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Relationships of sire breeding values and cutting parts of progeny in Czech Fleckvieh bulls

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Abstract

The aim of this study was to assess the effect of the meat yield breeding values of sires on highly valued parts of carcasses in their progeny. The study was carried out on Czech Fleckviehs, a breed dual purpose milk-beef production. Cutting parts evaluated were: round, strip loin and tender loin (first-class meat); rib, shoulder blade (boneless), fore shank, flank, chuck roll + neck (second-class meat) and separable fat.

The correlation analysis showed significant negative relationships only for the relative breeding values of trading classes and the rib (r=−0.2079); relative breeding values of net daily gain with strip loin (r=−0.2433). Although strip loin is an important first-class meat cut, the correlation is rather low. Correlations between other meat cuts with breeding values were non-significant. The correlation between meat cuts and age showed the same pattern as correlations between meat cuts and weight at slaughter. Significant negative correlations were found between first-class meat and increasing age (r=−0.1979) and weight (r=−0.2884). In contrast, for second-class meat there were positive correlation with increasing age and weight (r=0.3489 for age, r=0.4495 for weight). This also corresponds with the correlation between age or weight and specific first-class meat cuts (tender loin r=−0.2804, r=−0.3413, strip loin r=−0.3710, r=−0.2012) and second-class meat (sep. fat r=+0.2360, r=+0.2951, r for correlation with age and weight respectively).

Based on the calculations of canonical analysis 27.75 % explained variability was found for variables relative breeding value of net daily gain (RBVndg), relative breeding value of trading class (RBVtc), age and weight using a linear combination of variables for individual cuts. At the same time, 14.25 % explained variability was found for cut variables which can be expressed using linear combinations of RBVndg, RBVtc, age and weight.

Keywords: meat production, breeding value, cutting parts, Czech Fleckvieh

Zusammenfassung

Beziehungen zwischen Zuchtwerten Tschechischer Fleckviehbullen und wertvollen Fleischteilstücken ihrer Nachkommen

Ziel der Untersuchungen war die Prüfung des Einflusses der Fleischzuchtwerte tschechischer Fleckviehbullen des Milchfleischtyp auf die Schlachtkörperzusammensetzung ihrer Nachkommen. Die bewerteten Fleischteilstücke waren: Keule, Roastbeef, Filet, Rippe, Bug ohne Knochen, Vorderhesse mit Sternrose, Bauch, Fleischdünnung, Kamm+Spannrippe und abtrennbares Fett. Die Korrelationsanalyse ergab signifikant negative Beziehungen der relativen Zuchtwerte der Handelklasse zur Rippe (r=−0,2097) und der täglichen Zunahme des Roastbeefs (r=−0,2433). Sowohl für Roastbeef als auch andere wertvolle Fleischteile sind die Beziehungen zwar relativ gering aber negativ. Bei den anderen Fleischteilen fanden sich keine signifikanten Beziehungen zu den Zuchtwerten. Die Beziehungen zwischen den Fleischteilen und dem Alter zeigten gleiche Werte wie zum Schlachtgewicht. Bei den wertvollen Fleischteilen wurden mit steigendem Alter und Schlachtgewicht negative Beziehungen gefunden (r=−0,1979 bzw. r=−0,2884). Im Gegensatz dazu fanden sich bei den weniger wertvollen Fleischteilen signifikant positive Beziehungen mit steigendem Alter bzw. Gewicht (r=0,3489 bzw. r=0,4495).

Auf Grund der Kanonischen Faktorenanalyse ließen sich 27,75 % der Variabilität durch linearer Kombination der Variablen relativer Zuchtwert für Nettotageszunahme (RBVndg), relativer Zuchtwert der Handelsklasse (RBVtc), Alter und Gewicht erklären. Gleichzeitig wurden 14,25 % der Variabilität durch lineare Kombination für die Variablen Fleischteilstücke sowie die Variablen RBVndg, RBVtc, Alter und Gewicht erklärt.

Schlüsselwörter: Fleischproduktion, Zuchtwert, Fleischteilstücke, Beziehungen, Czech Fleckvieh

Introduction

The economic value of Czech Fleckvieh cattle in the Czech republic includes combined milk and beef production. This is represented as a breeding value within a comprehensive breeding plan. From the point of view of meat production, farmers use a relative breeding value of net daily gain (RBVndg) and a relative breeding value of trading class (RBVtc). These values predominatly affect the use of the bull in the population and thus greater or lesser spread of relevant genes (alleles). In calculating the breeding values however, highly valued meat cuts are not taken into consideration. In this study we focused on evaluating the relations between breeding values of meat production and specific cut parameters in bull carcasses. Negative correlations can reveal deterioration in economically important meat parts of carcasses during one-way breeding in concrete breeding values.

The meat quality and carcass traits of different beef breeds has been compared in a large number of studies (KMET *et al.* 2000, CAMPO *et al.* 1999, 2000, HOLLÓ *et al.* 2008, CHAMBAZ *et al.* 2001a,b, COOPMAN *et al.* 2007, HONG *et al.* 2008, DANNENBERGER *et al.* 2006, MANDELL *et al.* 1997, PEINADO *et al.* 2009, SEENGER *et al.* 2008, SEIDEMAN *et al.* 1987, SHERBECK *et al.* 1995, PFUHL *et al.* 2007, SUBRT *et al.* 2006, CANTET *et al.* 2003). Other studies have been carried out to characterize carcass, muscle and meat quality characteristics from cull cows or bulls. JURIE *et al.* (2006) described the carcass and muscle characteristics in four French breeds of beef cull cows between 4 and 9 years of age. Most studies have focused on the evaluation of carcasses (according to SEUROP) in relation to sex, quality of feed and level of hybridisation (ŠUBRT *et al.* 2004, BJELKA *et al.* 2004). ŘÍHA *et al.* (2007) studied the cut parameters of carcasses in terms of conformity to the SEUROP classification. Monitoring was carried out on 54 samples of meat breeds, divided into heifers, bulls and bullocks. The influence of cattle category on quality parameters of carcass was examined by FILIPČÍK *et al.* 2008. The authors reported that length and depth dimensions of cattle carcasses were the best evaluated in carcasses of cows. The largest meat proportion of rounds was measured in carcasses of steers whereas in heifers the meat proportion of rounds was the smallest. Evaluation of cattle carcass classification (according to SEUROP) and qualitative parameters of beef meat was studied by ŠUBRT *et al.* (2008a, b). Their conclusions were that current classifications of carcass do not take into account parameters of meat quality. The only evaluated varibale was degree of fattening which has a positive relation to content of intramuscular fat and energy value of the meat.

Research of the relationships between carcass traits from genetic point of view is the basic condition for usage of these results in cattle breeding concerned to carcass traits and beef quality. Heritabilities of and genetic correlations between additive direct and maternal genetic effects for calf market weight, and additive direct genetic effects for carcass traits were estimated for Japanese Black cattle by SHOJO *et al.* (2006). Data were collected from calf and carcass markets in Hyogo and Tottori prefectures and analyzed separately by prefecture. The estimates of direct-maternal genetic correlations for calf market weight were positive (0.17) in Hyogo and negative (–0.63) in Tottori. The direct effect for calf market weight positively correlated with the direct effect of carcass weight (0.87 and 0.56 in Hyogo and Tottori, respectively) but negatively correlated with the direct effect of beef marbling score (–0.10 in both prefectures). The estimates of genetic correlations between the maternal effect for calf market weight and the direct effects for carcass traits varied from –0.13 to 0.34 in Hyogo and from –0.14 to 0.15 in Tottori. DINIUS and CROSS (1978) studied feedlot performance, carcass characteristics and meat palatability of steers. Daily live weight gain was not significantly different (P>0.05) among treatments; however, the experimental periods were relatively short. Dressing percentage increased as the period of feeding concentrate increased. Differences in marbling were reflected by differences in USDA quality grade. Length of the period that concentrate was fed had little influence on cooking properties of the meat or palatability as judged by a trained taste panel. Extractable lipid from the longissimus muscle increased, the relative percentage of stearic acid decreased and that of oleic acid increased as the period of feeding concentrate increased.

Also, qualitative traits of beef become important in last years due to consumers requirements. So, new breeding traits were formulated and research in cattle selection was done. DIKEMAN *et al.* (2005) found that considerable variation exists in Warner-Bratzler shear force of *longissimus* muscle steaks from progeny of different breeds and from progeny among sires within breeds. It would be expected that 20 to 25 % of *longissimus* muscle steaks from yearling finished cattle would be unacceptable in tenderness unless effective electrical stimulation, needle tenderization, and/or aging longer than 14 days are used. Selection for marbling to improve tenderness would be expected to result in only subtle improvements in tenderness in most breeds. Heritability estimates and expected progeny differences for tenderness are sufficiently large in Simmental, Shorthorn, and Hereford breeds to allow breeders to begin to improve tenderness genetically.

Prediction of breeding values for tenderness of market animals was studied by BARKHOUSE *et al.* (1996). Data were tenderness measures on steaks from 237 bulls (Group II) slaughtered after producing freezable semen and on 1 431 related steers and heifers (market animals, Group I) from Angus, Hereford, Pinzgauer, Brahman, and Sahiwal crosses. The range in predicted breeding values of bulls for market animal tenderness was small and from

−0.34 to 0.32 kg for market animal shear force. If a mean of heritability estimates reported in the literature of 0.27 for shear value is assumed for market steer and heifer progeny instead of 0.02 as found in the present study, then selection based on estimates of shear force in young bulls would be relatively more effective in improving the shear force of market progeny.
Also, concrete tools for breeding and selection to carcass traits were described. VLECK *et al.* (1992) examined the genetic evaluation of sires and dams using an animal model for carcass traits based on measurements on slaughtered crossbred steers. This result, if valid using larger sets of data, may reduce the need for breeding values across breeds. Separate evaluations by breed followed by selection within breed would seem to be effective. The analysis described uses records from crossbred animals. For carcass traits, the carcass characteristics of the crossbred animals are the most direct measures of estimated breeding values of parents. Consideration of breed effects in genetic evaluation would allow monitoring of changes in differences among breeds. Such information would aid in making decisions for crossbreeding.

In this study we want to explore genetic relationships between present using breeding values in Czech Fleckvieh and carcass traits to prevent negative influence of selection to valuated carcass parts.

Material and methods

Investigation of the correlation between breeding value of meat production and highly valued meat cuts of carcass was studied in bulls of Czech Fleckviehs which is a dual purpose breed with combined milk beef production. The following cut parameters were used: rib, shoulder blade, fore shank, flank, round, striploin, tender loin, chuck roll+neck, sep. fat, first-class meat and second-class meat. The first-class meat group: shoulder blade, round, striploin and tenderloin. The second-class meat group: rib, fore shank, flank, chuck roll+neck. Studied were 185 samples. Slaughter took place over 321 to 899 days. Highly valued meat was weighed (in kg) and presented in percent from halfbody of carcasses (HC).

First, data were analysed using canonical analysis to analyse basic relationships in the two groups of selected parameters. The group on the right consisted of selected cuts. The group on the left consisted of relative breeding values, age and weight. A detailed correlation analysis was then performed between each parameter in the two described groups. Basic correlational statistics (correlation coefficient, *P*-value of model fit) were calculated as a description of derived relationships. The next step in data analysis was to estimate multivariate relationships between each meatinnes part and sample of selected parameters, to estimate the effect of trading class on cut. General linear models (GLM) in design described below (one fixed categorial effect-trading class in SEUROP, four fixed countinuous variables) were used for this purpose.

$$Y_{ijklm} = \mu + S_i + RBVndg_j + RBVtc_k + A_l + W_m + e_{ijklm} \quad (1)$$

where Y_{ijklm} is the estimate value of each cut, μ is the mean value, S_i is the class in SEUROP, $RBVndg_j$ is the relative breeding value of net daily gain, $RBVtc_k$ is the relative breeding value of trading class, A_l is the age at slaughter (in days), W_m is the weight (in kg) and e_{ijklm} is the residual error.

As a last step in analysis of cuts and routine recorded parameters, hierarchical a cluster analysis (with 1-r criterion for clusters' joint) was done. The hierarchical tree as a result of this analysis shows mutual relationships of cuts and aggregation parameters of meat yield based on correlations. For statistical data analysis, we used STATISTICA 8 software (Statistica 2008).

The data included the breeding value of meat production of bulls from December 2008. The analysis included: relative breeding value of net daily gain (RBVndg) and relative breeding value of trading class (RBVtc). For the progeny of test bulls these breeding values included (from the Progeny meat-test station) mainly: net daily gain, trading class and share of highly valued meat. For the sire (tests of the animal´s own performance in rearing centres) included the breeding value net daily gain and musculing. The calculation of breeding value did not include concrete data for highly valued meat e.g. share of shoulder blade, striploin, tenderloin, etc.

Results and discussion

Table 1 expresses the basic statistical data for examined traits. The table shows the average values and standard deviations. The age of slaughtered animals, and their corresponding weight ranged from 312 days (395.20 kg) to 899 days (811.85 kg). An important indicator in terms of meat yield is the proportion of the first- and second-class meat, or specific meat cuts of carcass. The average proportion for the first-class meat from HC was 15.86 % (min. 13.68 %, max. 21.64 %), for the second-class meat was 33.23 % (min. 28.07 %, max. 37.44 %).

Table 1
Basic statistical analysis of studied meat traits
Analysenwerte der erfassten Merkmale

Parameter	Average	Minimum	Maximum	S_x
Relative breeding value of net daily gain	100.57	84.00	122.00	7.48
Relative breeding value of trading classes	96.33	74.00	111.00	8.14
Age, days	556.64	321.00	899.00	82.47
Weight, kg	583.22	395.20	811.85	71.02
Rib, % of HC	11.25	7.92	15.52	1.26
Shoulder blade, boneless, % of HC	6.72	4.01	8.92	0.62
Fore shank, % of HC	3.36	1.95	4.54	0.38
Flank, % of HC	4.50	3.33	5.99	0.49
Round, % of HC	19.15	15.76	22.86	1.27
Strip loin, % of HC	4.41	3.36	5.36	0.37
Tender loin, % of HC	1.49	1.12	2.19	0.15
Chuck roll+Nec, % of HC	11.23	7.88	16.06	1.37
Separable fat, % of HC	2.82	1.04	6.84	1.03
First-class meat, % of HC	15.86	13.68	21.64	0.94
Second-class meat, % of HC	33.23	28.07	37.44	1.66

Based on the results of canonical analysis 27.75 % explained variability in the context of the controlled variables of the left set of parameters (RBVndg, RBVtc, age and weight) can be explained using single cuts. At the same time, it was found that only 14.25 % of explained variability of meat cuts – variables of the right set of parameters can be explained using RBVndg, RBVtc, age and weight. The parameters for meat cuts contains a higher proportion of unexplained variability within the set design of the evaluation and this corresponds with other results. Summary parameters of the left set contain 27.75 % variability which can be explained by linear combinations of meat cuts. In essence, this explanation based on a weighted sum of parts of the carcass, assumes that a substantial part of these sum parameters (with the exception of the genetic potential of their parents, their own performance, etc.) will be made up of the very process of cutting the carcass. Conversely, the lower percentage of explained variability in meat cuts using linear combinations of the left set of parameters reflects the fact that the breeding of beef cattle is not a priori based on the proportion of individual cuts of carcass.

Analysis of single partial correlations of parameters of both groups was the next step in the analysis of the data. Correlation and pattern of the regression curves of the studied traits are listed in Table 2 and Figure 1 and 2.

Correlation analysis of relative breeding values (RBVndg, RBVtc) revealed a significant relationship only to striploin (r=−0.2433) and rib (r=−0.2079) – Table 2. The correlation was negative showing the higher breeding value leads to decreasing the proportion of striploin and rib. Although striploin is a highly valued meat first-class meat cut, the correlations found were low. The correlation between the other meat cuts and breeding values were not significant. These relationships are also expressed in Figure 1. From this chart the relations of breeding values to highly valued cuts of carcass (especially shoulder blade, round, first-class meat, striploin, flank, sep. fat, tender loin and fore shank) are evident. It is also obvious these relations are not close. Similar conclusions are also evident from Figure 2 which shows the pattern of the regression curve. From these charts (1 and 2) and also tables 2 and 3 a low degree of dependence to independence of single meat cuts on breeding values is apparent. Only in the case of tenderloin and rib have significant but low regression coefficients been reported.

Correlations of age (or weight) at slaughter calculated for single cuts showed the same pattern. First-class meat has significantly negatively correlates with increasing age (r=−0.1979) and weight (−0.2884). In contrast, for second-class meat were found significant positive correlations with increasing age and weight (r=+0.3489 age, r =+0.4495 weight). This also corresponds with a correlation between age or weight and specific meat cuts belonging first-class meat or second-class meat. For instance, a correlation of age and weight with tenderloin (−0.2804, −0.3413) and striploin (−0.3710, −0.2012) had the same significant negative trend. Similar results for longissimus muscle were reported by SCARTH *et al.* (1973) and HINER and BOND (1971) Proportion of LM decreased with age of animals. HINER and BOND (1971) also reported decreasing during the 36 months' growing period for the semimembranosus, rectus femoris and adductor muscles. DE-SILES *et al.* (1977) compared proportion of round between two groups with different weights. Proportion of trimmed round were non-significantly lower in heavier animals. In contrast to first-class meat, the proportion of separable fat increased significantly with the increasing age (r=0.2360) and weight (r=0.2951). These trends are also evident from Figure 2, showing the pattern of the regression curve. These results are in general consistent with those reported by ARTHAUD *et al.* (1977) and SCARTH *et al.* (1973).

Table 2
Correlation analysis of studied meat cut traits and breeding values
Korrelationsanalyse der Fleischteilstücke und Zuchtwertschätzung

Parameter, % of HC	RBVndg	*P*	RBVtc	*P*	Age, days	*P*	Weight, kg	*P*
Rib	−0.0744	0.314	−0.2079	0.005	−0.0528	0.476	0.1382	0.061
Shoulder blade, Boneless	0.0363	0.624	0.1049	0.155	0.1469	0.046	0.0576	0.436
Fore shank	−0.0949	0.199	−0.1039	0.159	0.1355	0.066	−0.3381	0.000
Flank	0.0003	0.996	0.0420	0.571	−0.1020	0.167	0.2317	0.002
Round	−0.0400	0.588	0.1181	0.109	−0.1144	0.121	−0.2404	0.001
Strip loin	−0.2433	0.001	−0.0115	0.876	−0.3710	0.000	−0.2012	0.006
Tender loin	0.0312	0.673	−0.1304	0.077	−0.2804	0.000	−0.3413	0.000
Chuck roll+Neck	0.0170	0.819	0.0535	0.470	0.2732	0.000	0.4252	0.000
Separable fat	−0.0308	0.677	−0.1399	0.058	0.2360	0.001	0.2951	0.000
First-class meat	−0.1139	0.123	0.0726	0.326	−0.1979	0.007	−0.2884	0.000
Second-class meat	−0.0549	0.458	−0.0904	0.221	0.3489	0.000	0.4495	0.000

RBVndg relative breeding value of net daily gain, RBVtc relative breeding value of trading classes, HC

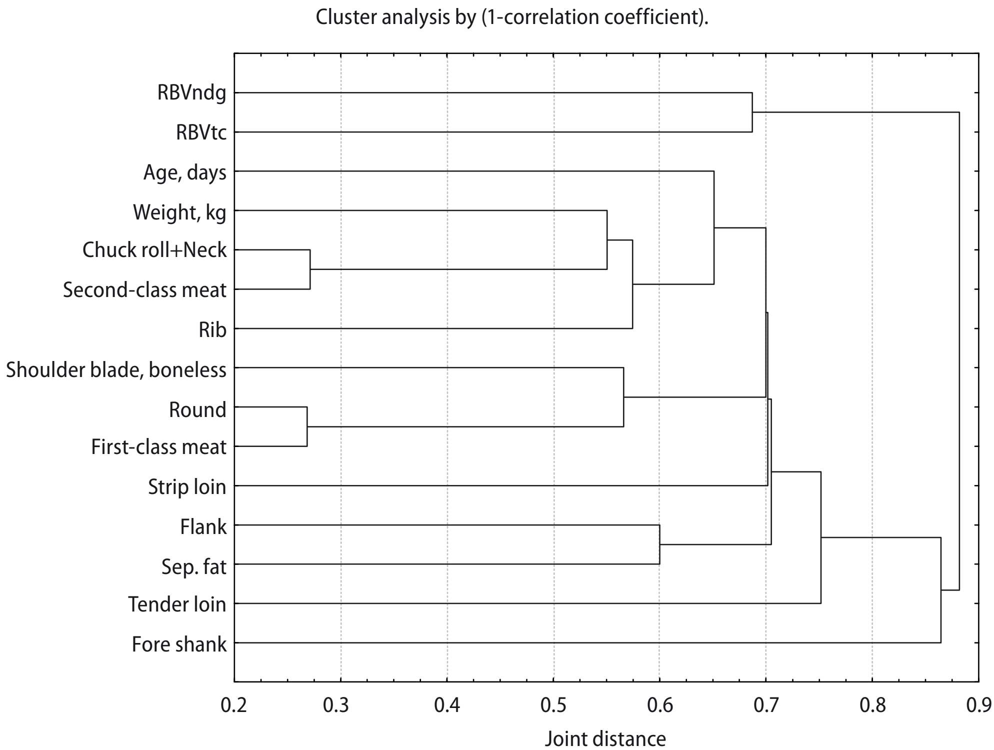

Figure 1
Cluster analysis dendrogram for studied parameters
Dendogramm der untersuchten Parameter

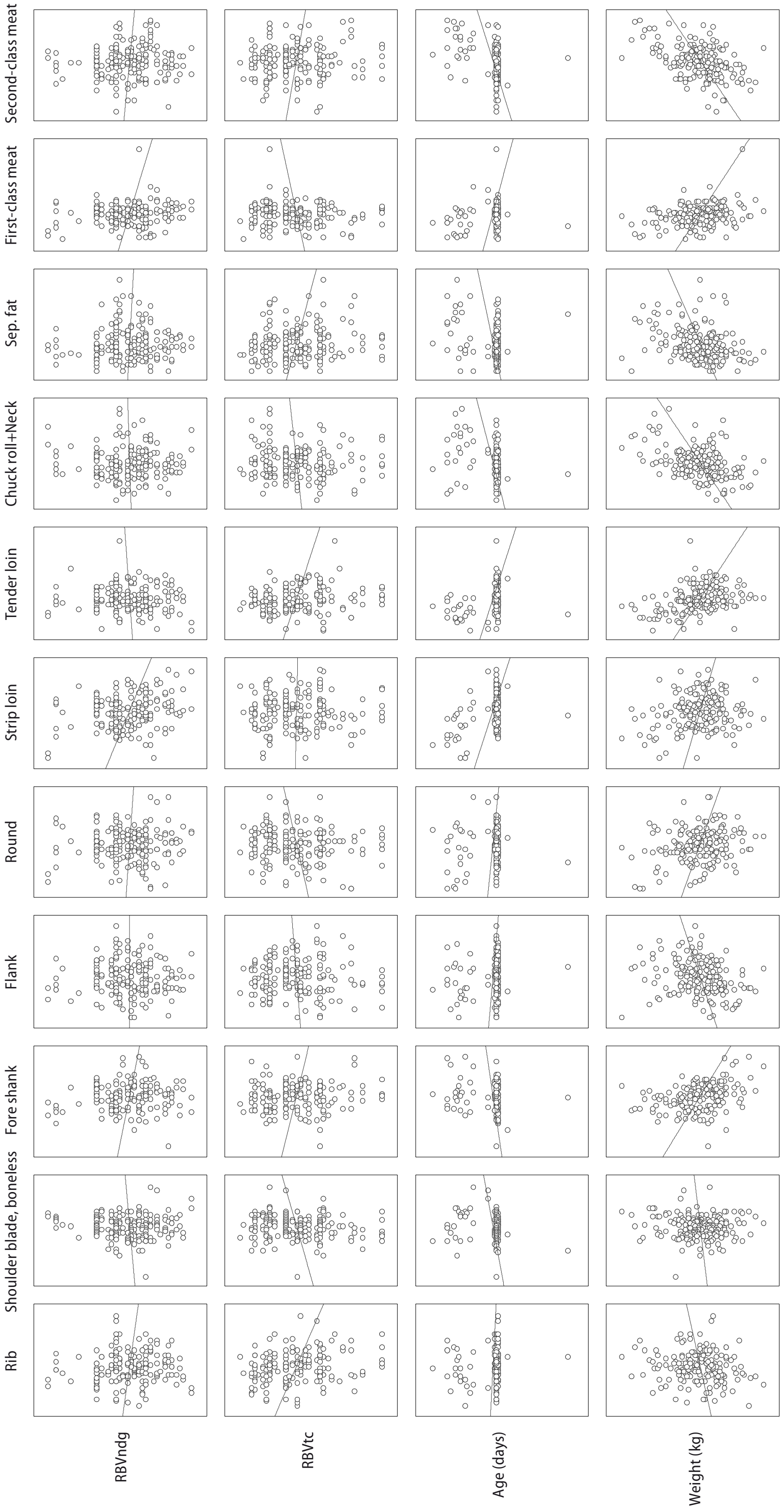

Figure 2
Correlations between studied meat cut traits and breeding values, weigth and age
Korrelationen zwischen Fleischteilstücken, Zuchtwerten, Alter und Gewicht

Detailed analysis of the linear relation of studied parameters to single meat cuts allows us to draw similar conclusions as in the analysis of partial correlations. In Table 3 is shown one-test of significance for single model of single meat cuts and coefficients r^2. In all cases, the models show significant differences between the predicted values and residuals and are significant for all studied variables. In this case too there was a significant effect of breeding values only on the rib (RBVtc) and striploin (RBVndg) and further a significant effect of RBVtc in the model for tenderloin.

Table 3
Basic statistical parameters of linear models for studied meat cuts
Basisparameter der Linearmodelle für erfasste Fleischteilstücke

Parameter, % of HC	r^2	*P*	RBVndg	RBVtc	Age, days	Weight, kg	Traiding class
Rib	0.0821	0.0173*	0.7761	0.0074**	0.1572	0.0290*	0.7427
Shoulder blade, boneless	0.1140	0.0013**	0.8317	0.2679	0.4657	0.7925	0.0006***
Fore shank	0.1961	0.0000***	0.7062	0.4588	0.0010**	0.0000***	0.1993
Flank	0.1140	0.0013**	0.6439	0.5083	0.1117	0.0021**	0.0716
Round	0.1239	0.0006***	0.2946	0.1413	0.4338	0.0001***	0.0088**
Strip loin	0.2117	0.0000***	0.0006***	0.6368	0.0000***	0.3853	0.48816
Tender loin	0.2075	0.0000***	0.0980	0.0148*	0.0267*	0.0002***	0.1133
Chuck roll+Neck	0.2852	0.0000***	0.3619	0.4713	0.1926	0.0004***	0.0002***
Separable fat	0.1305	0.0004***	0.8953	0.1547	0.0360*	0.0011**	0.6297
First class meat	0.1428	0.0001***	0.0642	0.3123	0.0513	0.0001***	0.0534
Second class meat	0.2730	0.0000***	0.2276	0.4677	0.0037**	0.0001***	0.2507

***$P<0.001$, **$P<0.01$, *$P<0.05$, RBVndg relative breeding value of net daily gain, RBVtc relative breeding value of trading classes

The effect of weight (or age) at the time of slaughter on proportion of single meat cuts is, in the combined linear relation to cuts in many cases significant or highly significant (except for shoulder blade and striploin) (Table 3). Evaluation of the effect of SEUROP classification (trading class) has shown a significant effect of this factor mainly in the traits: shoulder blade, round and chuck roll+neck (Table 3).

A dendrogram made by using cluster analysis performed on the basis of mutual correlations (Figure 1) shows the close dependence of the both breeding values and their summative value on the percentage proportion of single meat cuts. The dendrogram also shows the interrelationship of clusters of single cuts. In conclusion the correlation analysis showed significant negative relationships only for the relative breeding values of trading classes and the rib and relative breeding values of net daily gain with strip loin. Although strip loin is an important first-class meat cut, these correlations are low and the effect is not great. For the other traits of breeding values correlations with different cutting parts were non-significant. Correlation relationships of age (or weight) at slaughter showed significant negative correlation with first-class meat. In contrast, for second-class meat were found significant positive correlations with increasing age and weight. This also corresponds with correlation relations of specific meat cuts, divided into the first or second class.

Based on the results of canonical analysis was found 27.75 % explained variability in the context of studied variables of the left set of parameters (RBVndg, RBVtc, age and weight), which can be explained by single meat cuts. At the same time, only 14.25 % explained variability of meat cuts – variables of the right set of parameters was found which can be expressed by using linear combinations RBVndg, RBVtc, age and weight.

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