 % as compared with hens (p<0,01). Lipid class interrelation in egg yolks was other than in liver. Relative contents of phospholipids and cholesterol ethers in egg yolk as well as hens and Japanese quails was almost same

In egg yolks of Japanese quails, was observed some higher triacylglycerols level (p<0,01), whereas free cholesterol relative content was less as compared with hens (p<0,01).

The analysis of species specific of liver fatty acid composition was indicated on higher level of saturated fatty acids in laying hens, as compared with Japanese quails, that constituted 37, 42 % and 35,88 %, respectively (table 2).

Table 2

Total lipids fatty acid composition in liver of Japanese quails and laying hens; (M±m, n=4-5)

	Japanese quails (M±m, n=4)	Laying hens (M±m, n=5)
$C_{14:0}$	0,82±0,02A	0,35±0,02B
$C_{16:0}$	26,92±0,68a	23,33±0,85b
$C_{16:1}$	7,11±0,82a	3,89±0,40b
$C_{17:0}$	0,34±0,02a	0,57±0,07b
$C_{18:0}$	7,80±0,44A	13,17±0,76B
$C_{18:1}$	41,01±0,43	38,21±1,73
$C_{18:2}$	7,65±0,14A	10,85±0,57B
$C_{18:3}$	1,82±0,05A	0,90±0,03B
$C_{20:1}$	0,09±0,01A	0,30±0,04B
$C_{20:2}$	2,97±0,19A	0,72±0,02B
$C_{20:3}$	0,24±0,03a	0,43±0,05b
$C_{20:4}$	1,51±0,05a	4,15±0,59b
$C_{20:5}$	0,13±0,01a	0,40±0,08b
$C_{22:2}$	0,26±0,01A	0,10±0,01B
$C_{22:3}$	0,35±0,04	0,46±0,06
$C_{22:4}$	0,31±0,02	0,40±0,12
$C_{22:5}$	0,12±0,01	0,25±0,15
$C_{22:6}$	0,55±0,02a	0,33±0,05b
Saturated fatty acids	35,88	37,42
Unsaturated fatty acids	64,12	62,58
Polyunsaturated fatty acids	15,91	19,29

By that, this increasing of saturated fatty acids content is connected mainly with higher level of stearic acid ($C_{18:0}$). Unsaturated fatty acids summary content was higher in Japanese quails liver, that constituted 64,12 %, as compared with 62,58 % in laying hens. Results of our study was evidenced that higher unsaturated fatty acids content is connected mainly with

increasing level of oleic acid ($C_{18:1}$). Decreasing level of oleic acid in liver of laying hens, as compared with Japanese quails, can be explained by less content of palmitic acid ($C_{16:0}$), which is oleic acid precursor, and also by higher summary content of unsaturated fatty acids with chain length above 20 carbon atoms, which are inhibitors of enzymes Δ9 desaturase and elongase Elovl-6 (Jump D.B., et al 1999; Jump D.B., 2002). In liver of Japanese quails were predominated palmioleic ($C_{16:1}$), oleic ($C_{18:1}$) and linolenic ($C_{18:3}$) unsaturated fatty acids, as compared with fatty acid composition in liver of laying hens.

Linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) fatty acids are essential fatty acids, controlling two basic functions in animal organism, namely including in composition of structure lipids that are cell membrane components and also are precursors of eicosanoids such as prostacyclins, prostaglandins, leicotriens and tromboxans (Kunze D.,1993;. Smith W. L., 1989). ώ-6 and ώ-3 polyunsaturated fatty acids formation are depending on content in ration of linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) acids, whith are desaturation system competitors. This process is regulated by way of competitive inhibition of enzymes (Elolvl-2, Elolvl-5, Δ5- and Δ6-desaturases), and transformation of each unsaturated fatty acid is depending on its concentration and content of formed products (Smith W. L., 1989). In case of high linolenic ($C_{18:3}$) acid content in tissues of Japanese quails was observed inhibition of synthesis of more unsaturated fatty acids ($C_{22:2}$, $C_{22:6}$) of linoleic acid series and on contrary (Sprecher H., 2000), that was established in our case.

ώ-6 fatty acids are linoleic acid ($C_{18:2}$) derivatives. Its summary content ($C_{18:2}$, $C_{20:2}$, $C_{20:3}$, $C_{20:4}$, $C_{22:2}$) was highest in liver lipids of laying hens and constituted 16, 25 %, against 12,63 % in Japanese quails. It is necessary to attract attention on increasing level of linoleic ($C_{18:2}$) and arachidonic ($C_{20:4}$) (linoleic derivative) acids in liver of laying hens, as compared with Japanese quails and constituted 10,85 % and 4,15 % respectively.

ώ-3 fatty acids content was higher in liver of Japanese quails (3,28 %), as compared with laying hens (2,74 %), mainly in account of linoleic ($C_{18:3}$) and docosohexaenic ($C_{22:6}$) acids.

Species peculiarities of fatty acid composition of egg yolk total lipids of Japanese quails and laying hens are presented in Table 3. Saturated fatty acids content was higher in egg yolk of Japanese quails, as compared with laying hens, in account of palmitic ($C_{16:0}$) and stearic ($C_{18:0}$) acids, constituted 22,29 % and 11,42%, respectively.

Table 3

Total lipids fatty acid composition in egg yolk of Japanese quails and laying hens; (M±m, n=3–5)

Unsaturated fatty acids concentration was higher in egg yolk of laying hens mainly in account of oleic acid ($C_{18:1}$).

Higher polyunsaturated fatty acids level was established in total lipids of egg yolk of Japanese quails, that constituted 25, 35 %, as compared with 19,03 % in egg yolk of laying hens. Higher polyunsaturated fatty acids concentration was accompanied with greater content of linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) acids. High level of linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) fatty acids in egg yolk of Japanese quails is agreed with our previous studies about high triacylglicerols level in egg yolk of Japanese quails, since linoleic and linolenic fatty acids was found mainly in composition of triacylglicerols (Fisinin V.I., et al., 1990). Besides it was established higher by 8, 2 times eicosadiene ($C_{20:2}$) and by 12,1 times linolenic ($C_{18:3}$) acids level in egg yolk of Japanese quails, as compared with laying hens.

Fatty acid	Species	
	Japanese quails (M±m, n=3)	Laying hens (M±m, n=5)
$C_{10:0}$	0,15±0,02	0,13±0,03
$C_{14:0}$	0,71±0,05A	0,41±0,03B
$C_{16:0}$	22,29±1,25	21,22±1,07
$C_{16:1}$	3,97±0,35	4,83±0,25
$C_{17:0}$	0,28±0,02a	0,43±0,04b
$C_{18:0}$	11,42±0,70	9,52±0,77
$C_{18:1}$	35,83±1,44A	44,43±1,73B
$C_{18:2}$	16,84±0,97	15,76±0,94
$C_{18:3}$	3,16±0,18A	0,26±0,01B
$C_{20:2}$	2,87±0,25A	0,35±0,02B
$C_{20:3}$	0,44±0,03	0,23±0,05
$C_{20:4}$	2,04±0,13	2,43±0,35
Saturated fatty acids	34,85	31,71
Unsaturated fatty acids	65,15	68,29
Polyunsaturated fatty acids	25,35	19,03

Eggs of Japanese quails contain higher levels as follows: phosphorus -by 5 times, iron - by 7,5 times, vitamin B_1 -.by 6 times, vitamin B_{12} – by 15 times, significantly increasing level of vitamin A, nicotinic acid, cobalt, copper, essential amino acids, in comparison with eggs of laying hens..According to literature data are differences in content of lipid peroxidation products in egg yolk of Japanese quails and laying hens (Karpa I., et al., 2004; Kystsiv V.O., 2008), in particularly egg yolk of Japanese quails contain less level of lipid hydroperoxides and TBA-reactive substances, increasing its biologic and feed value.

Thus, obtained results indicate about existence of clear species specific of lipid and fatty acid composition of liver and egg yolk of Japanese quais and laying hens, which can be explained by different growth intensity, egg incubation terms, sex maturition age.

Conclusions

In results of our study was determined that total lipids content in liver of Japanese quails and laying hens was almost same, but in egg yolk less by 20,96 %.It was established less level of phospholipides, mono- and diacylglycerols and higher content of triacylglycerols in total lipids composition in liver of Japanese quails, as compared with liver of hens. In egg yolk of Japanese quails was observed higher triacylglicerols level and less free cholesterol content. It was established higher palmitic acid level among saturated fatty acids anh higher content of oleic and linolenic acids among unsaturated fatty acids in composition of liver total lipids of Japanese quails. In liver of laying hens was observed higher level of stearic, linoleic and arachidonic acids. It was shown higher relative content of saturated and polyunsaturated fatty acids in egg yolks lipids of Japanese quails. Oleic acid level was higher in egg yolk of laying hens.

В. О.Кисців, І. Б Ратич., Ф. Боровєц, Б. Я.Кирилів, Л. В Андреєва.

ВИДОВІ ОСОБЛИВОСТІ ЛІПІДНОГО ТА ЖИРНОКИСЛОТНОГО СКЛАДУ ТКАНИН ПЕЧІНКИ І ЖОВТКІВ ЯЄЦЬ У ПЕРЕПІЛОК ТА КУРЕЙ-НЕСУЧОК

Р е з ю м е

У результаті досліджень видових особливостей ліпідного та жирнокислотного складу тканин печінки і жовтків яєць у перепілок та курей-несучок встановлено, що у перепелів і курей концентрація загальних ліпідів у печінці була приблизно однаковою, а в жовтку перепелів на 20,96 % меншою. У складі загальних ліпідів печінки перепелів відносний вміст фосфоліпідів, моно- і диацилгліцеролів є меншим, а триацилгліцеролів більшим, ніж у печінці курей. У жовтку перепелиних яєць був вищим вміст триацилгліцеролів і меншим – вільного холестеролу. У складі ліпідів печінки перепелів серед насичених жирних кислот був вищим рівень: пальмітинової кислоти, а ненасичених – олеїнової і ліноленової кислот. У печінці курей спостерігався вищий рівень стеаринової, лінолевої та арахідонової кислот. У ліпідах жовтка перепелів відзначено вищий відносний вміст насичених та поліненасичених жирних кислот. Рівень олеїнової кислоти був вищим у жовтку курей.

Таким чином, як видно з отриманих даних існує чітка видова специфіка ліпідного і жирнокислотного складу тканин печінки і жовтків яєць перепелів і курей, яка зумовлена різною інтенсивністю росту, терміном інкубації яєць, віком статевого дозрівання.

В. О.Кисцив, И. Б Ратыч., Ф. Боровец, Б. Я.Кырылив, Л. В Андреєва.

ВИДОВЫЕ ОСОБЕННОСТИ ЛИПИДНОГО И ЖИРНОКИСЛОТНОГО СОСТАВА ТКАНЕЙ ПЕЧЕНИ И ЖЕЛТКОВ ЯИЦ ПЕРЕПЕЛОК И КУР-НЕСУШЕК

А н н о т а ц и я

В результате исследований видовых особенностей липидного и жирнокислотного состава тканей печени и желтков яиц в перепелок и кур-несушек показано, что у перепелов и кур концентрация общих липидов в тканях печени была приблизительно одинаковой, а в желтке перепелов на 20,96 % меньше. В составе общих липидов печени перепелов относительное содержание фосфолипидов, моно- и диацилглицеролов было меньшим, а триацилглицеролов большим, чем в тканях печени кур. В желтке перепелиных яиц было выше содержание триацилглицеролов и меньшим - свободного холестерола. В составе липидов печени перепелов среди насыщенных жирных кислот был выше уровень: пальмитиновой кислоты, а ненасыщенных - олеиновой и линоленовой кислот. В печени кур наблюдался высокий уровень стеариновой, линолевой и арахидоновой кислот. В липидах желтка перепелов отмечено выше относительное содержание насыщенных и полиненасыщенных жирных кислот. Уровень олеиновой кислоты был выше в желтке кур.

Таким образом, как видно из полученных данных существует четкая видовая специфика липидного и жирнокислотного состава тканей печени и желтков яиц перепелов и кур, обусловленная разной интенсивностью роста, сроком инкубации яиц, возрастом полового созревания.

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Рецензент: головний науковий співробітник лабораторії живлення ВРХ, доктор біологічних наук, професор В. Г. Янович.