



Prediction of the energy and protein value of DDGS for cattle

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Introduction

- Distillers Dried Grains & Solubles = byproduct of bio-ethanol production
 - Feedstuff with high energy and protein content
 - Variable quality because of different grains, production processes
 - Need for an accurate prediction of the nutritive value with convenient and fast methods
-
- Four year project: feed evaluation of DDGS for cattle, pigs and poultry
- ⇒ **Prediction of the energy and protein value of DDGS for cattle**

Origin and type of DDGS (n=13)

- 7 ≠ production units (Belgium, Germany, France, The Netherlands, Spain, Hungary, Austria)
- 7 wheat based DDGS ($\geq 50\%$ wheat + mainly maize, but also barley, triticale, triticale, sorghum, sugar syrup)
- 3 wheat DDGS
- 3 maize DDGS

Analyses

- **Moisture:** 4 h at 103 °C (71/393/EC)
- **Crude protein (CP):** Kjeldahl (ISO 5983-2)
- **Crude fat:** hydrolysis with HCl + PE (ISO 6492 B)
- **Crude fibre:** fibersac (92/89/EC)
- **NDF:** fibersac: fat extraction + α -amylase + $\text{Na}_2\text{O}_3\text{S}$ (Van Soest et al., 1991)
- **ADF:** fibersac: fat extraction (Van Soest et al., 1991)
- **ADL:** ADF-residue + 72% H_2SO_4 (Van Soest et al., 1991)
- **Starch:** amyloglucosidase (NEN 3574)
- **Sugars:** Luff Schoorl (71/250/EC)
- **Gross Energy:** adiabatic bomb calorimeter (ISO 9831)
- **Crude ash** (ISO 5984)
- **OMDcellulase:** cellulase digestibility of OM (De Boever et al., 1986)
- **OMDrumen fluid:** rumen fluid digestibility of OM (Tilley and Terry, 1963)

Chemical composition (g/kg DM)

	Mean \pm SD	Range
Dry matter (g/kg)	911 \pm 16	879 – 933
Crude protein	324 \pm 28	277 – 366
Crude fat (B)	100 \pm 27	72 – 148
Crude fibre	84 \pm 10	67 – 103
Crude ash	53 \pm 7	38 – 63
NDF	318 \pm 33	240 – 366
Hemicellulose (NDF - ADF)	169 \pm 30	106 – 213
Cellulose (ADF – ADL)	87 \pm 15	48 – 112
Lignin	62 \pm 27	24 – 118
Starch	40 \pm 33	14 – 129
Sugars	40 \pm 17	13 – 66

Energy evaluation cattle (n=13)

Digestion trials with sheep

- 13 DDGS and 1 batch grass hay: 3 series from March 2010 to October 2011
- 5 castrated sheep weighing 74 ± 9 kg
- 1 kg DM: 50% DDGS+ 50% hay in 2 times/d
- Recuperation-adaptation period: 10 to 24 days
- Experimental period: 10 days → total collection of feces per animal
- Digestion coefficients of CP, CF, Cfat, Other Carbohydrates by difference



Calculation of energy value (Van Es, 1978)

$$\text{NEL (kJ/kg)} = 0.6 \times (1 + 0.004 \times (q-57)) \times 0.9752 \times \text{ME}$$

with $q = \text{ME/GE} \times 100$

$$\text{and ME (kJ/kg)} = 15.90 \text{ DCP} + 37.66 \text{ DCfat} + 13.81 \text{ DCF} + 14.64 \text{ DOC}$$

Digestibility and energy value

	Mean \pm SD	Range
OMD _{in vivo} (%)	78.8 \pm 2.5	74.6 – 83.8
OMD _{cellulase} (%)	86.1 \pm 1.1	84.7 – 88.3
OMD _{rumen fluid} (%)	71.1 \pm 2.5	67.0 – 76.0
Gross energy (MJ/kg DM)	21.2 \pm 0.6	20.3 – 22.1
Net energy lactation (MJ/kg DM)	8.00 \pm 0.49	7.16 – 8.73

Deriving prediction equations for NEL

Multiple linear regression analysis: $Y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$

Y : NEL (MJ/kg DM)

x_n : CP, Cfat, ash, CF, NDF, ADF, ADL, HC (hemicellulose), C (cellulose),
STA, SUG, GE, OMDcellulase, OMDrumen fluid

x in formula when contribution $p < 0.05$

Determination coefficient (R^2)

Residual standard deviation (RSD)

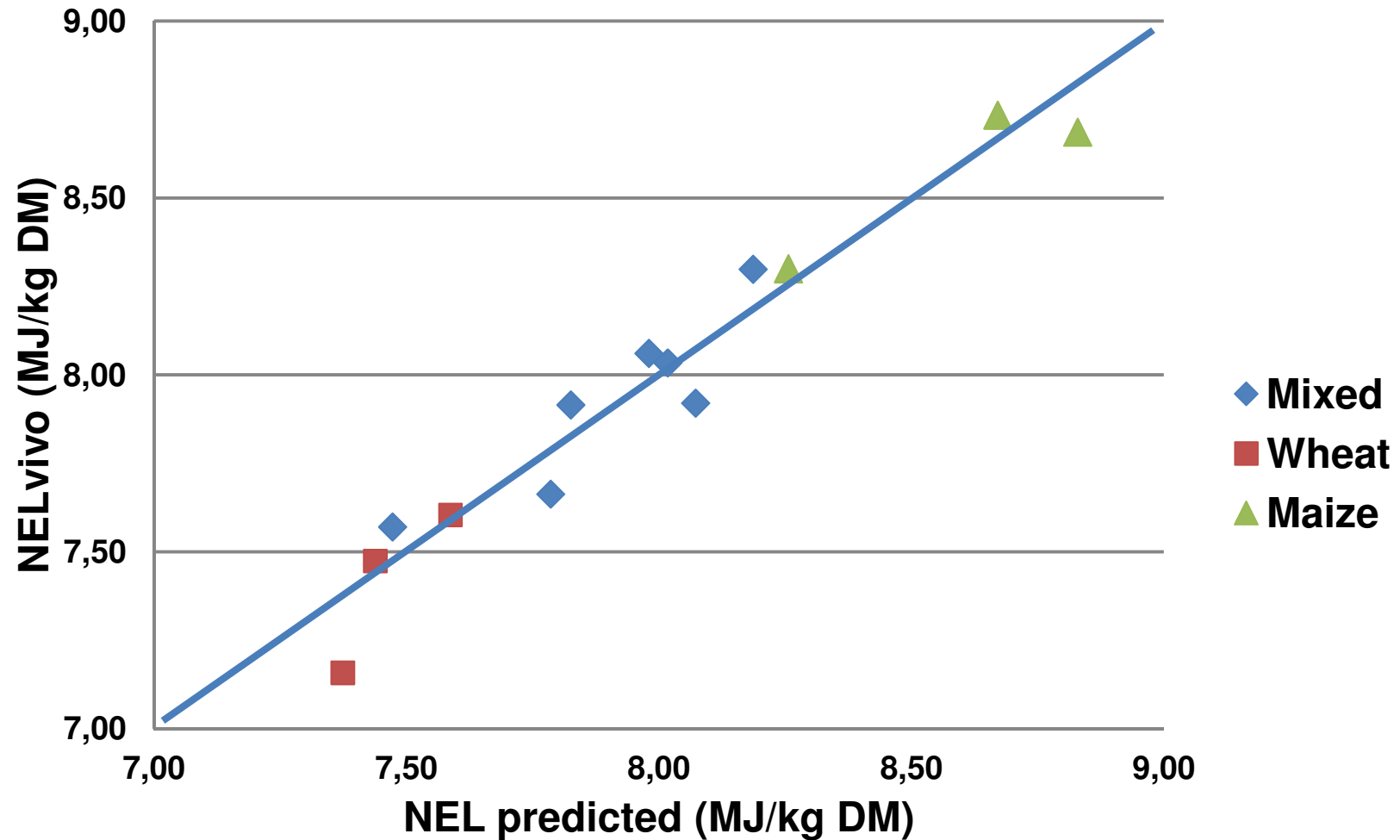
Prediction power (SD/RSD)

Prediction of NEL (n=13)

Parameters	R ² %	RSD MJ/kg DM	SD/RSD
+Cfat**	72	0.25	1.9
+Cfat*** + OMDcellulase (p=0.062)	79	0.21	2.2
+Cfat* + OMDcellulase* - Cfat ² (p=0.059)	85	0.18	2.6
+Cfat*** + HC**	86	0.17	2.8
+Cfat*** + ash** - ADF*	86	0.17	2.8
+Cfat*** + OMDcellulase** - STA*	88	0.16	2.9
+HC** + Cfat* - Cfat²*	91	0.14	3.4
+Cfat*** - ADF** + ash* + NDF*	91	0.14	3.4

* P<0.05, **P<0.01, ***P<0.001

Prediction of NEL with Cfat, ash, NDF, ADF



Protein evaluation cattle (n=10)

Rumen degradation characteristics of OM, CP and NDF

- nylon bag technique (37 μm)
- 3 lactating cows: maize s. + grass s. (50/50) + conc. according to requirements
- Samples ground through 3 mm
- Incubation times: 0, 3, 8, 24, 48 and 336 h

Intestinal digestibility of CP and AA

- mobile nylon bag technique
- 2 cows with cannula in duodenum: ration cfr. above
- Residue after 12 h rumen incubation
- 1 h in pepsin-HCl
- incubation in duodenum \rightarrow recuperation of bags in feces



Calculation according to Dutch system (Tamminga et al., 2007)

- **DVE** (protein digestible in the intestines) = DVBP + DVMP – DVEP
- **OEB** (degraded protein balance) = MPN – MPE
- **DLYS & DMET** (lysine & methionine digestible in the intestines)

Protein value DDGS cattle (n=10)

	Mean \pm SD	Range	SBM*
Crude protein (g/kg DM)	324 \pm 27	273 – 349	491
Rumen bypass protein (%)	61.9 \pm 7.6	48.7 – 76.8	42.1
Intestinal digestibility BP (%)	91.3 \pm 3.2	84.0 – 94.8	97.8
DVE (g/kg DM)	212 \pm 14	178 – 231	252
OEB (g/kg DM)	51 \pm 30	-3 – 95	193
Lysine (g/kg DM)	6.6 \pm 0.8	5.2 – 7.6	30.4
DLysine (g/kg DM)	6.3 \pm 0.5	5.4 – 7.1	16.6
Methionine (g/kg DM)	5.1 \pm 0.4	4.4 – 5.6	6.8
DMethionine (g/kg DM)	3.9 \pm 0.5	3.3 – 4.8	4.3

* Dutch Feed Tables (CVB, 2007)

Prediction equations for protein value

Multiple linear regression analysis: $Y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$

Y : %bypass protein, %intestinal digest. BP, DVE, OEB, DLYS, DMET

x_n : CP, Cfat, CF, NDF, ADF, ADL, HC (Hemicellulose), C (Cellulose),

STA, SUG, GE, OMDcellulase, OMDrumen fluid +

- N-solubility in water (CVB, 2003)
- N-degradability in *Streptomyces griseus* during 6 h (Cone et al., 1995)
- ADIN/N

x in formula when contribution at $p < 0.05$

Determination coefficient (R^2)

Residual standard deviation (RSD)

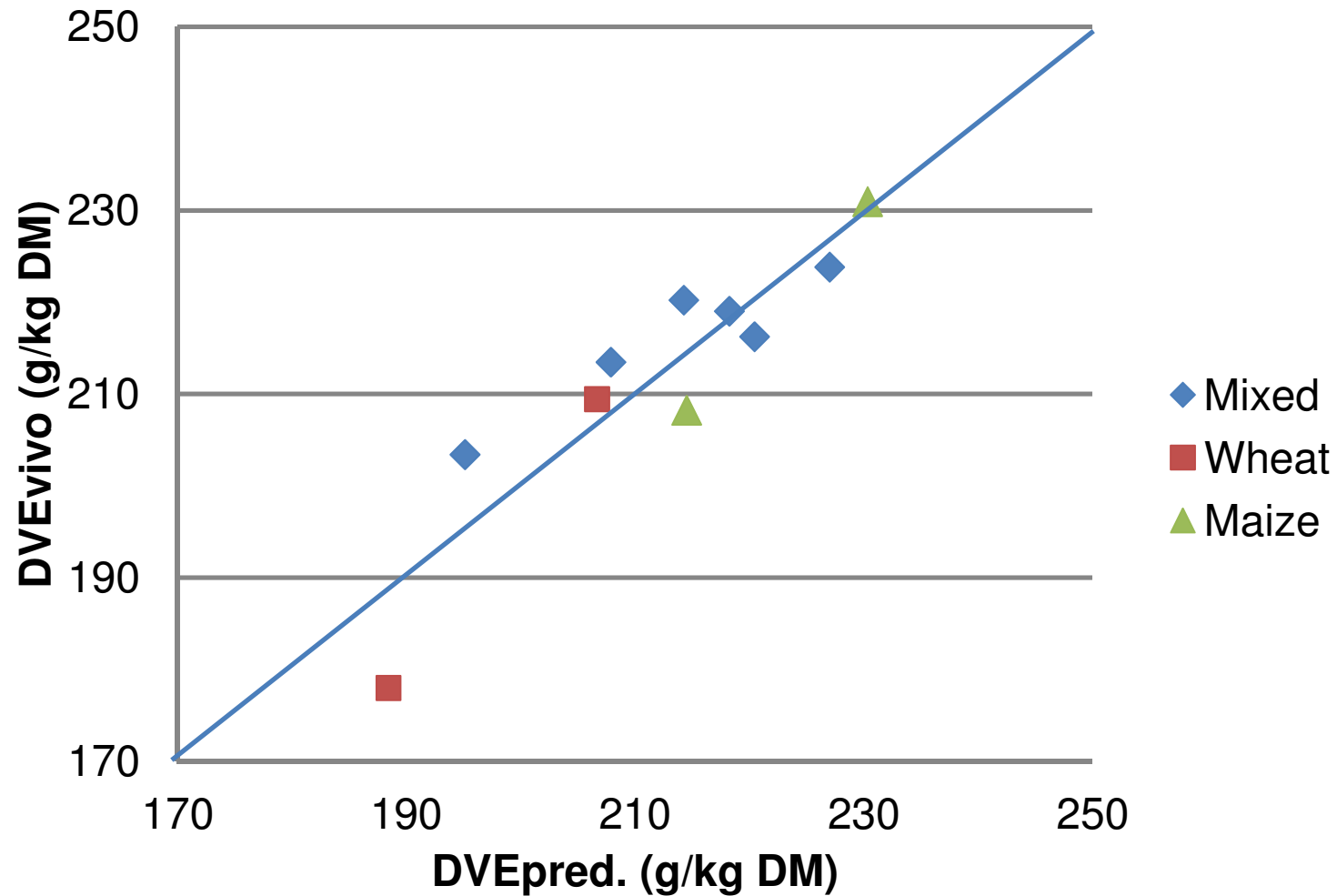
Prediction power (SD/RSD)

Prediction of protein value

Parameters	R ²	RSD	SD/RSD
Bypass Protein (48.7 – 76.8%)	%	%-units	
-Ndeg**	56	5.0	1.5
-Ndeg** -Nsol*	81	3.3	2.3
Intestinal digestibility BP (84.0 – 94.8%)	%	%-units	
-ADF***	78	1.5	2.1
DVE (178 – 231 g/kg DM)	%	g/kg DM	
-Nsol*	45	11	1.3
-Nsol*** + OMDcellulase**	78	7	2.0
OEB (-3 – 95 g/kg DM)	%	g/kg DM	
+CP***	74	15	2.0
+CP*** + Nsol*	87	11	2.7

* P<0.05, **P<0.01, ***P<0.001

Prediction of DVE with Nsol. & OMDcell.



Prediction of digestible AA

Parameters	R ²	RSD	SD/RSD
DLYS (5.4 – 7.1 g/kg DM)	%	g/kg DM	
-SUG**	71	0.28	1.8
DMET (3.3 – 4.8 g/kg DM)	%	g/kg DM	
-SUG**	58	0.32	1.6
-SUG** - Nsol**	86	0.18	2.8

* P<0.05, **P<0.01

Conclusion

- Accurate prediction of NEL with Cfat, NDF and ADF
- Good prediction of protein value with CP, Nsol, Ndeg, OMDcellulase
- Potential of sugar content to predict digestible amino acids

Need for further validation!

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