

COMPOSITION OF INTRAMUSCULAR LIPIDS IN GROWING LAMBS

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The content of total lipids and lipid types as well as individual phospholipids in intramuscular fats (chloroform - methanol extraction) of m.m.longissimus dorsi and semimembranosus in lambs of two breeds aged 1, 45, 90, 180, 270, 360 days, was analysed.

The total lipid content increases with the growth of lambs of both breeds. Changes are parallel for both muscles analysed. Parallel with total lipids an increase in absolute values of phospholipids was observed. Expressed, however, in percentage to total lipids, a clear trend emerges to their relative decrease with the growth of animals. Phospholipid content in m.semimembranosus is always lower than that of m.long.dorsi regardless of animals' age. Absolute values of cholesterol also increase with lamb growing, but no particular differences, under the influence of age, are observed in percentage against total lipids. The neutral fat content increases both absolutely and relatively with lamb growing. The neutral fat content is higher in m.semimembranosus which is better expressed in local sheep breeds. The percentage ratio of individual phospholipids: lysolecithin, sphingomyelin, lecithin and kephalin was established.

COMPOSITION DES LIPIDES INTRAMUSCULAIRES CHEZ LES AGNEAUX CROISSANTS

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La teneur en lipides totaux et types lipidiques, ainsi que les phospholipides individuels dans les graisses intramusculaires (extrait: chloroform-méthanol) du m.m.longissimus dorsi et semimembranosus des agneaux de deux races âgés de 1, 45, 90, 180, 270, 360 jours a été analysée.

La teneur en lipides totaux augmente avec la croissance des agneaux pour les deux races. Les changements sont parallèles pour les deux muscles analysés. Parallèlement aux lipides totaux, une augmentation des valeurs absolues des phospholipides est observée. Exprimés en pourcentages envers les lipides totaux, une tendance s'annonce clairement de leur diminution relatives avec la croissance des animaux. La teneur en phospholipides du m.semimembranosus est toujours plus basse que celle du m.long.dorsi, indépendamment de l'âge des animaux. Les valeurs absolues du cholestérine augmente également avec la croissance des agneaux, mais en pourcentages envers les lipides totaux, pas de différences particulières, sous l'influence de l'âge, ne sont observées. La teneur en graisses neutres augmente absolument et relativement avec la croissance des agneaux. La teneur en graisses neutres est plus haute dans le m.semimembranosus, qui est exprimée mieux dans la race locale de brebis. Le rapport de pourcentage des phospholipides individuels: lysolécithine, sphingomyéline, lécithine et képhaline, est également établi.

ZUSAMMENSETZUNG DER INTRAMUSKULÄREN LIPIDE IN WACHSENDEN LÄMMERN

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Der Gehalt an Gesamtlipiden und Lipideklassen sowie an einzelnen Phospholipiden im intramuskulären Fett /Extraktion Chloroform:Methanol/ von *M. longissimus dorsi* /M.L.D./ und *M. semimembranosus* /M.S./ wurde an Lämmern von zwei Rassen im Alter von 1, 45, 90, 180, 270, 360 Tagen untersucht. Der Gehalt an Gesamtlipiden nimmt mit dem Wachstum der Lämmer von den beiden Rassen zu. Die Änderungen verlaufen parallel in den beiden untersuchten Muskeln. Parallel mit der Zunahme von Gesamtlipiden wird eine gewisse Zunahme der absoluten Phospholipidewerte beobachtet. In Prozent von Gesamtlipiden ausgedrückt macht sich jedoch eine deutliche Tendenz nach einer relativen Abnahme mit dem Wachstum der Tiere bemerkbar. Der Gehalt an Phospholipiden in M.S. ist in allen Fällen niedriger als in M.L.D. unabhängig des Alters der Tiere. Die absoluten Werte des Cholesterins nehmen mit dem Alter der Tiere auch zu, in Prozent von den Gesamtlipiden aber werden keine besonderen Differenzen unter dem Einfluß des Alters beobachtet. Der Gehalt an Neutralfett nimmt absolut wie auch relativ mit dem Wachstum zu. M.S. hat einen höheren Gehalt an Neutralfett als M.L.D. Das kommt deutlicher bei den Tieren der einheimischen Rasse zum Vorschein. Das Prozentverhältnis der einzelnen Phospholipide: Lyssolezithin, Sphingomyelin und Kephalin wurde festgestellt.

СОСТАВ ИНТРАМУСКУЛЯРНЫХ ЛИПИДОВ РАСТУЩИХ ЯГНЯТ

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Исследовано содержание общих и индивидуальных липидов в интермускулярной жирности (экстракция хлороформ:метанол) из *M. longissimus dorsi* и *M. semimembranosus* из двух пород ягнят в возрастах 1, 45, 90, 180, 270, 360 дней.

Содержание общих липидов увеличивается с возрастанием ягнят и у двух пород. Изменения, которые наступают в двух исследованных мускулах параллельны. В тоже время наблюдается и увеличение абсолютных стоимостей фосфолипидов. Выразив их количество в процентах по отношению к общим липидам видно что оно относительно уменьшается с возрастанием животных. Содержание фосфолипидов в *M. semimembranosus* всегда меньше во сравнение с их содержанием в *M. longissimus dorsi* независимо от их возрасти. Абсолютные стоимости холестерина тоже увеличивается с возрасти, но в процентах к общим липидам никаких особых не наблюдается. Нейтральные липиды увеличиваются и у двух пород ягнят. У *M. semimembranosus* нейтральных липид больше чем у *M. longissimus dorsi*. Это как раз проявляется сильнее в местной породе овец. Установлены и процентные соотношения индивидуальных фосфолипид: лизолецитин, сфингомиелин, лецитин и кефалин.

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It is known that both total intramuscular lipids and single lipid types as well as their fatty acid composition exert influence on meat palatability. Lipid composition in animal tissues and organs is too diverse and varies according to the breed/Cramer and Marchello, 1964, Gillis and al., 1973, Hecker and al., 1975/, the sex/Terrell and al., 1969, Gillis and al., 1973/, the muscle type/Blumer and al., 1962, Terrell and al., 1967, O'Keefe and al., 1968, Wangen and al., 1971/ and the age of animal/Zink and al., 1970, Waldman and al., 1968, Hecker and al., 1975/.

Those studies concern mainly lipids in muscles of pigs, cattle and poultry. Studies on intramuscular lipids in growing lambs are too scanty and refer mainly to their fatty acid composition.

The purpose of the present study was to get data about changes occurring in lipid composition of some muscles in growing lambs.

MATERIALS AND METHODS

The study was conducted on 36 lambs different both in phenotype and genotype/origin/ : lambs of Merinofleisch and lambs of local coarse-wool pigmented breed. Three male lambs of each breed aged 1, 45, 90, 180, 270 and 360 days were slaughtered. Samples for analysis were taken from m.Semimembranosus and m.Longissimus dorsi. Total lipids were extracted according to Bligh and Dyer's method, after double treating with chloroform:methanol/2:1/, chloroform, water. Total lipids obtained were used for analysis of single lipid types. Total phospholipids were determined after the method of Chen and al. Individual phospholipids were separated on thin-layer chromatography, after the system described by Wagner and al., and phosphor amount in each eluted fraction was determined after the method of Chen and al. Total amount of cholesterol was determined according to Schöenheimer and Sperry's method based on Lieberman-Burchard's reaction in Specol spectrophotometer at 620 nm wave length.

RESULTS

Data concerning the content of total lipids, phospholipids, cholesterol and neutral lipids in both absolute amount and percentage of total lipids are given in table 1 for Merinofleisch lambs and in table 2 for lambs of local breed.

In both breeds the amount of total lipids increases approximately in equal rate in both muscles analysed. In all cases, however, the content of total lipids is higher at m.Semimembranosus. This difference is better emphasized in lambs of local breed.

With the growth of animals some increase in absolute amounts of cholesterol was observed. This increase is mainly between 1 and 45 days of age. It is interesting that no essential differences were established between single ages, concerning the percentage expression toward total lipids. No definite differences are also found between both muscles. Cholesterol amount, however, in the lipids of local breed is slightly lower than that in lambs of Merinofleisch breed. This difference, more or less, remains in all age groups in both muscles.

Regardless of all that with the growth of lambs phospholipid content increases, intensity of this increase is very poorer than the growth of total lipids. As a result, percentage content of phospholipid toward total lipids decreases with the growth of animals. Phospholipid level in both muscles in lambs of the first four ages is almost equal or higher in m.l.dorsi. In lambs aged 240 and 360 days phospholipid content is higher in m.Semimembranosus. This phenomenon repeats itself in both breeds and means that this is not an accidental fact. Even in Merinofleisch lambs this difference is better marked as well in percentage toward total lipids in muscles.

Analysis of individual phospholipids/table 3/shows that in both analysed muscles the fraction of phosphatidylcholine prevails, m.Semimembranosus being relatively poorer in phosphatidylcholine than m.longissimus dorsi in all age groups. With the growth of lambs up to 180 days of age no significant changes are observed concerning amount of phosphatidylcholine in both muscles. Its content is highest at 270 days of age in lambs of Merinofleisch breed while in lambs of local breed this increase continues always after this age.

The amount of phosphatidylethanolamine trends to increase with the growth of animals. Changes mentioned above were observed in both muscles of investigated breeds. These changes are especially indicative after 180 days of age. Results show that m.longissimus dorsi in lambs of local breed is richer in phosphatidylethanolamine compared to the other breed investigated. The most characteristic difference in the levels of phosphatidylcholine and phosphatidylethanolamine was observed after 180 days of age which correlates with the increased phospholipid level in both muscles of investigated breeds.

Chromatographic analysis shows a low content in lysophosphatidylcholine without any age and interbreed changes to be observed. No significant changes are established in svingomieline content. Insignificant changes in the last two phospholipid levels have no essential effect on total phospholipid level, therefore they are not given in the table.

Studies carried out on different age state show that changes in single lipid classes concern mainly neutral lipids in both muscles and both breeds. A trend is coming up to higher content in neutral fats of m.Semimembranosus, this being better expressed in lambs of local breed.

DISCUSSION

Changes we are observing in total lipid content with the growth of lambs are normal and have been observed repeatedly in all species of domestic animals.

The fact that cholesterol content increases almost with the same intensity, as in total lipids, means that its amount changes depending on total lipid level. On the contrary, Hecker and al. observes a decrease in cholesterol level of intramuscular lipids in growing cattle. Apparently, the age of lambs and type of muscle from which lipids are extracted do not exert influence on its percentage content of intramuscular lipids.

Phospholipids being fundamental structural components of cellular and membranal formations undergo relatively slight changes with the growth of lambs but in percentage toward total lipids they decrease. Such differences were reported by Hecker and al., in cattle. According to White and al.,/1968/, one of the functions of phospholipids in muscles is to serve as a structural bridge between watersoluble protein and unpolar lipids. Higher phospholipid content in m.Semimembranosus found by us corresponds to results of Campbell and al., who have found an inverse proportional dependance between total lipid level and phospholipid content in a given muscle. Our data concerning the amount of total lipids in the first four ages for both muscles are in a contradiction to the conclusion of Wanger and al.,/1974/ that phospholipid content is higher in more actively operating organs and tissues. Furthermore, Morrison and al.,/1971/, studying muscles in pigs, have found that darker coloured muscles were richer in phospholipids. In our studies, in the first four ages m.longissimus dorsi had higher phospholipid content, although according to our unpublished data/Pinkas/ colouring intensity of m.Semimembranosus is higher even in the first months of life of lambs. In the last two ages, however, to the more actively operating muscle semimembranosus corresponds a higher phospholipid content. Results from the studies show that positive dependance found between functional activity of the muscle and phospholipid level/Wanger, Campbell/occurs in lambs at a later age.

Results obtained for phospholipids and cholesterol show that a definite quantitative mutual relation remains between those two components, which is determined by their participation into the structure of cellular formations.

Higher phosphatidylcholine level in m.longissimus dorsi in both breeds compared to m.Semimembranosus may be associated probably to specific functional role of given muscle.

High phosphatidylcholine level observed in m.longissimus dorsi in local breed lambs is accompanied by a higher phosphatidylethanolamine content. It may be due to breed differences since such a relation was not observed in Merinofleisch breed.

Changes found in the amount of neutral fats in the course of growing, correspond to number of other studies both for intramuscles and for lipids in other organs and tissues. It is obviously that lipids exert an essential influence on the meat palatability, particularly through their fatty acid composition, that being reported in next work/Pinkas and al., in press/.

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Table 1

Table 2

Merinofleisch breed									Local coarse-wool pigmented breed								
Lipid classes/mg %/									Lipid classes/mg %/								
Age /days/	Muscle	T L	P L	%	C	%	N L	%	T L	P L	%	C	%	N L	%		
1	L.d.	1750	724	41,4	97	5,5	929	53,1	1610	865	53,7	73	4,5	672	41,7		
	Semim.	1900	733	38,6	103	5,4	1064	56,0	1770	607	34,3	85	4,8	1078	60,9		
45	L.d.	2020	841	41,6	173	8,6	1006	49,8	2490	932	37,4	113	4,5	1445	58,0		
	Semim.	2080	703	33,8	192	9,3	1185	56,9	2520	900	35,7	110	4,4	1510	59,9		
90	L.d.	2340	759	32,4	167	7,1	1414	60,4	2530	860	34,0	107	4,2	1563	61,8		
	Semim.	2500	748	29,9	171	6,8	1581	63,2	2640	848	32,1	112	4,2	1680	63,7		
180	L.d.	2810	834	30,0	157	5,6	1819	64,4	2380	854	35,9	100	4,2	1426	59,9		
	Semim.	2820	840	29,8	168	6,0	1816	64,2	2620	776	28,8	120	4,5	1794	66,7		
270	L.d.	2900	838	28,9	193	6,7	1869	64,4	2870	920	32,1	138	4,8	1812	63,1		
	Semim.	2980	925	31,0	182	6,1	1873	62,9	2920	946	32,3	137	4,7	1837	63,0		
360	L.d.	3800	820	21,6	195	5,1	2785	73,3	3820	1096	28,7	159	4,2	2565	67,1		
	Semim.	4020	980	24,4	204	5,1	2836	70,5	4660	1221	26,2	193	4,1	3247	69,7		

Legend: TL- total lipids; PL - phospholipids; C - cholesterol; NL - neutral lipids;
% - percent of the total lipids

Table 3

		Merinofleisch breed						Local coarse-wool pigmented breed					
Individual phospholipids	Age /days/	1	45	90	180	270	360	1	45	90	180	270	360
	Muscle												
Phosphatidylcholine	m.Longissimus dorsi	413	446	417	484	561	451	467	494	456	427	534	647
	m.Semimembranosus	330	323	352	353	435	421	291	423	305	334	388	537
Phosphatidylethanolamine	m.Longissimus dorsi	159	190	144	175	192	209	216	205	249	265	304	219
	m.Semimembranosus	188	210	172	244	194	294	198	210	254	245	293	402