Influence of Breed, Sex and Anatomical Location on Lipid and Fatty Acid Composition of Bovine Subcutaneous Fat

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Abstract Thirty-one animals including Japanese Black (9 steers), Holstein (8 steers and 2 heifers) and Japanese Black × Holstein (F_1) (6 steers and 6 heifers) were used to determine the lipid and fatty acid composition of subcutaneous fat at a constant slaughter weight. Subcutaneous fat samples for the lipid analysis were taken from the shoulder, loin, rump, brisket and flank regions. Total lipid contents extracted from subcutaneous fat were not significantly affected by breed, sex and location, although Japanese Black had a tendency to have somewhat more total lipid content than Holstein. Percentages of TG and PL were significantly affected by sex and anatomical location. Heifers had a higher percentage of TG and a lower percentage of PL. Flank subcutaneous fat had the highest percentage of TG and the lowest percentage of PL. The effects of breed, sex and location on the fatty acid composition of TG, PL and FFA classes were significant with some exceptions and similar tendencies were observed in the fatty acid composition of these classes. The principal features were as follows; (1) Japanese Black were higher in C18:1 and TUSF contents, and C18/C16 ratio than Holstein, and the reverse was true for saturated fatty acids, i.e., C14:0, C16:0 and C18:0 fatty acids, while F_1 animals had intermediate values between their parental breeds for these fatty acids; (2) heifers had more unsaturated fatty acids in TG and PL classes than steers; (3) flank subcutaneous fat was less abundant in unsaturated fatty acids than other locations. From the above mentioned results, it was suggested that the fatty acid composition of lipid classes varied with the factors and particularly the breed effect was most remarkable.

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In beef cattle, as well as other meat animals, fat is one of the major components of the carcass and not only its quantitative distribution and partition, but also its qualitative characteristics play an important role in determining carcass quality. Therefore, the quantitative and qualitative variation of carcass fat is related to the economy and efficiency of beef production. On the other hand, its quantity and quality vary among individuals derived from different breeds, sexes, ages and feeding conditions and among fat depots[1,2]. In spite of the general recognition that there are marked differences in the propensity of fattening, the carcass quality between Japanese Black and Holstein, as well as between heifers and steers, little information is available as to the qualitative aspects of the beef carcass fat as concerned to the breed and sex.

In many reports[3-17], the quality of carcass fat was understood as its physical and chemical property or its constitutional fatty acids of total lipids. Though triglycerides normally comprise over 90% of the total lipids in adipose tissue[18], phospholipids and

other lipids, which may have important roles in flavor and in the keeping quality of meat, are still included. Therefore, it is necessary to clarify the lipid and fatty acid composition of the adipose tissue systematically. In addition, in most of these reports with regard to subcutaneous, intermuscular and visceral depot fat, only one or two samples collected from a given depots were considered as representatives of such a depot or whole body, and the effect of the location within a fat depot on these composition has not been clarified sufficiently.

The present study, as a part of the fundamental research on improving beef carcass characteristics, was conducted to determine the lipid and fatty acid composition of bovine subcutaneous fat as related to breed, sex and anatomical location at a constant slaughter weight.

Materials and Methods

Animals. Thirty-one animals were used in this study, including Japanese Black (9 steers), Holstein (8 sterrs and 2 heifers) and Japanese Black × Holstein (F_1) (6 steers and 6 heifers). They were full-fed on ordinary fattening rations from 6~8 months of age after weaning, except for the 3 Holstein steers which were limited-fed during the initial 6 month period and thereafter full fed. Most of animals were slaughtered at the end point of 550 kg live weight, but the 6 Holstein steers were slaughtered at 600 kg. The slaughter age of animals ranged from 454 to 754 days.

Sample Collection. Subcutaneous fat samples were collected from five locations on the left side of each carcass at the time of dissection after a 48 hour chilling period. The shoulder (over the 5 th thoracic vertebra), loin (over the 2 nd lumber vertebra), rump (pin bone edge), brisket (over the last sternebra) and flank (hind flank) comprised the locations. Samples were placed in polyethylene bags and immediately frozen and stored (−20℃) until required for chemical analysis.

Lipid Analysis. Frozen subcutaneous fat was crushed with a mortar and pestle. Lipids were extracted from the crushed fat samples with chloroform and methanol solvent (2:1, v/v)[19]. Each portion of the lipid extract was subsequently used for determination of total lipid contents, lipid composition and the fatty acid composition of three lipid classes.

Total lipid contents (mg/g wet tissue) were determined gravimetrically[20].

In order to determine lipid composition, the lipids were separated into classes by thin-layer chromatography (TLC) and then charred with 70% sulfuric acid saturated with potassium dicromate[21]. Quantitative estimation of each lipid class was performed densitometrically.

The fatty acid composition of triglycerides (TG), free fatty acids (FFA) and phospholipids (PL) was determined by gas-liquid chromatography (GLC) followed by preparative TLC. That is, the lipids were separated by preparative TLC and visualized according to the procedure by KATES[22]. Each lipid class was immediately scraped into an incubation tube and then methyl esterification was performed by the HCl-methanol method as described by YAMAKAWA[23].

The fatty acid metyl esters were separated on a dual column gas chromatograph, equipped with a flame ionization detector and nitrogen was used as the carrier gas at a flow rate of 60 ml/min. A 3.0 mm I. D. × 3.0 m glass column was packed with 15% diethylene succinate coated onto 80/100 mesh chromosorb W (acid washed). Column temperature program was linearly conducted by 3℃/min from 170℃ to 205℃, while detectors were maintained at 220℃. Fatty acid peak areas were quantified with an electric integrator.

Statistical Analysis. Data were analyzed by least-squares procedure[24] using the computer program, LSML 76[25]. The model included four fixed effects (i. e., breed, sex, anatomical location and nutrition level); the two-way interaction between breed and location; and pooled and within-breed partial regression on slaughter weight (average 523 kg). DUNCAN's new multiple range test was used to determine which differences between means was significant[26].

Results

Seven lipid classes, i. e., TG, PL, FFA, cholesterol (CH), diglycerides (DG), monoglycerides (MG) and cholesterol esters (CE) were identified on the thin-layer chromatogram. However, because of the trace amounts of MG and CE, these classes were not quantified. In addition, relative minor classes of CH and DG were not included in the statistical analysis (Table 1).

Table 1. Least-squares means and standard errors for total lipid contents and lipid composition[1),2)]

Effect	Total lipids (mg/g tissue)	Lipid class		
		TG (%)	PL (%)	FFA[3)] (%)
Breed				
Japanese Black	897.6(13.2)	91.4(0.6)	2.9(0.3)	3.0(0.3)
B×H (F_1)	889.3(13.5)	90.8(0.6)	2.9(0.3)	2.9(0.3)
Holstein	870.9(6.1)	92.0(0.3)	3.0(0.1)	2.7(0.1)
Sex		**	*	
Steer	880.2(7.0)	90.7(0.3)^{b}	3.2(0.1)^{a}	2.9(0.2)
Heifer	883.6(12.4)	92.1(0.5)^{a}	2.7(0.2)^{b}	2.8(0.2)
Location		**	**	
Shoulder	886.1(10.2)	91.4(0.4)^{bc}	3.0(0.2)^{a}	2.8(0.2)
Loin	883.8	90.9^{c}	3.1^{a}	3.1
Rump	891.9	91.7^{ab}	2.9^{ab}	2.7
Brisket	876.4	90.9^{bc}	3.2^{a}	3.0
Flank	891.5	92.2^{a}	2.6^{b}	2.7

1) The relative amounts of lipid classes are expressed as relative weight percentages of TG, PL, FFA, CH and DG. 2) The figures within parentheses show the standard errors. 3) The abbreviation used are as follows: TG, triglycerides; PL, phospholipids; FFA, free fatty acids. * $P < 0.05$. ** $P < 0.01$. a, b, c: Within a main effect, means in the same column with no common superscripts differ significantly ($P < 0.05$).

Twelve fatty acids were identified on the gas chromatogram of the fatty acid methyl esters of TG and FFA. Three more fatty acids were usually contained in the PL class. Therefore, the fatty acid composition of each class was expressed as weight percentages of these fatty acid methyl esters. The statistical analyses were carried out for the major fatty acids of each class (Table 2, 3 and 4).

Although the results of analysis of variance are not shown here, the nutritional level effect and the linear effect were significant for several lipid classes and their constitutional fatty acids. On the other hand, breed × location interaction was not significant for any of them.

Total Lipid Contents and Lipid Composition.

The least-squares means of total lipid contents and lipid composition by breed, sex and location are shown in Table 1.

The total lipid contents were not significantly affected by any of the factors. Japanese Black, however, had a tendency to have somewhat more total lipid content than Holstein. In the analysis of lipid classes, percentages of TG and PL were significantly affected by sex and anatomical location (Table 1). The least-squares means showed that the percentage of TG was lower ($P<0.01$) and that of PL was higher

Table 2. Least-squares means and standard errors for the fatty acid composition[1),2)] of triglycerides

Effect	Fatty acid[3)]							
	C14:0 (%)	C16:0 (%)	C16:1 (%)	C18:0 (%)	C18:1 (%)	C18:2 (%)	TUSF[4)] (%)	C18/C16[5)]
Breed	**	**		**	**	**	**	**
Japanese Black	2.3^{b} (0.2)	21.0^{b} (0.7)	6.9 (0.5)	8.2^{b} (0.7)	53.6^{a} (0.9)	2.2^{c} (0.3)	65.1^{a} (1.1)	2.2^{a} (0.1)
B×H (F_1)	2.5^{b} (0.2)	23.1^{a} (0.7)	7.1 (0.5)	8.8^{b} (0.8)	49.4^{b} (1.0)	3.4^{a} (0.3)	62.2^{b} (1.1)	1.9^{b} (0.1)
Holstein	3.0^{a} (0.1)	24.3^{a} (0.3)	6.9 (0.2)	10.3^{a} (0.3)	46.9^{c} (0.4)	2.8^{b} (0.5)	58.9^{c} (0.5)	1.9^{b} (0.01)
Sex	**	**			**		**	
Steer	2.8^{a} (0.1)	23.6^{a} (0.4)	6.8 (0.2)	9.4 (0.4)	48.8^{b} (0.5)	2.9 (0.1)	60.9^{b} (0.6)	1.9 (0.04)
Heifer	2.3^{b} (0.2)	22.0^{b} (0.6)	7.1 (0.4)	8.8 (0.7)	51.1^{a} (0.9)	2.7 (0.2)	63.2^{a} (1.1)	2.0 (0.1)
Location	*	**	**	**	**		**	**
Shoulder	2.6^{ab} (0.1)	23.8^{a} (0.5)	7.2^{a} (0.4)	8.2^{a} (0.6)	49.6^{ab} (0.7)	2.8 (0.2)	62.2^{a} (0.9)	1.9^{b} (0.1)
Loin	2.5^{b}	23.5^{ab}	7.2^{a}	8.2^{a}	50.0^{ab}	2.7	62.4^{a}	1.9^{b}
Rump	2.5^{b}	22.1^{cd}	7.3^{a}	8.7^{a}	50.5^{a}	2.9	63.1^{a}	2.0^{a}
Brisket	2.5^{b}	21.9^{d}	7.2^{a}	8.8^{a}	50.8^{a}	2.8	63.3^{a}	2.0^{a}
Flank	2.8^{a}	22.7^{bc}	5.8^{b}	11.7^{b}	48.8^{b}	2.7	59.3^{b}	2.1^{a}

1) Fatty acids are expressed as the relative weight percentages of 12 fatty acid methyl esters. 2) The figures within parentheses show the standard errors. 3) Number of carbon atoms: number of double bonds. 4) Total unsaturated fatty acids. 5) (C18:0+C18:1)/(C16:0+C16:1) ratio. *$P<0.05$, **$P<0.01$. a, b, c, d: Within a main effect, means in the same column with no common superscripts differ significantly ($P<0.05$).

Table 3. Least-squares means and standard errors for the fatty acid composition[1),2)] of free fatty acids

Effect	Fatty acid[3)]							
	C14:0 (%)	C16:0 (%)	C16:1 (%)	C18:0 (%)	C18:1 (%)	C18:2 (%)	TUSF[4)] (%)	C18/C16[5)]
Breed	*	* *		* *	* *		* *	* *
Japanese Black	1.9^{b} (0.3)	11.0^{c} (1.1)	10.4 (0.8)	5.4^{b} (0.7)	60.6^{a} (1.5)	4.0 (0.5)	77.9^{a} (1.6)	3.0^{a} (0.2)
B×H (F_1)	1.8^{b} (0.3)	13.4^{b} (1.1)	9.4 (0.8)	7.0^{a} (0.7)	56.8^{b} (1.6)	5.2 (0.5)	73.9^{b} (1.7)	2.8^{a} (0.2)
Holstein	2.3^{a} (0.1)	16.3^{a} (0.5)	9.1 (0.4)	7.6^{a} (0.3)	53.4^{c} (0.7)	4.6 (0.2)	70.0^{c} (0.8)	2.5^{b} (0.1)
Sex								
Steer	2.2 (0.1)	14.0 (0.6)	9.7 (0.4)	6.4 (0.3)	57.1 (0.8)	4.3 (0.3)	73.8 (0.9)	2.7 (0.1)
Heifer	1.8 (0.2)	13.1 (1.0)	9.6 (0.7)	6.9 (0.6)	56.8 (1.4)	4.9 (0.4)	74.0 (1.5)	2.8 (0.2)
Location		*	* *	* *			* *	*
Shoulder	2.0 (0.2)	14.8^{a} (0.7)	9.7^{a} (0.6)	6.4^{b} (0.5)	55.9 (1.2)	4.6 (0.4)	73.1^{bc} (1.3)	2.6^{b} (0.1)
Loin	2.0	13.7^{abc}	10.0^{a}	6.1^{b}	57.1	4.5	74.3^{ab}	2.7^{ab}
Rump	1.9	12.9^{abc}	10.1^{a}	6.3^{b}	57.4	4.7	74.9^{ab}	2.8^{ab}
Brisket	1.9	12.6^{c}	10.2^{a}	6.1^{b}	57.8	4.0	75.5^{a}	2.8^{ab}
Flank	2.1	13.9^{ab}	8.2^{b}	8.3^{a}	56.4	4.6	71.7^{c}	2.9^{a}

1) Fatty acids are expressed as the relative weight percentages of 12 fatty acid methyl esters. 2) The figures within parentheses show the standard errors. 3) Number of carbon atoms: number of double bonds. 4) Total unsaturated fatty acids. 5) (C18:0+C18:1)/(C16:0+C16:1) ratio. * $P<0.05$, ** $P<0.01$. a, b, c: Within a main effect, means in the same column with no common superscripts differ significantly ($P<0.05$).

($P<0.05$) in steers than in heifers. Among locations, the flank and rump subcutaneous fat had the highest percentages of TG and the lowest percentages of PL ($P<0.01$). In contrast with these locations, the reverse was true for the loin and brisket fat.

Fatty Acid Composition of TG, FFA and PL.

The least-squares means of the percentages of the major fatty acids of TG, FFA and PL are shown in Table 2, 3 and 4, respectively. The least-squares means of total unsaturated fatty acids (TUSF) and (C18:0+C18:1)/(C16:0+C16:1) ratio (C18/C16 ratio) are also shown in these tables. The latter value may reveal the degree of fatty acid chain-elongation whose activity has been demonstrated in bovine[27)], with the assumption that C16:0 is the normal product of fatty acid synthesis *de novo*.

In the TG class, all fatty acids and indices represented in Table 2 were more or less affected by breed, sex and/or location. The breed effect, however, was most prominent among three factors. Particularly, percentages of C18:1 and C16:0 fatty acids which were most abundantly contained in bovine subcutaneous fat were most remarkably affected by breed. That is to say, Japanese Black had the highest percentage of C18:1 ($P<0.01$), while Holstein had the lowest. The reverse was true for saturated

Table 4. Least-squares means and standard errors for the fatty acid composition[1),2)] of phospholipids

Effect	Fatty acid[3)]								
	C14:0 (%)	C16:0 (%)	C16:1 (%)	C18:0 (%)	C18:1 (%)	C18:2 (%)	C20:4 (%)	TUSF[4)] (%)	C18/C16[5)]
Breed		**	*	**	**	**		**	**
Japanese Black	1.2 (0.3)	13.2^{b} (1.1)	8.0^{a} (0.7)	9.2^{b} (1.0)	51.0^{a} (1.9)	3.9^{c} (0.6)	3.0 (1.0)	72.4^{a} (1.6)	4.0^{a} (0.2)
B×H (F_1)	1.1 (0.3)	15.1^{b} (1.2)	7.1^{ab} (0.7)	11.2^{b} (1.0)	41.7^{b} (2.0)	6.7^{a} (0.6)	4.0 (1.0)	66.5^{b} (1.6)	3.3^{b} (0.2)
Holstein	1.5 (0.1)	17.2^{a} (0.5)	6.2^{b} (0.3)	13.1^{a} (0.5)	39.9^{b} (0.9)	4.9^{b} (0.3)	5.0 (0.5)	62.0^{c} (0.7)	3.0^{b} (0.1)
Sex		**				*		**	**
Steer	1.2 (0.2)	17.0^{a} (0.6)	7.0 (0.4)	11.7 (0.5)	43.9 (1.0)	4.6^{b} (0.3)	3.5 (0.5)	64.8^{b} (0.8)	3.2^{b} (0.1)
Heifer	1.3 (0.3)	13.4^{b} (1.1)	7.1 (0.7)	10.6 (0.9)	44.6 (1.8)	5.7^{a} (0.5)	4.5 (0.9)	69.2^{a} (1.5)	3.7^{a} (0.2)
Location				**	**				
Shoulder	1.3 (0.2)	16.1 (0.9)	7.5^{a} (0.6)	10.3^{b} (0.8)	45.0 (1.5)	4.9 (0.4)	3.4 (0.7)	67.2 (1.2)	3.3 (0.2)
Loin	1.2	15.7	7.2^{a}	10.6^{b}	44.3	5.0	4.3	67.1	3.3
Rump	1.2	14.8	7.3^{a}	11.0^{b}	44.7	5.2	3.8	67.4	3.5
Brisket	1.2	14.3	7.6^{a}	11.1^{b}	44.3	5.3	3.9	68.0	3.6
Flank	1.4	15.1	5.9^{b}	12.8^{a}	42.8	5.2	4.5	65.3	3.5

1) Fatty acids are expressed as the relative weight percentages of 15 fatty acid methyl esters. 2) The figures within parentheses show the standard errors. 3) Number of carbon atoms: number of double bonds. 4) Total unsaturated fatty acids. 5) (C18:0+C18:1)/(C16:0+C16:1) ratio. *$P<0.05$, **$P<0.01$. a, b, c: Within a main effect, means in the same column with no common superscripts differ significantly ($P<0.05$).

fatty acids, i.e., C14:0, C16:0 and C18:0 acids. For these fatty acids, F_1 animals had a tendency to have intermediate values between their parental breeds. Only C18:2 fatty acid was contained in F_1 at a higher level than both breeds. These differences indicated that Japanese Black had the highest percentage of TUSF, while Holstein had the lowest and F_1 had an intermediate value. Since Japanese Black had the lowest percentage of C16:0 and the breed difference was smaller in C18:0 than in C18:1 (i.e., 2% vs 7%), Japanese Black had a higher C18/C16 ratio than others. Between sex, steers had a lower percentage of C18:1 and higher percentages of C14:0 and C16:0 than heifers ($P<0.01$). Thus steers had a lower percentage of TUSF than heifers ($P<0.05$). The fatty acid composition of TG class from the flank region differed from other subcutaneous locations. The flank subcutaneous fat contained the highest percentages of C16:0 ($P<0.01$) and C18:0 ($P<0.05$), resulting in the lowest percentage of TUSF. C18/C16 ratio was higher in the flank, brisket and rump than in other locations.

The least-squares means of the fatty acid composition of FFA and PL classes are shown in Tabble 3 and 4, respectively. Once again the breed effect was most

prominent in these classes, as well as that of TG. The similar tendencies to that of TG observed in the fatty acid composition of FFA and PL classes, though the percentages of a given fatty acid of each class differed from each other (for example, C18:1 fatty acid contained in the Japanese Black subcutaneous fat was 53.6, 60.6 and 51.0% with regard to TG, FFA and PL classes, respectively). C20:4 fatty acid of the PL classes, which is one of the specific polyunsaturated fatty acids localized in the cell membrane was not significantly affected by any of factors.

Discussion

In preceding reports[28,29], breed and sex differences for total lipid contents were recognized in bovine subcutaneous fat obtained from animals which were not well-fattened. The increment of total lipid contents, however, occured primarily at an early stage of growth and fattening in the pig[30], sheep[31] and cattle[31]. Therefore, in well-fattened animals, the lipid contents per unit tissue reached the maximum level and were consequently less influenced by breed, sex and location. In fact, LOVEDAY et al.[32] found that in their comprehensive crossbreeding experiment, there were no breed differences in total lipid contents of bovine adipose tissue.

A little information is available as to the lipid composition of bovine subcutaneous fat. It was reported that no lipid classes were significantly affected by breed and sex[33,34]. Though some differences were observed in our results, the lipid composition may not be so modified by breed, sex and location, as well as the total lipid contents.

The fatty acid composition of TG, FFA and PL classes were affected by breed, sex and location, and then the similar tendencies were observed in the fatty acid composition of these classes. These results corresponded with many reports in which the fatty acid composition of total lipids obtained from bovine subcutaneous fat was affected by breed[12,13,15,16], sex[5,6] and location[6,35]. Since adipose tissue was the major site of fatty acid synthesis in ruminants[2,18] and the principal fatty acids synthesized in bovine adipose tissue were C16:0, C18:0 and C18:1[27], the differences in the fatty acid composition may be due to the endogenous fatty acid synthetic mechanism including desaturation and chain-elongation. Several research workers, however, reported that in general the fatter and older the animals of a given breed, the more mono-unsaturated their depot fat becomes[5,7,13,14,16,17]. Therefore, it is possible that the breed and sex effects were confounded with age effect, since the heifers were older than the steers and the Japanese Black were also older than the Holstein, when fattening cattle were compared at a constant weight. Thus, in addition to our present study, it is necessary to compare animals slaughtered at a constant age or various stages of fattening in order to obtain exact information about the breed and sex differences.

As described in our foregoing results and discussion, the fatty acids obtained from each class was made up of primary lipids which varied with breed, sex and location. It was recognized in general that firmness of carcass fat was influenced by the fatty acid composition and TSUCHIYA et al.[4] reported that fat color was correlated with melting points and iodine numbers. On the other hand, lipids, especially fatty acids,

were one of the important precursors of various flavor compounds, such as aldehydes, primary alcohols, γ-lactones etc[36]. In the studies on meat flavor, it was revealed that the basal flavor of meat was common to meat animals, while the differences in the fatty acid composition resulted in those of carbonyl compounds after pyrolysis[37,38]. Recently, SELKE et al.[39-41] have reported that volatile components from heated model triglycerides, including tristearin, triolein and trilinolein were different from each other. From their results, it is possible that the fatty acid composition was one of the major factors associated with meat flavor. In fact, WESTERLING and HEDRICK[17] revealed that C18:1 fatty acid was positively correlated with meat flavor. It is suggested from our results and their reports that among the lipids analyzed in this study, the fatty acids were the most probable compounds which are related to meat appearance and palatability. In particular, the remarkable breed difference in C18:1 which was the most abundant fatty acid in bovine subcutaneous fat is of interest in connection with the general recognition that there are differences in fat color and quality, and meat palatability between Japanese Black and Holstein.

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牛の皮下脂肪組織中脂質および脂肪酸組成に対する品種，性および蓄積部位の影響

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と殺時体重を一定にした場合の，牛の皮下脂肪組織中脂質および脂肪酸組成に対する品種，性および部位の影響を明らかにする目的で，以下のように分析を実施した．材料は，黒毛和種（♂：9頭），ホルスタイン種（♂：8頭，♀：2頭）および黒毛和種×ホルスタイン種（F_1）（♂：6頭，♀：6頭）計31頭の肥育牛の枝肉から，解体時に得た5部位の皮下脂肪（肩，腰，臀，胸，腺）を用い，総脂質含量，脂質組成およびトリグリセリド(TG)，遊離脂肪酸（FFA），リン脂質（PL）の各画分の脂肪酸組成を求めた．総脂質含量は，黒毛和種で高い傾向が認められたが，品種を含むいずれの原因に関しても有意性は認められなかった．脂質組成に関しては，TG%とPL%において，性および部位の効果が有意であった．性間では，未経産牛が去勢牛よりもTG%が高く，PL%が低く，一方部位間では，下腺部皮下脂肪が最もTGに富み，PLが少ない傾向にあった．各画分の脂肪酸組成に対する各要因の効果は，いくつかの例外を除いて有意であり，しかも，品種，性，部位の各要因ごとにみた脂肪酸組成の差異は，いずれの画分においても類似した傾向を示した．その主要な特徴は以下の通りであった．(1)品種間では，黒毛和種がホルスタイン種よりもC18:1, TUSF(総不飽和脂肪酸割合）に富み，C18/C16比が高く，これに対して，C14:0, C16:0, C18:0などの飽和脂肪酸が少なかった．一方，F_1は両品種の中間値をとる傾向にあった．(2)未経産牛は去勢牛よりも，TG, PL画分において不飽和脂肪酸に富んでいた．(3)部位間では，下腺部で不飽和脂肪酸が最も少なかった．以上の結果，一定と殺時体重ベースでは，脂質画分中の脂肪酸組成が各要因の影響を受けやすく，とくに品種の効果が顕著であることが示唆された．

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