

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



Modul no. 4: Precision Livestock Farming

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Evaluation of fat/muscle content

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HENNESSY GRADING PROBE



AUTOFOM



COMPUTED TOMOGRAPHY



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- Data obtained from FOM measurements
 - Back fat thickness (mm) – BF
 - Muscle thickness (mm) – MD
(*Musculus longissimus dorsi*)

- Values of lean meat content obtained from dissection
 - Lean meat content (%) – LMP

LMP	BF	MD
60.01	16	58
55.37	20	50
72.04	13	57
61.13	14	60
65.15	18	67
64.13	13	67
57.83	16	56
53.67	22	60
66.47	13	65
59.96	12	58
68.06	11	65
67.10	10	60
69.36	11	67
66.34	11	61
69.28	9	62
63.37	13	65
66.52	11	58
69.61	9	74
66.13	12	63
59.71	13	59

Example 1:

Find out if the back fat thickness (BF) and the muscle thickness (MD) correlate with the lean meat content and therefore whether it is possible to use these measured values for the prediction of the lean meat content.

We can solve the problem using **multivariate correlation and regression analysis**

Dependent variable (y):

- Lean meat content (LMP)

Independent variables (x_1, x_2):

- Back fat thickness (BF)
- Muscle thickness (MD)

- 1) Assessment of a relation between variables **correlation coefficient (r)** /coefficient of determination (r^2)
- 2) Constructing of regression equation with one dependent and two independent variables

$$y = a + b_1x_1 + b_2x_2$$

where y – dependent variable; x_1 a x_2 – independent variables;
a – intercept; b_1 and b_2 – regression coefficients



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We can use, for example, MS Excel.

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The screenshot shows a Microsoft Excel interface with the following details:

- Top Bar:** Automatické ukládání, Domů, Vložení, Rozložení stránky, Vzorce, **Data** (highlighted with a yellow circle), Revize, Zobrazení, Automatizovat, Nápověda.
- Data Tab Options:** Dotazy a připojení, Organizace, Seředit, Filtr, Vymazat, Použít znova, Text do sloupců, Dynamické, Odebrat, Ověření, Sloučit, Relace, Spravovat datový model, Citlivostní analýza, List, Prognóza, Seskupit, Oddělit, Souhrn, Přehled, Analýza dat (highlighted with a yellow circle).
- Table:** A data table with columns labeled LMP, BF, and MD. Rows 1 through 21 contain numerical values.
- Dialog Box:** Analyza dat (Analysis) dialog box is open, showing "Analytické nástroje:" (Tools): Kovariance, Popisná statistika, Exponenciální výrovnaní, Dvouvýběrový F-test pro rozptyl, Fourierova analýza, Histogram, Klouzavý průměr, Generátor pseudonáhodných čísel, Kovariogram a percentily, and **Regresce** (Regression) (highlighted with a yellow circle). Buttons OK, Storno, and Nápověda are visible.

Automatické ukládání



Soubor

Domů

Vložení

Rozložení stránky

Vzorce

Data

Revize

Zobrazení

Automatizovat

Nápověda

Načíst
dataZ Text/
CSVZ
webuZ tabulky
nebo oblastiZ obrázku
zdrojeExistující
připojeníAktualizovat
všeDotazy a připojení
Vlastnosti
Propojení sestřít

Organizace

A
Z
Z
AZ
AVymazat
Filtr

Použit znova

Upřesnit

Načíst a transformovat data

A1



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	LMP	BF	MD												
2	60,01	16	58												
3	55,37	20	50												
4	72,04	13	57												
5	61,13	14	60												
6	65,15	18	67												
7	64,13	13	67												
8	57,83	16	56												
9	53,67	22	60												
10	66,47	13	65												
11	59,96	12	58												
12	68,06	11	65												
13	67,1	10	60												
14	69,36	11	67												
15	66,34	11	61												
16	69,28	9	62												
17	63,37	13	65												
18	66,52	11	58												
19	69,61	9	74												
20	66,13	12	63												
21	59,71	13	59												
22															

Regres

Vstup

Vstupní oblast Y:

Vstupní oblast X:

Popisky Konstanta je nula

Hladina spolehlivosti %

Možnosti výstupu

Výstupní oblast:

Nový list:

Nový sestřít

Rezidua

Rezidua Graf s rezidui

Standardní rezidua Graf regresní přímky

Normální pravděpodobnost

Graf pravděpodobnosti

OK

Storno

Nápověda



Results

Regression Statistics	
Multiple R	0.816245
R Square	0.666257
Adjusted R Square	0.626993
Standard Error	3.073185
Observations	20

Correlation coefficient

0.816245

0.666257

Coefficient of determination

ANOVA

	df	SS	MS	F	Significance F
Regression	2	320.52	160.26	16.96868	8.89215E-05
Residual	17	160.5559	9.444463		
Total	19	481.0759			



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Regression

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	Coefficients	Standard Error	t Stat	P-value	Lower	Upper	95.0%	Upper 95.0%
Intercept	61.92299	10.92	5.67	0.00	38.89	84.96	38.89	84.96
BF	-0.97097	0.23	-4.31	0.00	-1.45	-0.50	-1.45	-0.50
MD	0.24515	0.15	1.63	0.12	-0.07	0.56	-0.07	0.56

$$y = a + b_1x_1 + b_2x_2$$
$$y = 61.92299 - 0.97097x_1 + 0.24515x_2$$

Results

- Dependent variable estimation

$$y = 61.92 - 0.97x_1 + 0.25x_2$$

$$y = 61.92299 - 0.97097 * 16 + 0.24515 * 58$$

$$y = 60.60638$$

LMP	BF	MD	Estimated LMP
60.01	16	58	60.60638
55.37	20	50	.
72.04	13	57	.
61.13	14	60	.
65.15	18	67	
64.13	13	67	
57.83	16	56	
53.67	22	60	
66.47	13	65	
59.96	12	58	
68.06	11	65	
67.10	10	60	
69.36	11	67	
66.34	11	61	
69.28	9	62	
63.37	13	65	
66.52	11	58	
69.61	9	74	
66.13	12	63	
59.71	13	59	

Results

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- Comparison of exact and estimated values of lean meat content (LMP)

	exact LMP	estimated LMP	residuum
60.01	60.60638	-0.59638	
55.37	54.76128	0.60872	
72.04	63.27413	8.765866	
61.13	63.03863	-1.90863	
65.15	60.87082	4.279176	
64.13	65.72567	-1.59567	
57.83	60.11607	-2.28607	
53.67	55.27088	-1.60088	
66.47	65.23536	1.23464	
59.96	64.49026	-4.53026	
68.06	67.1773	0.882702	
67.1	66.9225	0.1775	
69.36	67.6676	1.692396	
66.34	66.19668	0.143316	
69.28	68.38377	0.896225	
63.37	65.23536	-1.86536	
66.52	65.46122	1.058776	
69.61	71.32561	-1.71561	
66.13	65.71602	0.413978	
59.71	63.76444	-4.05444	

Example 2:

Based on previous calculations estimate lean meat content in the carcass with these measured values:

- Back fat thickness(BF) = 15 mm
- Muscle thickness (MD) = 62 mm

We find out the lean meat content by substituting these values into the regression equation

$$y = 61.92 - 0.97x_1 + 0.25x_2$$

$$y = 61.92 - 0.97 * 15 + 0.25 * 62$$

$$y = \mathbf{62.87 \%}$$

A lean meat content of approximately 63 % can be expected on this carcass.



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Conclusion

- The multivariate regression analysis was used to predict lean meat content.
- Back fat thickness and muscle thickness were considered as independent variables.
- The assembled regression model with two independent variables allowed a very accurate estimation of lean meat content.

Correlation coefficient $r = 0.82$
Coefficient of determination $r^2 = 0.67 = 67\%$
- However, since this is a statistical analysis, verifying the results on a more significant number of observations would be necessary.

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Thank you for your attention!

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Picture sources

<https://www.frontmatec.com>

<https://www.jarvisitalia.it/en/prodotto/hennessy-probing-system>

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