

## CALCULATION OF HAY ENERGY VALUE WITH A REGRESSION EQUATION

## IZRAČUNAVANJE ENERGETSKE VRIJEDNOSTI SIJENA REGRESIONOM JEDNADŽBOM

Jasna M.A. Stekar, F. Zagožen and A. Golob

Original scientific papers  
Izvorni znanstveni članak  
UDK: 636.085.532  
Primljeno-Received: 15. srpanj-july 1994.

### SUMMARY

From 655 random samples of hay, first cut, we calculated a regression equation for the content of starch equivalent (SE) and net energy for lactation, German one (NEL). The first equation is  $SE: \text{kg}^{-1} \text{DM} = 16.5855 + 1.2750 \text{XP} + 0.9242 \text{XL} - 0.7965 \text{XF} + 0.5928 \text{XX}$ . The multiple  $R = 0.9796$  with standard error 1.4502. The second equation is:  $NEL (\text{MJ}) \text{kg}^{-1} \text{DM} = 1.6276 + 0.1281 \text{XP} + 0.0898 \text{XL} - 0.3650 \text{XF} + 0.0583 \text{XX}$ . The multiple  $R = 0.9565$  with standard error 0.1597. Both multiple  $R$  are very highly significant. The estimation of SE and NEL in hay is better with equations as with tabular coefficients of digestibility.

### Introduction

It was established that a very heterogeneous hay composition is the main reason for the statistically differences among various authors which appeared in calculations of the energy value of hay based on chemical analysis of samples and coefficients of digestibility from tables (Stekar et al., 1993a, Stekar et al., 1993b). The energy value obtained by the equation ( $SE = 23.700 + 1.014 \text{XP} + 0.810 \text{XL} - 0.734 \text{XF} + 0.415 \text{XX}$ , Cmok et al., 1987) estimated hay more objectively and accurately enough. As the samples ( $n = 207$ ) used for the calculation of the equation were of very good quality, the energetic value obtained from it was overestimated.

### Material and methods

For the equations, calculation data on chemical composition of 655 random samples of hay were used. All samples were analysed in the same laboratory (Biotechnical Faculty, Zootechnical Department). The average results of analyses are given in Table 1.

The average content of starch equivalent (SE), net energy for lactation, German one (NEL) and digestible crude protein, calculated with digestibility coefficients from tables (DLG, 1991) are given in Table 2.

Multiple regressions were calculated by statistical package SPSS. The significance of the multiple  $R$  was additionally tested by F test.

### Results

1. SE. The new regression equation for the estimation of SE in hay appears:  $SE \text{ kg}^{-1} \text{ DM} = 16.5855 + 1.2750 \text{XP} + 0.9241 \text{XL} - 0.7965 \text{XF} + 0.5928 \text{XX}$ . The multiple  $R$  is high, it is 0.9796 and is very highly significant. The standard error is 1.4502.

With including the crude ash into consideration, the multiple  $R$  became insignificantly higher.

Prof. dr. Jasna M.A. Stekar, prof. dr. Franc Zagožen and mag. Andrej Golob: University of Ljubljana, Biotechnical Faculty, Zootechnical Department Ljubljana, Slovenia

**Table 1. The hay composition, g kg<sup>-1</sup> DM.**  
**Tablica 1. Sadržaj sijena, g kg<sup>-1</sup> ST.**

	DM g kg <sup>-1</sup>	XP	XL	XF	XA	XX
Mean value Prosjek	850.93	111.23	27.39	330.67	76.58	453.84
Standard deviation Standardna devijacija	36.85	30.96	12.40	41.71	16.32	38.65
Standard error Standardna pogreška	1.44	1.21	0.48	1.63	0.64	1.51
Minimum	699.10	30.60	3.40	188.80	41.50	151.30
Maximum	936.60	231.20	95.30	452.60	165.60	566.30

**Table 2. The nutritive value of hay.**  
**Tablica 2. Hranjiva vrijednost sijena**

	SE kg <sup>-1</sup> DM- ST	DXP g kg <sup>-1</sup> DM-ST	NEL (MJ), kg <sup>-1</sup> DM-ST
Mean value Prosjek	338.60	62.76	4.50
Standard deviation Standardna devijacija	71.95	24.85	0.55
Standard error Standardna pogreška	2.81	0.97	0.02
Minimum	154.30	13.41	2.69
Maximum	514.20	156.95	6.11

We carried out the equations with the stepwise including the separate nutrients.

If the regression equation was calculated on the base of crude fibre only the multiple R was also high and very highly significant. The regression was: SE kg<sup>-1</sup> DM = 87.2257 - 1.6134 XF. The multiple R = 0.9354 and standard error = 2.5460.

By taking the crude protein content into account, the multiple R became rather higher 0.9613 and standard error rather lower, too 1.9861. The equation was: SE kg<sup>-1</sup> DM = 69.3979 + 0.6669 XP - 1.2991 XF.

Nitrogen - free extractives were on the third place if their influence on the regression was considered. The equation sounds: SE kg<sup>-1</sup> DM = 36.6408 + 1.1246 XP - 0.9989 XF + 0.39909 XX. The multiple R = 0.9709, standard error = 1.7270.

So the influence of ether extract was, beside the crude ash, the lowest one.

When SE is calculated on the base of all determinations of Weende analysis, the estimation is very accurate. We think that for needs in practice the estimation on the base of crude fibre and crude protein content only is accurate enough in most cases.

2. NEL (German) When all groups of crude nutrients were taken into consideration the regression equation was: NEL (MJ), kg<sup>-1</sup> DM = 1.6276 + 0.1281 XP + 0.0898 XL - 0.0365 XF + 0.0538 XX. The multiple R = 0.9565 was very highly significant with standard error = 0.1597.

When crude ash was added as a variable, the re-

gression equation was: NEL (MJ), kg<sup>-1</sup> DM = 1.1173 + 0.1316 XP + 0.0934 XL - 0.0314 XF + 0.0106 XA + 0.0585 XX. The multiple R was a bit higher, only 0.9567. It was very highly significant also and standard error was a little lower 0.1594.

It follows from the present results that the estimation of NEL on the base of the content of crude protein, crude ether extract, crude fibre and nitrogen - free extractives is a good one and suitable for practice. When the content of crude ash is added, the estimation is a bit better.

We carried out the equations, similar as by SE, by including individual nutrients.

On the base of crude fibre content only the regression equation was: NEL (MJ), kg<sup>-1</sup> DM = 8.3830 - 0.1163 XF. The multiple R = 0.8738 and standard error = 0.2657. The multiple R was very highly significant.

If the crude protein content was added into calculation, the equation was: NEL (MJ), kg<sup>-1</sup> DM = 6.4468 + 0.0726 XP - 0.0824 XF. The multiple R became evidently higher, R = 0.9294, and standard error lower, 0.2010.

With including the third variable, nitrogen-free extractives into regression equation the multiple R was higher, it was 0.9429 and standard error lower 0.1822.

The estimation of NEL, German one, the content in hay is accurate enough on the base of weende analysis determinations. We would not advise to estimate NEL in hay with the content of crude protein and crude fibre only, as it is the case with SE.



## Conclusion

On the base of nutrient content it is possible to estimate energetic value, SE and NEL (German) of hay with the regression equations better then with tabular coefficients of digestibility.

## Literature

1. Stekar, J.M.A., F. Zagožen, I. Ovčar Sešelj, A. Golob (1993a): A Estimation of the hay net energy value with digestibility coefficients or regression equation. Krmiva, In print.
2. Stekar, J.M.A., F. Zagožen, I. Ovčar Sešelj, I., A. Golob (1993b): Ocena neto energijske vrednosti mrve s koeficienti prebavljivosti in regresijsko enačbo. Zb. Biotehniške fak., Univ. v Ljubljani, Kmetijstvo (Zootehnika), 62, 287-296.
3. Cmok, N., J.M.A. Stekar, F. Zagožen, (1987): Primerjava škrobne vrednosti mrve, izračunane na različne načine. Zb. Biotehniške fak., Univ. v Ljubljani, Kmetijstvo (Živinoreja), Supplement 11/I, 241-248.
4. Futterwerttabellen für Wiederkäuer (1991). DLG Verlag, Frankfurt/M., 111.

## SAŽETAK

Iz 655 nasumce uzetih uzoraka sijena, prvi otkos, izračunata je regresijska jednadžba za sadržaj škrobnog ekvivalenta (ŠE) i netto energije za laktaciju, njemačku jedinicu (NEL). Prva jednadžba je  $\text{ŠE: kg}^{-1} \text{ST} = 16.5855 + 1.2750 \text{XP} + 0.9242 \text{XL} - 0.7965 \text{XF} + 0.5928 \text{XX}$ . Multipli R = 0.9796 sa standardnom pogreškom 1,4502. Druga jednadžba je:  $\text{NEL (MJ) kg}^{-1} \text{ST} = 1.6276 + 0.1281 \text{XP} + 0.0898 \text{XL} - 0.3650 \text{XF} + 0.0583 \text{XX}$ . Multipli R = 0.9565 sa standardnom pogreškom 0.1597. Obadva multipla R su vrlo visoko singifikantni. Procjena škrobnog ekvivalenta i NEL-a u sijenu je bolja s jednadžbom nego s tabelarnim koeficijentom probavljivosti.

## TVORNICE KRMNIH SMJESA

Po najpovoljnijim uvjetima snabdjevamo vas krmnim komponentama:

- lucerna paletirana
- ječam
- zob
- kukuruzni gluten



ČAKOVEC d.d.

I. Mažuranića 2 tel. 040/812-760 fax 040/816-401

R. Boškovića 32 tel. 040/816-866 fax 040/816-064