Topic 3: Contemporary development of processing of raw materials of animal origin (meat quality evaluation)
Practical example

As already mentioned in the theoretical lecture, it is important to determine the fat and muscle content in the carcass. Various instrument methods are used for this purpose; injection probes are often used, such as the fat o meter, which you can see in the first picture.
Using this device, the back fat thickness and the Musculus longissimus dorsi muscle thickness were determined in 20 pig carcasses. At the same time, the lean meat content was determined by dissection of the same carcasses. The input data is shown in this table.
Our task will be to find out whether the back fat thickness and the muscle thickness correlate with the lean meat content and, therefore, whether it is possible to use these measured values to predict the lean meat content in the carcass.
We will solve the task using multivariate correlation and regression analysis. In this case, we will choose the lean meat content as the dependent variable; the independent variables will be the measured characteristics, i.e., the back fat thickness and the muscle thickness. Correlation analysis will first allow us to assess the relationship between the dependent and two independent variables. The strength of this relationship is given by the correlation coefficient, denoted by the lowercase letter r, whose absolute value ranges between 0 and 1. The higher the value of the correlation coefficient, the stronger the relationship. We say that the variables (or traits) are correlated. That means if independent variables change, the dependent variable will change as well.
Subsequent regression analysis will allow us to mathematically describe the detected relationship. Here, we see a regression equation where y is the dependent variable; in our case, the lean meat content, x1, x2 are the independent variables, the back fat thickness and the muscle thickness, and b1, b2 are regression coefficients, indicating the change in the dependent variable, when the independent variable changes by one unit. The intercept does not have a direct biological interpretation, but it is important for the correct mathematical description of the relationship in the equation.
We can use, for example, the MS EXCEL for these calculations.
In the sheet where we have already written down the input data, we choose the option Data, then select Data Analysis from the toolbar, choose Regression from the menu, and confirm with the OK button.
In the following dialog window, we enter the data from which we want to calculate the regression. As the input area Y, we choose the column where the values of the dependent variable LMP (that is the lean meat content) are listed. As the input area X, we select and mark both columns with the values of independent variables (that is, the measured values of back fat thickness and muscle thickness). After confirming with the OK button, the results will be displayed on the new sheet.
The high correlation coefficient r = 0.82 indicates a close relationship between the lean meat content and both independent variables, back fat thickness and muscle thickness. The coefficient of determination shows us the proportion of variability of the dependent variable explained by the selected regression model. The value of 66% is relatively high and shows that the given model was well designed, which is also confirmed by the very low significance value of the F statistic.
To construct the regression equation, we find in the results the values of the necessary parameters, the intercept (61.92), and both regression coefficients - for the back fat thickness, the regression coefficient is -0.97 (we insert it into the equation as b1) and for the muscle thickness, the regression coefficient is 0. 24 (we insert it into the equation as b2). Here we already see the whole assembled equation that tells us that

Lean meat content equals 61,92 – 0,97*back fat thickness + 0,24*muscle thickness.
By substituting the measured values of back fat thickness and muscle thickness into the regression equation, we can theoretically calculate the estimates of the lean meat content for all 20 cases.
Here, we see a comparison of the estimate and the exact values of the lean meat content in individual carcasses. The last column of the table shows the so-called residuals, or the differences between the exact and estimated values of lean meat content. Positive values mean that our estimate was slightly lower than the exact measured value, and vice versa; negative values indicate an overestimation compared to reality.
Since we have already verified through the analysis that it is possible to estimate the lean meat content with relatively high reliability based on the measured back fat thickness and muscle thickness, we can move on to task 2.
Based on the previous calculation, we have to estimate what the lean meat content will be for a carcass, for which the following values were measured:

- Back fat thickness equals 15 mm
- Muscle thickness equals 62 mm

We can calculate the lean meat content by substituting the measured values into the regression equation and adding up the value of y.
A lean meat content of approximately 63 % can be expected on this carcass.
Finally, we will summarize the content of this presentation.
The multivariate regression analysis was used to estimate lean meat content.
Back fat and muscle thickness, which can be measured relatively easily, were considered independent variables.
The assembled regression model with two independent variables allowed a very accurate estimation of lean meat content.
The correlation coefficient equals 0.82; the coefficient of determination equals 0.67 or 67 %.
However, since this is a statistical analysis, verifying the results on a more significant number of observations would be necessary.