Are the nutrients and energy values for commercial compound feeds in the NorFor feedstuff table correct? – a NIR screening conducted using different laboratories

M. Åkerlind[1] and N. I. Nielsen[2]
[1] *Växa Sverige, Box 7024, 750 07 Uppsala, Sweden.*
[2] *SEGES, Dairy and Beef Research Centre. Agro Food Park 15, 8200 Aarhus N, Denmark.*
Correspondence: maria.akerlind@vxa.se

Introduction

The NorFor model has been used in ration formulation for cattle using different software in the Nordic countries for nearly 10 years. The increased use of NorFor during these years has led to an increased focus on the energy value of compound feeds, as the energy content in relation to price is a key parameter (kr/MJ) when dairy and beef farmers purchase feeds. In NorFor, energy values are calculated under a set of standard conditions which implies a cow weighing 600 kg and consuming 20 kg DM/d (Åkerlind and Volden, 2011). This standard energy value is listed as a NEL20 value in the NorFor FeedStuff Table (FST; www.norfor.info). The NorFor FST is unique in the sense that it contains nutrient and energy values for approximately 2000 commercial compound feeds. Feed companies themselves upload and update their own compound feeds and NorFor has established guidelines on how to do this (www.norfor.info/feed-company).

Due to the increased focus on energy values for compound feeds in the NorFor system, some concrete cases of discrepancies between NEL20 listed in the NorFor FST and on the delivery note/sales materials have been reported. Farmers and advisors have occasionally asked: "why does my compound feed have one NEL20 value in the sales materials/product sheet and another value in the NorFor feedstuff table (FST)?". Also feed companies have been puzzled by the NEL20 or AAT20 values reported by other feed companies in the NorFor FST. Furthermore, some advisors have noticed that compound feeds from specific feed companies often are chosen in least cost ration optimizations at the expense of compound feeds from other companies.

In Denmark, the energy content of commercial compound feeds has been analyzed for more than 20 years in order to ensure that the farmer gets the quality he/she has paid for. This analysis is done by use of an enzymatic method (EFOS) that measures organic matter digestibility which can be further used in the calculation of Feed Units (Weisbjerg and Hvelplund, 1993). The latest analyses of compound feeds in Denmark by NIR at Kvægbrugets ForsøgsLaboratorium (KFLab) contained 90 compound feeds with declared feed units (FU) and 291 compound feeds with declared fat and protein contents (Kristensen and Thøgersen, 2015). Thus, the EFOS method helps to ensure that the declared energy content is correct in commercial compound feeds and therefore such a method helps the farmer and the advisor to choose the most profitable compound feed based on a transparent energy content and price. Unfortunately, such a method is not available at the moment for measuring NEL20 in the NorFor system.

The objectives of this investigation were:

- to compare nutrients and energy values in the NorFor FST with analyzed values for commercial compound feeds
- to identify if the magnitude of the differences between analyzed and FST values were related to specific feed companies
- to identify possible differences in NIR analyzes between laboratories

- to identify possible pathways to determine the NEL20 content in compound feeds with unknown composition of ingredients

Materials and Methods

Sampling

In 2015, the collection of compound feeds from dairy farms in Denmark (DK; n=15), Norway (NO; n=10) and Sweden (SE; n=15) and from feed factories in Iceland (IS; n=6) was initiated and a total of 46 samples were collected by farmers and/or advisors. The intention was, within each country, to select commonly used compound feeds that would represent different feed companies and a large variation in energy content and nutrients in terms of crude fat (Cfat), crude protein (CP), NDF and starch. A total of 20 feed companies were represented: 7 from DK, 3 from IS, 4 from NO and 6 from SE with 1 (n=4), 2 (n=8), 3 (n=6) or 4 samples (n=2) per company.

A*nalyses*

All samples were analyzed by NIR at KFLab in Denmark and the SE and NO samples were also analyzed by NIR at Blgg AgroXpertus (Blgg) in the Netherlands.

Comparison of NorFor feedstuff table values with analyzed values

The information on nutrients and energy values for the specific compound feeds were extracted from the NorFor FST on the same day as the sample was collected on farm. The NorFor FST and the NorFor model are available via national software tools where ration formulation is done. The software tools where nutrients and energy values were extracted were: DMS in DK, IndividRAM in SE and Optifór in IS and NO. In order to have a reference for differences between NorFor FST values and analyzed values, EU tolerances for cattle feeds were chosen (Table 1).

Table 1 EU tolerances (EU 939/2010) for cattle feeds that were applied when comparing analyte values from the NorFor feed stuff table with analyzed values

Declared content	Lower tolerance (too low content)	Upper tolerance (too high content)
Crude protein		
>24%	3% units	3% units
8-24%	12.5%	12.5%
<8%	1% unit	1% unit
Crude fat		
>24%	3% units	6% units
8-24%	12.5%	25%
<8%	1% unit	2% units
Ash		
>24%	No lower tolerance	3% units
8-24%		12.5%
<8%		1% unit
Crude fiber and NDF[1]		
>20%	3.5% units	3.5% units
10-20%	17.5%	17.5%
<10%	1.7% units	1.7% units
Starch		
>20%	3.5% units	7% units
10-20%	17.5%	35%
<10%	1.7% units	3.4% units

[1] NDF is not part of the EU-regulation (EU 939/2010) but was here assumed to have same tolerance as crude fiber.

Results and Discussion

Composition of the compound feeds, estimated by NIR, is presented in Table 2. The range was wide for crude protein, crude fat, NDF, starch and estimated energy (NEL20).

Table 2 Nutrients and energy content of 46 compound feeds from 20 feed companies in Denmark (n=15), Iceland (n=6), Norway (n=10) and Sweden (n=15). Values represent analyzed values from KFLab

	Mean	Min.	Max.	s.d.
Crude protein, g/kg	219	138	406	67
Soluble CP, g/kg CP	231	152	366	43
Crude fat, g/kg	60	27	142	21
NDF, g/kg	204	87	297	47
Starch, g/kg	212	5	397	110
NEL20, MJ/kg	7.54	6.6	8.7	0.48

Figures 1a-d show comparisons between nutrients from the NorFor FST and analyzed values for 46 commercial compound feeds. In order to visualize how small/big the differences are between analyzed values and FST values, the EU-tolerances (EU 939/2010) for declared nutrients in cattle feeds were applied. Generally, values of commercial compound feeds in NorFor FST are updated once or twice a year by the feed companies. However, the composition of ingredients can change many times during the year and therefore, small deviations between values in FST and values in the compound can be expected.

The investigation of crude protein contents (Figure 1a) showed that 10 samples were outside the minimum and maximum EU tolerances. It could be argued that the EU permitted tolerances might be too narrow and too strict for FST values that are updated once or twice a year, but this was chosen to have some sort of reference point.

The investigation of crude fat (Figure 1b) showed that 5 samples had less analyzed fat compared with the value in NorFor FST. There was one extreme outlier (Figure 1b). Swedish compound feeds stand out in the analysis of crude fat from KFLab, i.e. KFLab reported lower crude fat contents than what the feed companies have listed in NorFor FST (Figure 1b). However in general, KFLab measured 9% lower crude fat than Blgg on the Swedish samples (data not shown). In Sweden, it is common to use fat in the form of calcium soaps in compound feeds and therefore a hydrolysis is needed to break the calcium ester links to get correct analytical results. However, both laboratories present NIR results based on chemical analysis of fat that include hydrolysis, so this does not seem to be the explanation. One can speculate that either chemical analysis of crude fat between laboratories are done differently (although the method should be the same) and/or the fat sources in the compound feeds used for the NIR calibration at the two laboratories differ substantially.

The investigation of NDF (Figure 1c) showed that 9 samples were outside the minimum and maximum levels corresponding to the EU limits for crude fiber.

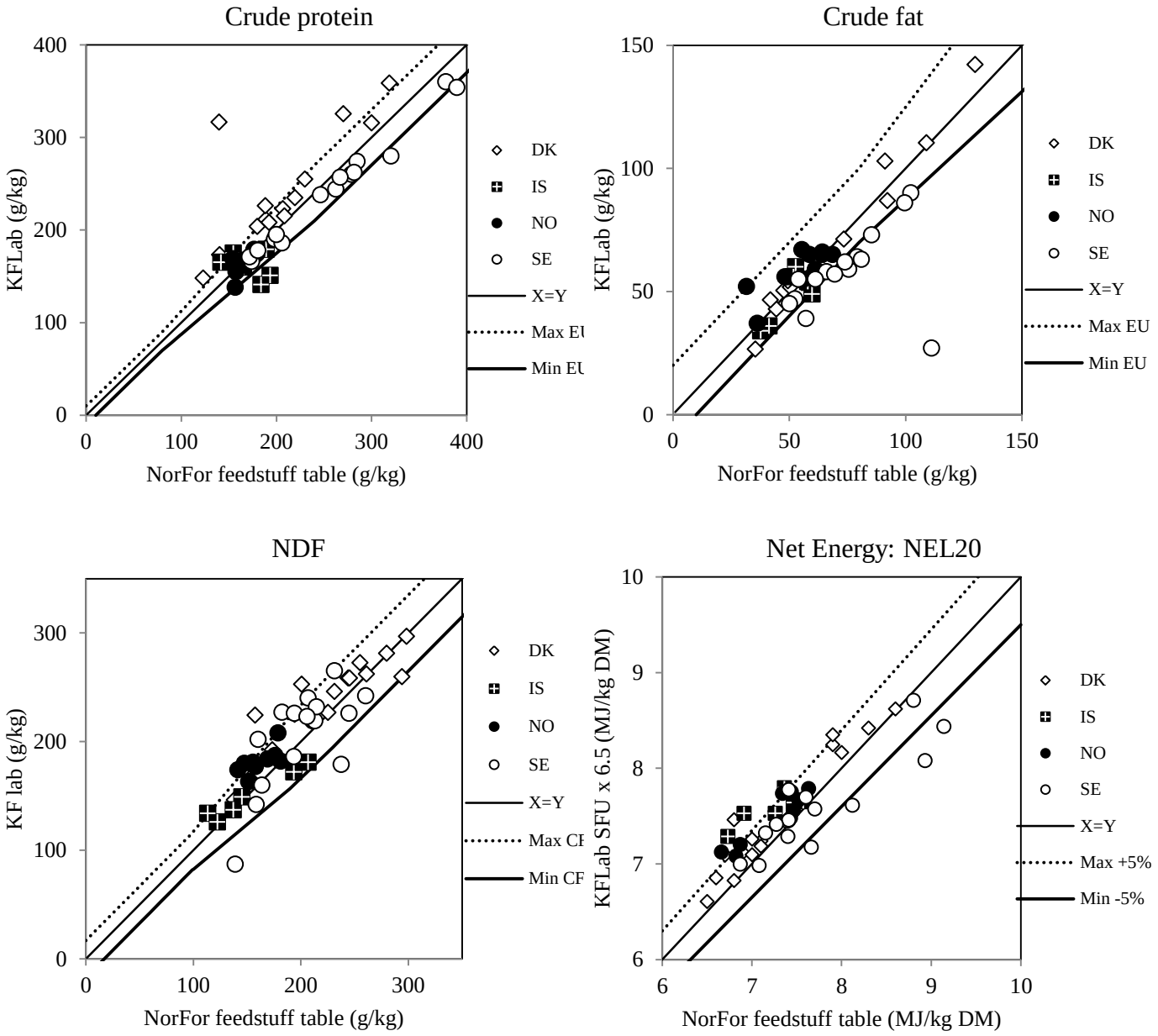

Figure 1 a-d Comparisons between NIR analyzed nutrients from Kvægbrugets ForsøgsLaboratorium (KFLab) and corresponding nutrients from the NorFor feed stuff table for 46 compound feeds from 4 countries (DK=Denmark; IS=Iceland; NO=Norway; SE=Sweden). The max and min EU line indicate upper and lower tolerances, respectively, for declared contents in cattle feeds. SFU=Scandinavian Feed Unit

The investigation of net energy (NEL20) (Figure 1d) showed that 9 samples were outside the minimum and maximum levels. Results from one of the samples could be explained by an extreme outlier for crude fat. It is noteworthy that three of the samples, which were below the minimum line, i.e. higher NEL20 values in NorFor FST than analyzed, came from one feed company. This deviation could not be explained by analyses of nutrients in this screening. There is no analytical method for NEL20 at the moment and therefore, NEL20 was estimated from the NIR results of EFOS and crude fiber via calculation of the Scandinavian Feed Unit (SFU), according to Weisbjerg and Hvelplund (1993). Based on raw materials from the

NorFor FST and data on compound feeds from Weisbjerg and Hvelplund (1993), a relationship between SFU and NEL20 was established (Figure 2).

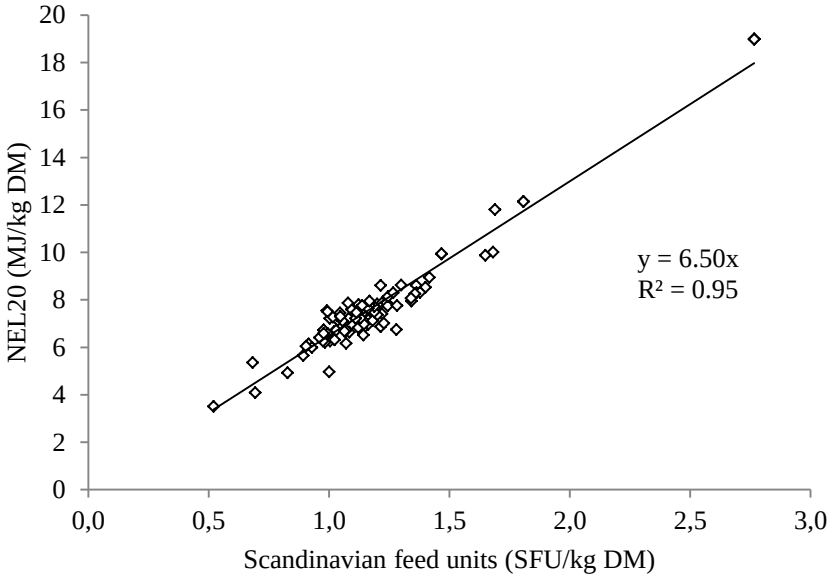

Figure 2 The relationship between Scandinavian feed units (a Danish energy value for cattle feeds) and NEL20 based on 78 raw materials from the NorFor feedstuff table and 23 compound feeds from Weisbjerg and Hvelplund (1993).

An evaluation of the NIR analyses from the two laboratories showed in general good agreement, except for soluble CP (Table 3).

Table 3 Evaluation of the correspondence between NIR analyses performed by Blgg and KFLab on 21 compound feeds from Norway and Sweden

	MPE (%)	RMSPE	Intercept	Slope	R^2
DM, g/kg	1	8	332	0.62	0.41
Ash, g/kg	14	9	26	0.54	0.46
Crude protein, g/kg	6	13	-1.0	1.03	0.97
Soluble CP, g/kg CP	26	60	182	0.13	0.07
Crude fat, g/kg	11	7	8.5	0.82	0.82
NDF, g/kg	13	24	38	0.81	0.81
Starch, g/kg	9	18	10	0.98	0.98
Crude fiber, g/kg	12	10	-2.3	0.93	0.93
OMD, % of OM	2.8	2.3	31	0.63	0.68
NEL20[1], MJ/kg DM	3.6	0.26	0.32	0.98	0.86

[1]NEL20 was not analyzed but calculated from a relationship between NEL20 and SFU (see Figure 2).

Conclusions

- Some caution should be exercised as results are based on a small sample size (46 out of ~2000) and also on analysis by NIR
- Generally, there was a reasonable agreement between declared nutrients in FST and analyzed values:
  - 10 samples (22%) were outside EU-tolerances for protein
  - 5 samples (11%) contained less fat than the EU-tolerance
- Indications that one feed company (out of 20) declared higher energy values in FST than found by estimations

- Good agreements were found between NIR results from Blgg and KFLab, except for soluble CP.
- This investigation has led to a specification of guidelines for updating compound feeds to the NorFor FST
- There is a need for a laboratory method to determine NEL20. A possible way forward is to use an *in vitro* OMD analysis.

Perspective
NorFor will pursue efforts to find a cheap and fast method with good accuracy and precision that can quantify the energy content in compound feeds in terms of NEL20.

References

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