Evaluation of Cattle's Dressing Percentage and Meat Yield in Latvia

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ABSTRACT

The article presents results of study of main factors, which affecting quality of cattle carcass, where quality is defined as carcass grading or classification (class, category, fat cover) result, dressing percentage and meat yield. The classification result is comprised of cattle sex, age and fatness and muscle development – conformation evaluation, additionally to these factors also animal's breed or crossbreed and weight are taken into account. The paper shows analysis of bovine animals dressing percentage, where data acquired by trial method, obtaining dressing percentage of 1,228 carcasses according to cattle population and classification results. The anatomical dissection for obtaining the meat yield and meat yield ratio was done for cattle carcasses (n=118) of different classes and categories. The data were analyzed, using statistical data processing and factorial regression analysis. It was established that the fat class of cattle carcass has the most significant impact on the meat yield and can be considered statistically proven; and dressing percentage and meat yield ratio for male (categories A, B and C) bovine animals is higher than for female (categories D and E) animals. The statistical model for prediction of meat yield is presented.

Keywords: cattle, carcass, dressing percentage, meat yield, Latvia.

1. INTRODUCTION

The cattle breeding and beef production branch is one of the main agricultural branches for the following reasons:

- it has next highest proportion (6%) in agricultural goods value structure after such branches like milk, cereals, pork and potatoes; although till now the main reason behind this had been mostly the development of dairying in Latvia;
- it is one of the sources of manure, necessary for soil fertility assurance and conservation;
- the Common Agriculture Policy of European Union measure (pasturing) for grassland and meadow keeping, in order to receive area Single Area Payments.

The aim of this study was to assess main factors influencing cattle carcase's quality characteristics. The following considerations formed the necessity to study impact of various bovine carcass quality factors (breed, category, class of conformation and fat cover, etc.) on

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dressing percentage and meat yield; and to establish the cattle dressing, i.e., ratio of carcass weight to live weight, and also meat yield, taking into account carcass classification results for:

- breeders should have clear guidelines on preferable bovine quality indices;
- abattoirs, depending on carcass realization's kind, give their guidelines and requirements of necessary indices of delivered cattle to breeders;
- Supervising Authorities could inspect and find the circulation of meat of potentially unknown origin, comparing the amount of meat, obtained from purchased bovine, to amount of meat used in further processing.

2. MATERIALS AND METHODS

The trial for determination of main factors, which have an impact on quality of cattle carcasses were carried out during 19th of June to 6th of September 2006 at the abattoir of J/C "Ruks" (Cesis). In the trial 1228 bovine animals were slaughtered for obtaining dressing percentage and 118 out of them - representative sample were subjected to detailed anatomical dissection for evaluating meat or beef yield.

At first cattle carcasses were classified into the following categories: A – carcasses of uncastrated young male animals of less than two years of age; B – carcasses of other uncastrated male animals; C – carcasses of castrated male animals; D – carcasses of female animals that have calved; E – carcasses of other female animals.

The indicators determined for each slaughtered cattle are as follows: identification number, breed or crossbreed, age, live weight, carcass or slaughter weight and classification class and category. The classification of cattle carcasses was performed according to the requirements of Commission Regulation No 103/2006 (Commission of the European Communities, 2006) and Council Regulations No 1183/2006 (Council of the European Communities, 2006).

For each carcass, which had scheduled for dissection, weight was evaluated after fat removing or trimming. The weight of different parts of carcass was estimated and dressing percentage of slaughtered animals was calculated using the following formula:

$$y = \frac{S*100}{L} \quad (1)$$

where, y – dressing percentage, %; S – slaughter weight, kg; L – live weight, kg.

Retail meat or beef yield of dissected animals was calculated using the following formula:

$$y = \frac{\sum(L + Te + F + Br + S + Sh + C + N + Tr)*100}{CW} \quad (2)$$

where, y – retail meat or beef yield, %; L – leg, kg; Te – tenderloin, kg; F – flank, kg; Br – brisket, kg; S sirloin, kg; Sh - shoulder, kg; C – chuck, kg; N – neck, kg; Tr – trimming; CW - cold weight of carcass, kg.

For estimation of meat yield of cattle carcasses and influencing factors the factorial or multiple regression analysis were carried out using special modelling program "R" ("R", 2006) that

provides a wide variety of statistical and graphical techniques (linear and non-linear modelling, statistical tests, time series analysis, classification, clustering, etc.). The parameters were analyzed in two ways: in absolute units (e.g. weight) and in relative (percentage) expressions, where carcass weight; meat yield and losses had referred against slaughter weight, but carcasses' fraction weight - against meat yield. The following categorical parameters that have an impact on meat yield were analyzed: breed; category; conformation - muscle development class and fat cover class. The representative data has analyzed by evaluating different cross-section's distribution on the categorical variables.
All data were analyzed with simple correlation analysis using Pearson's correlation coefficients and general linear models procedure. The correlation of categorical variables was described with Kendall tau rank correlation coefficient, because several researchers (Agresti, 1996; Ferguson et.al., 2000; Cailliez, 1983) noted that Pearson's correlation is fairly robust and it usually agrees well in terms of statistical significance with results obtained using Kendall's rank correlation (On the relationship between…; Kendall's Tau…). If the x and y values are independent, Kendall's tau will be close to 0. Kendall's tau-b is a nonparametric measure of association based on the number of concordances and discordances in paired observations. The formula for Kendall's tau-b is:

$$\tau = \frac{\sum_{i<j} \operatorname{sgn}(x_i - x_j)\operatorname{sgn}(y_i - y_j)}{\sqrt{(T_0 - T_1)(T_0 - T_2)}} \tag{3}$$

where: $$T_0 = {n(n-1)}/{2} \tag{4}$$

and $$T_1 = {\sum t_i(t_i - 1)}/{2} \tag{5}$$

For establishing statistical model in addition the correlation analysis were carried out where base parameters was complemented with age and live weight square and logarithm values as well as with controllable (dependent) variable   meat yield. This approach was chosen in order to incorporate in model cattle's biological traits and their effect on meat yield.

3. RESULTS

Researcher K. Bruns (2005) pointed out that economically important factors for cattle evaluation are: live weight; dressing percentage; muscle development or conformation; fat thickness; meat yield; and quality grade. The dressing percentage is one of many factors affecting the value of a slaughter animal (The Beefsite, 2006). A basic knowledge of dressing percentage is important in understanding slaughter cattle pricing system and pricing variability.
According to researches of different authors (Hunsley, 1999; Mc Kieran et.al., 2007; Peterson et al., 2002; Yeates, Gaden, 1998; Department of Primary Industries and Fisheries, 2006) there are many factors, which affect dressing percentage, for instance: sex, age, weight, fatness, weight, muscularity, gut fill, feed type, breed, pregnancy status, weather conditions. Any factor which affects either live weight (such as gutfill) or carcass weight (such as bruising or deduction for

shrink) affects dressing percentage (Agyemang et al., 1997) - the ratio of carcass weight to live weight; and meat or beef yield.
The categories structure of slaughtered animals in our trial is as following - 46% from all slaughtered animals (n=1229) represent Category A and 32% represents Category D (Categories have been determined in accordance with European Union classification system – SEUROP). Detailed distribution into categories of slaughtered and dissected animals is shown in Table 1.

Table 1. The distribution of slaughtered and dissected cattle by categories

Category	Slaughtered animals		Dissected animals	
	Number	%	Number	%
A	566	46	61	52
B	34	3	9	8
C	50	4	7	6
D	392	32	28	24
E	187	15	13	11
Total	1229	100	118	100

The following different breeds and crossbreeds have represented slaughtered animals by one to nine animals: Hereford; Holstein Black&White; Limousin; Charolais; Latvian Brown; Aberdinangus; Angler; Danish Red; Holstein Red&White; Swedish Red&White; Belgian Blue. However, these data are not presentable and might be coincidental for evaluation breeds as factor influence. While, the age of the slaughtered bovine animals ranged from 1 to 187 months (cows). The basic statistics of the data are shown in Table 2.

Table 2. The statistical indices for different cattle and their carcasses characterizing features

Indices	Age, month	Live weight, kg	Carcass weight, kg	Meat yield, %	Dressing, %
Minimum	11.00	272.00	121.80	58.36	38.20
Average	34.94	471.02	237.71	74.73	50.37
Maximum	187.00	778.00	443.20	82.04	62.38
Standard deviation	34.95	94.00	57.03	3.73	4.90

Important indicator analyzed here is meat yield ratio since it shows the saleable, i.e, valuable meat ratio to live weight. Knowing this indicator, it is possible to deduce, which types of cattle are more valuable to be breed. Meat yields in each category by conformation and fat cover classes show a connection - leaner carcasses, i.e., with lower fat cover class have higher meat yield. Some foreign researchers (Yeates, Gaden, 1998) have similar observations, proving in their research that fat cover increasing by 1 mm and the meat yield ratio decreases by 1%. So we can affirm that fatter cattle tend to have a higher dressing percentage, but lower retail beef yield due to extra trimming. Analyzing this data, a following question arises: if farmers should breed fatty bovine animals with better-developed muscles or leaner animals with lesser-developed muscles, since the meat result is similar. The statistical indices for dressing percentage and meat yield are given in Table 2.
For describing relationship between categorial variables the correlation analysis were carried out. Correlation of categorial variables was described with Kendall's tau rank correlation coefficient

using statistical modelling program “R”. Correlation coefficients of variables are summarized in Table 3.

Table 3. The correlation coefficients of different categorial variables (n=118)

Indices	Breed	Category	Conformation class	Fat cover class
Breed	1.00	-0.13	-0.07	0.00
Category	-0.13	1.00	-0.01	0.30
Conformation class	-0.07	-0.01	1.00	-0.04
Fat cover class	0.00	0.30	-0.04	1.00

Results of author’s analysis show that correlation between variables was not marked. High correlation is between cattle category and fat cover class but it is not significant. Although Kendall’s tau-b correlation coefficient is indicator whose values increases faster than Pearson’s correlation coefficient that is more traditionally used however value 0.3 describes low connection or correlation. The main conclusion is that all variables, which were subjected to analysis, are independent and can be used in other analyses where this independence is essential (e.g. regression analysis).

In continuance of research were arranged variables of statistical model, carried out observations of descriptive statistics and correlation analysis of continuous variables. For analysis were used variables that was given previously and: dressing percentage (% from live weight); meat yield (% from warm carcass weight); meat yield (% from live weight); meat yield (% from cold carcass weight); losses (% from carcass weight); meat yield by fractions, %. Yet, the amount of descriptive data about distribution of cattle breed’s continuous variables (minimum, average and maximum, standard deviation), which was obtained was big, their analysis’ result did not show significant relationship. For determining character of relationship between continuous variables of representative sample of cattle carcasses were carried out appropriate correlation analysis. In this case was calculated Pearson’s correlation coefficient (Edwards, 1976), where results are shown Table 4.

Table 4. Pearson’s correlation coefficients of base statistical indices of cattle and their carcasses

Indices	Age	Live weight	Age square	Live weight square	Age logarithm	Live weight logarithm	Meat yield
Age	1.000	0.373	0.959	0.355	0.955	0.380	0.373
Live weight	0.373	1.000	0.265	0.991	0.460	0.990	1.000
Age square	0.959	0.265	1.000	0.247	0.840	0.275	0.265
Live weight square	0.355	0.991	0.247	1.000	0.446	0.963	0.991
Age logarithm	0.955	0.460	0.840	0.446	1.000	0.462	0.460
Live weight logarithm	0.380	0.990	0.275	0.963	0.462	1.000	0.990
Meat yield	0.373	1.000	0.265	0.991	0.460	0.990	1.000

* $p<0.05$

The animal’s age and one of the weight parameter have been incorporated in factorial regression analysis model, as degree of the correlation between these variables is low. The live weight was chosen as base parameter, because it is more frequently used and for practical purposes more easily definable. The relationship between different variables has evaluated, where the results indicate that dressing percentage has influenced by animal's age and carcass weight. The correlation coefficients - r are 0.502 and 0.272, respectively, which specify medium relationship. In its turn, meat yield has been influenced by dressing percentage and animal's age - r=0.246 and 0.182 (Table 5). Significant differences between indices of the male and female animals were recognized. For instance, the meat yield of male representatives has influenced by their live and carcass weight, while, the meat yield of female representatives has influenced by their age.

Table 5. The correlation coefficients that represents linear relationship between two different variables

Relationship between two variables, (n=118)	Correlation coefficient (r)*		
	Slaughtered animals	Male animals	Female animals
Dressing percentage - age	0.502	0.176	0.440
Dressing percentage - live weight	0.031	0.445	0.037
Dressing percentage - carcass weight	0.272	0.617	0.269
	Dissected animals	Male animals	Female animals
Meat yield - age	0.182	0.062	0.261
Meat yield - live weight	0.099	0.021	0.144
Meat yield - carcass weight	0.030	0.114	0.319
Meat yield - dressing percentage	0.246	0.304	0.427

* p<0.05

The regression function of factorial analysis has been performed by continuous variables of animal's live weight (kg) and age (month) logarithm. The following statistical model – regression equation (6) has obtained, which well describes meat yield (kg) from animal dependence from its live weight and age, where unexplained impact is less than 2%:

$$y = b_1 * x \; + b_2 * x_2 \tag{6}$$

where predictor is y - meat yield (kg), independent variables x1 - live weight(kg) and x2 - animal age(month) natural logarithm ; and regression coefficients are following:

b_1 = + 0.4374 Standard deviation = 0.018; t-test value = + 26.7
Pr(>|t|) < 2e-16

b_2 = – 20.411 Standard deviation = 2.57; t-test value = – 7.95
Pr(>|t|) = -7.947 1.50e-12

4. CONCLUSIONS

The trend that higher dressing percentage is for fatter (3, 4 and 5 fat cover classes) and more muscled (U, R and O conformation classes) carcasses have observed in the trial, which has done in Latvia.

For estimation the following factors, which influenced meat yield: category of bovine animal, carcass conformation and fat cover classes, the main relationship has been observed - leaner carcasses, i.e., with lower fat cover class have higher meat yield. The lower meat yield ratio for fatter carcasses is due to extra trimming procedure or process.

Significant differences between indices of male and female animals were recognized. For instance, meat yield of male representatives has influenced by their live and carcass weight, while, the meat yield of female representatives has influenced by their age.
The following statistical model – regression equation for prediction of bovine animal's meat yield (kg) was obtained, which well describes meat yield (kg) dependence from animal's live weight (kg) and age (month) logarithm, where unexplained impact is less than 2%:
$y = 0.44 * x_1 - 20.41 * \ln x_2$.

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