IAG ring test feed composition 2016

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Summary

The analysis of composition in terms of ingredients is important for detecting economic fraud and for monitoring feed safety. Composition analysis and label control of feed is regulated in Regulation (EC) 767/2009. In a broader view, composition analysis in the entire food chain can improve the effect of monitoring actions. The new legislation on food labelling (Regulation (EC) 1169/2011), effective from December 13th 2014, obliges to provide more detailed information to customers on composition and related topics.

A ring test was organized for the microscopic determination of botanic composition in animal feed in the framework of the annual ring tests of the IAG - International Association for Feeding stuff Analysis, Section Feeding stuff Microscopy. The organizer of the ring test was RIKILT - Wageningen UR, The Netherlands. The aim of the ring study was to provide the participants information on the performance of the local implementation of the method for composition analysis of feed.

The sample was based on an artificially produced feed mimicking a ruminant feed, and distributed without label information. The participants were requested to produce a correct declaration of the ingredients of the sample. The results were analysed using the IAG model for uncertainty limits. Shares of ingredients in the feed formulation outside the limits of the model were indicated as under- or over-estimations.

A total of 25 sets of results was returned. The percentage of under- or over-estimations was 28.6% for the seven main ingredients. In the overview of results, the two declared wheat ingredients and the two declared corn products were pooled to one ingredient each. This was necessary since some participants declared a general ingredient ("wheat" and "corn") and others a specific type (gluten or bran). The use of the original declarations would result in an extra number of non-matching estimations without precise justification. The share of the citrus pulp, in the presence of an equal amount of beet pulp, was underestimated or not detected in 44% of the results. Citrus pulp as such is recognisable as feed ingredient. Still almost three quarter of all estimations appeared to be correct in the ranges of the uncertainty model. This means that visual inspection of the composition of a sample can be used for label control and this method can support traceability of ingredients in case of an incidence.

The current results indicate that specific formulations can influence the precision of the estimation of the composition of the feed. The current lack of a complementary system for (chemical) proximate analysis could be a drawback for the overall approach of supporting traceability, necessary for fighting food fraud and for supporting feed safety. Besides a proper method description and up-to-date descriptions of ingredients, well developed skills of technicians are vital for a good performance.

1 Introduction

In the framework of transparency and the demand for traceability of the source of feed ingredients, it is necessary to establish the formulation of a feed. The legal basis for this examination is the obligatory label declaration of feeds, regulated for years by EU legislation and currently part of Regulation (EC) 767/2009. The main objectives are the prevention of economic fraud and a sufficient monitoring of feed safety.

The analysis of composition of feeds by means of microscopic methods has a long history. It has been a major activity of the IAG section Microscopy from its existence in 1959 (www.iag-micro.org). In 1998 a protocol on the microscopic identification of ingredients in feed was established in German, and translations to English and French were decided to be prepared (http://www.iag-micro.org/files/39_wien98.pdf?10,12).

The method IAG-A2 is based on a procedure of sieving the sample and applying several embedding and staining methods. The different sieve fractions consist of a fine, mediate and coarse material. The presence of specific ingredients (e.g. starch, fibres seed hulls) deviates largely among the sieve fractions. Examinations are to be carried out both a binocular microscope (up to 70 x magnification) and a compound microscope (100 – 400 x magnification; IAG, s.n.). At the final stages the share of the different ingredients are summed up over the different sieve fractions. The methods relies on identification of the ingredients supported by handbooks or reference material (IAG, s.n.). The identification of legal ingredients (Feed catalogue: Regulation (EC) 242/2010) is a complicated procedure.

Besides the availability of a protocol, the current practices are heavily based on the existing skills of the technicians. In the view of a process of improvement of monitoring programs, which was recently established for food in Regulation (EC) 1169/2011, the maintenance and dissemination of these skills needs attention.

In this report the ring test for composition 2016 is presented, which was organised by RIKILT on behalf of the IAG Section Feeding Stuff Microscopy.

2 Methods

2.1 Materials and procedure

The IAG ring test for botanic composition 2016 was chosen to be based on an artificial compound feed; the formulation was taken from a ruminant feed. The feed was based on a formulation with cornglutenfeed (30%), citruspulp (15%), beetpulp (15%), palmkernelmeal (15%), rapeseedmeal (8.5%), wheat (5%), wheat semolina (5%), soybeanmeal (5%) and mineral mix (1.4%).
The IAG ring test for botanic composition 2016 was combined with the IAG ring test for animal proteins (sample 2016-A). The results of this ring test are being published in a separate report (van Raamsdonk *et al.*, 2016). More details on the initial test results are published in that report.

2.2 Organization of the ring trial

All IAG members, all NRLs, participants of former ring tests and a series of putative interesting laboratories were informed about the ring test for 2016. In all cases an invitation letter included in the IAG Newsletter 2015 and a participation form were distributed. Until the beginning of March a total of 27 participants for the microscopic composition analysis were listed. The samples with an accompanying letter were sent to all participants on Monday 7th of March 2016. On Monday March 9th an E-mail message was sent to all participants, together with a file containing a sheet with instructions (see Annex 1) and the electronic report forms (see Annex 2 and 3), and the request to confirm the receipt of the package.
The sample was intended to be analysed according to IAG method 2: "Method for the Identification and Estimation of Constituents in Animal Feedingstuff" (IAG, s.n.). Further instructions to the participants were enclosed in the box with samples, which are reproduced in Annex 4.
The closing date for reporting results was fixed at April 8th. Several requests were received to extend the period for analysis with two weeks. This request was granted and the closing date was set at April 15th. Since the analysis of the results was carried out during May, all the results were considered valid and taken into consideration.
The draft report was finalised at May 27th.

2.3 Analysis of results

The results are analysed according to the IAG scheme of uncertainty limits as approved during the 2006 meeting in Rostock. These limits are presented in Table 1. The model is graphically presented in Figure 1. Shares of ingredients in the feed formulation outside the limits of the model were indicated as "wrong".

Table 1   *IAG model for uncertainty analysis of the composition of a compound feed.*

Actual amount in %	Accepted uncertainty limits
< 2%	"traces "
2.0 – 5.0%	+/- 100% relative
5.01 – 10.0%	+/- 5% absolute
10.01 – 20.0%	+/- 50% relative
20.01 – 50.0%	+/- 10% absolute
> 50%	+/- 20% relative
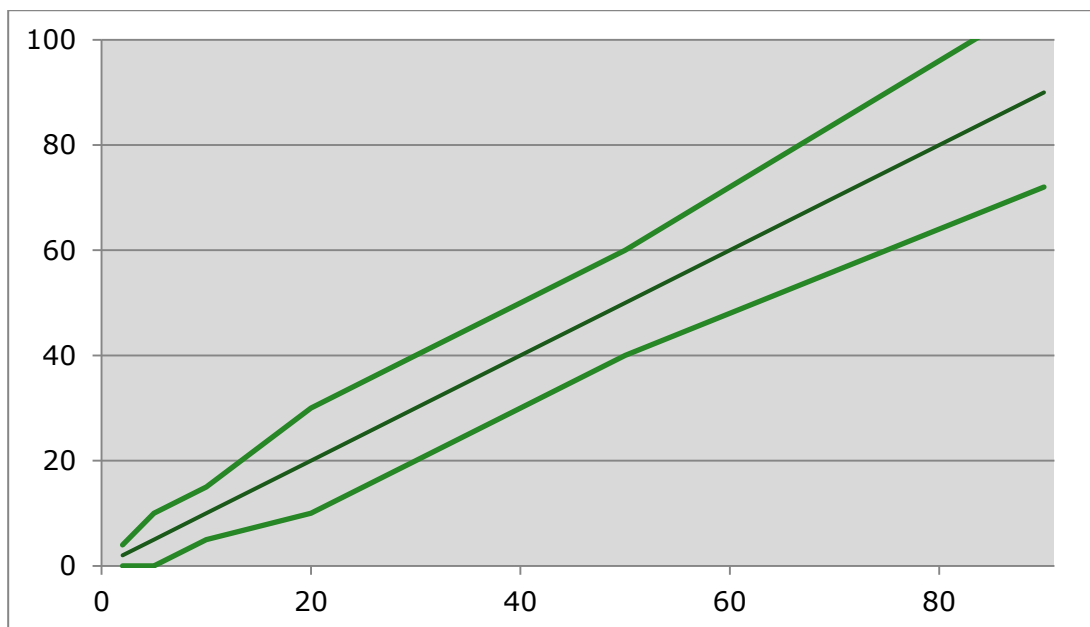
Figure 1   *IAG model for estimating uncertainty. X-axis: correct portion of ingredient in %, Y-axis: estimated portion of ingredient in %. Inner line: correct estimation, outer lines: limits for uncertainty interval at a given percentage.*

3   Results

Twenty-seven samples were sent to all participants, for which 25 sets of results were returned. All results were received by E-mail, in most cases by means of a scan and the original report file. Not in all cases a scan as pdf-file was submitted although this was clearly requested. In all those cases that a participant send in several versions of the report sheet the most recent version was used. All reports were included.

The 25 participants, which successfully submitted their results, originated from 10 countries: 9 member states of the European Union, and one other country. The list of participants is presented in Annex 5. More than half of the participants originated from Germany (13).

The procedure for the analysis of the composition is described in IAG method A2 (IAG, s.n.). This method is familiar to most participants as members of IAG section Microscopy. This method was applied by 16 participants. Other applied methods include a VD LUFA method, the AFNOR V18A method, an AAFM method, and internal laboratory procedures.

The results of the 25 participants are fully presented in Annex 6 and summarised in Table 2. The evaluations will be based on the pooled results per participants for the wheat products and for the corn products, since some participants did not discriminate between the specific types.

Table 2   *Overview of the main ingredients of the analysed sample, the correct composition, the a-priori calculated uncertainty range, and the statistics of the results in terms of median and numbers of participants that under- or overestimated the share of the ingredients. N = 25.*

ingredient	correct	range:	median	# (%) under est.	# (%) over est.
Corn total	30.0%	20.0-40.0%	22.0%	11 (44%)	0 (0%)
Citrus pulp	15.0%	7.5-22.5%	12.0%	10 (40%)	3 (12%)
Palmkernel meal	15.0%	7.5-22.5%	15.0%	2 (8%)	1 (4%)
Beet pulp	15.0%	7.5-22.5%	20.0%	0 (0%)	8 (32%)
Wheat total	10.0%	5.0-15.0%	13.0%	0 (0%)	7 (28%)
Rapeseed meal	8.5%	3.5-13.5%	10.0%	0 (0%)	7 (28%)
Soy meal	5.0%	0.0-10.0%	5.0%	NA	1 (4%)

The estimated amounts were correct in 71.4% of the estimations of the seven major ingredients as listed in Table 2. Three out of 25 participants made one error, seven participants made two errors, seven participants made three errors, two participants made four errors, and one participant made five errors. There is no clear correlation with the method applied.

The ingredient citrus pulp was underestimated or not found in 40% of the result sets. Related to this, beet pulp was in 32% of the cases overestimated. Figure 2 illustrates the distribution of the estimated shares of the seven major ingredients. At a real share of 15%, citrus pulp, palmkernelmeal and beet pulp show large differences among their estimations. Above this, corn as major ingredient was underestimated in 44% of the reports. DDGS was reported by one participant, possibly as indication of the corn portion in the feed, but without further specification of that DDGS ingredient. One participant estimated the total of beet and citrus pulp at a share of 20%. Since this would be the lower limit for a total share of 30% for both these ingredients, this was accepted as correct. In principle, underestimations cannot occur for ingredients with the lower limit of the range at 0.0%.

The indications of the target animal for this type of feed included ruminant (10), cattle (8) and pig (1). Six participants did not provide an indication. Considering the choice to mimic a formulation of a ruminant feed, this result is near to optimal.
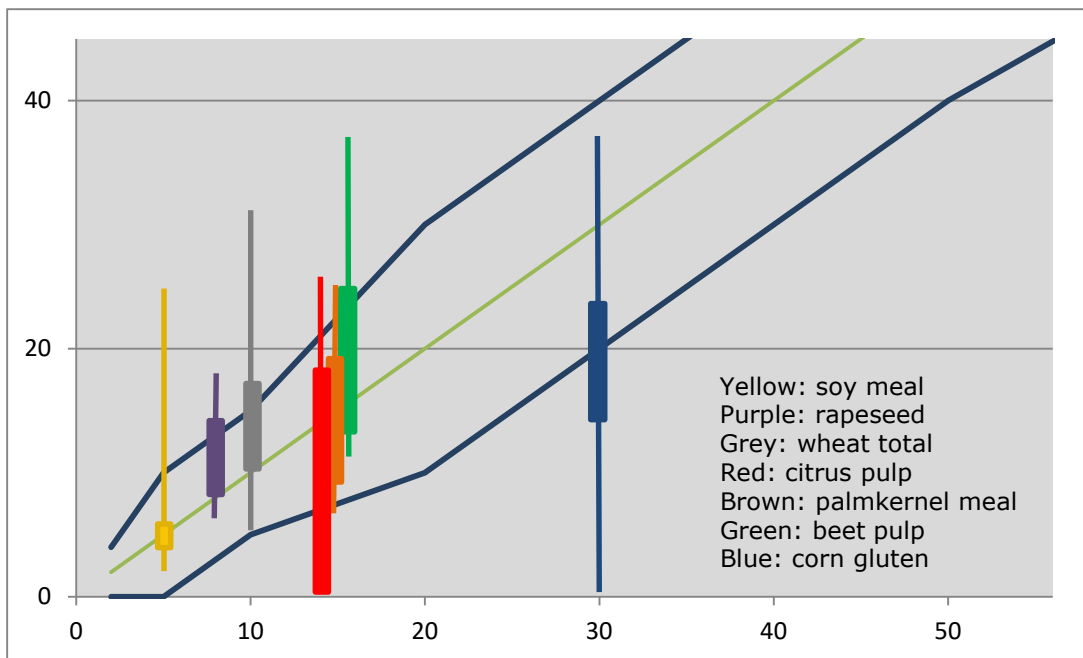
Figure 2 *The results of the IAG ring test composition 2016 projected on the uncertainty limits of the IAG model. X-axis: real share, Y-axis: estimated share. Bars: P_{25} – P_{75} percentile interval, vertical line: minimum – maximum range.*

4 Discussion

4.1 Method application

Several aspects are involved in the process of identification. Examinations at different magnifications are important in a specific order and additional evaluation steps are applied depending on the initial results. Specific expertise is needed depending on the type of ingredients, e.g. starch identification for cereal products and tuber crops, and structure of fibres and oil detection for by-products of oilseeds. Notwithstanding this complicated procedure and compared to the established limits (Figure 2) the current results need further attention, since the number of under- and over-estimations was lower in previous years (2014: 7.7%, 2015: 20.4%, 2016: 28.6%; van Raamsdonk *et al.*, 2014, 2015, this report). This comparison is affected by a bias: the 2014 test set up differently, aiming at label control, i.e. a declaration was given, which means that a direction towards the composition was given. The tests of last year and this year were blank, without any indication of a composition.

A major cause of the number of under- and over-estimations was the combination of beetpulp and citruspulp. These two ingredients can usually be discriminated based on their features, since one is a tuber (beet) and the other is a fruit (citrus). In contrast to last year and despite the apparent difficulty to identify and estimate the share of certain ingredients, the indications of the target animal were very consistent: 18 out of 25 participants indicated ruminant or cattle as targeted animal. This might be based on the high share of the pulp ingredients.

Results of IAG ring tests on composition of compound feeds in previous years (unpublished results) revealed a trend in the sense that higher shares are underestimated and lower shares are overestimated. The IAG model for uncertainty limits was agreed upon in 2006 after an extensive evaluation of alternatives. Nevertheless, in the range of 5 – 10% share of an ingredient in the formulation of a feed (Table 1) absolute limits were used in the model. This is also the range where overestimations are to be expected. A further analysis of unpublished results of past IAG ring tests for composition could provide data for improving the model.

In the past assessment of the biological composition of a feed was supported and, if necessary, adjusted by proximate analysis, of which Weende analysis is the classical approach (German: Weender Analyse; https://de.wikipedia.org/wiki/Futtermittelanalytik). Weende analysis, originally developed in the 19th century (Henneberg and Stohmann, 1859) provides information on basic chemical parameters: moisture, contents of ash, fat, protein and crude fibres. Since extensive information is available on the parameters of individual ingredients, the initial visually estimated shares of the several biological ingredients can be confirmed or optimized using this detail data. Currently several approaches exist for proximate analysis, such as Cornell Net Carbohydrate and Protein System (CNCPS), Van Soest and Near-Infrared Reflectance Spectroscopy, although these systems do not aim at the same set of parameters (Bovera *et al.*, 2003; Godoy *et al.*, 2016). It needs to be stated that the sole visual analysis of the composition of a compound feed without complementary information lacks the possibility of confirmation and adjustment, which might influence the precision of the final result. A good process description consisting of necessary steps, sieve fractions, the necessary parameters to be established in every step and for every fraction, and the procedure for combining all data in a final conclusion, together with documentation on identifying feed ingredients could help to improve the method.

4.2 Justification for establishing composition

European legislation requires that feeds and feed materials are labelled according to a range of requirements, including composition. It has been stated that labelling serves enforcement, traceability and control purposes (Regulation (EC) 767/2009, pre-ambule 17). Feed materials should be mentioned in order of decreasing share, and additional information on composition should be available on request with uncertainty limits of +/- 15% (Regulation (EC) 767/2009, Article 17). It is not stated if this is a relative or absolute range. Annex IV of Regulation (EC) 767/2009 presents requirements for

the labelling of basic parameters such as crude proteins, crude fibres, sugars, starch, oils and fats, minerals, moisture, crude ash and related parameters with a mix of absolute and relative ranges. Monitoring of the correct declaration of the amount of the feed materials used in a compound feed (or other feed) is necessary for two reasons.

At first economic fraud can be based on the replacement of an expensive ingredient by a cheaper one. Secondly, certain compositions can give direction to look for specific unwanted contaminants. The fractionation of a sample in a sediment and a flotate can help to pinpoint the presence of contaminants and might improve their traceability. In the framework of the current report these opportunities apply to feed analysis. In a broader view, composition analysis in the entire food chain can improve the effect of monitoring actions. The new legislation on food labelling (Regulation (EC) 1169/2011), effective from December 13th 2014, obliges to provide more detailed information to customers on composition and related topics.

5 General conclusions and recommendations

5.1 Conclusions

The current results indicate that specific formulations can influence the precision of the estimation of the composition of the feed. The estimations for some ingredients can be mutually influencing, such as for beet pulp and citrus pulp. Corn was underestimated by almost half of the participants. Still almost three quarter of all estimations appeared to be correct in the ranges of the uncertainty model. This means that visual inspection of the composition of a sample can be used for label control and this method can support traceability of ingredients in case of an incidence.
The current lack of a complementary system for (chemical) proximate analysis could be a drawback for the overall approach of supporting traceability, necessary for fighting food fraud and for supporting feed safety. Besides a proper method description and up-to-date descriptions of ingredients, well developed skills of technicians are vital for a good performance.

5.2 Recommendations

- A more detailed process description could help to optimise the method for establishing the composition of a compound feed.
- In the view of the need for proper means for identification, tools for maintenance and dissemination of expertise are important for future performance.
- Considering the general overestimation, especially at lower shares, an evaluation of the IAG uncertainty model can help to improve its application.

Acknowledgements

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Annex 1   Basic instructions for the test procedure

IAG ring test 2016 composition

Instructions for the IAG ring test

1   You have received a box with an introduction letter and either one or four vials containing 50 grams of possibly contaminated animal feed. Please report the receipt of your package as soon as possible by E-mail to the address mentioned below.

2   The sample meant for analysis of composition is indicated on the letter enclosed in the package. Analysis for composition is preferably carried out using method A2 of the IAG section Microscopy. Other methods, however, are allowed. Take care to homogenise the content of each vial before taking the amount for analysis.

The sample meant for analysis of composition is also part of the sample set for the detection of animal proteins. The amount of material (50 grams) should be available for performing both tests.

Link to IAG method A2

3   The results need to be reported as percentual estimations on the tab "Results". The organiser will apply the uncertainty intervals to your estimations as part of the evaluation. Reporting consists of the following steps:

3a   Please fill in the questionnaire on the page "Procedure".

Most of the cells contain a drop-down list. These lists can be used to select an answer as follows. When clicking on a cell, the cursor changes into a hand. A second click will open the drop-down list.

Your unique lab number is mentioned in the introduction letter.
All the fields with a drop-down list have to be completed.

3b   Please enter your results in the fields at page "Results". Your unique lab number automatically shows up after your have entered it at the page Procedure. Enter yourself the unique label of the vial.

4   After completing the two forms "Procedure" and "Results", they have to be sent to the organisers in two ways:

4a   Save the Excel file by using "Save as …", add your unique lab code to the end of name (replace the ## signs with your lab number). The forms have to be sent by E-mail as Excel file and as a scan (*.PDF) to leo.vanraamsdonk@wur.nl and to nastasja.vanderhee@wur.nl.

4b   Results will be included in the final evaluation and report only if both forms are sent in by electronic mail, and after the proper receipt of the requested fee.

5   Direct any questions to leo.vanraamsdonk@wur.nl

6   Closing date is April 8th, 2016.

RIKILT   Wageningen UR, the Netherlands

Annex 2   Report form for procedure details

	select your choice from a drop down list	type in your answer if necessary
Please complete at least all the pink cells with a drop down list that apply to your procedure		
IAG ring test 2014 composition		
Please select your unique lab number	**-- select --**	
Have you read the ring test instructions?	-- select --	
Which detection method do you use?	-- select --	

Annex 3   Report form results

IAG ring test 2015 composition

lab number

sample number

	estimated %
Total:	0.0
Final conclusion on feed type:	-- select --

Comment if necessary

Signature:

Date: 8-4-2016

Annex 4   Additional instructions

Test 2015-B: botanic composition of sample: [   ]

The sample with the number indicated   here   ↑   is meant for the analysis of the botanic composition. Take care to homogenise the content of the vial before taking the amount for analysis. This sample will be used for two purposes: detection of animal proteins if you have subscribed to this ring test, and analysis of botanic composition.

The current test does not provide a label declaration. The report form contains a series of empty rows where the ingredients can be entered in order of their share (highest share on top), together with your estimation of the share in percent in the second column. Finally you are requested to indicate the assumed target of the feed (e.g. broiler feed, calve feed).

All results can be entered in the report form with "composition" in the name.

Annex 5   List of participants

Austrian Agency for Health and Food Safety-AGES	Austria
FLVVT	Belgium
Danish Veterinary and Food Administration	Denmark
IPL Atlantique	France
Inovalys-Nantes	France
CVUA-RRW	Germany
SGS Germany GmbH	Germany
Landeslabor Berlin-Brandenburg	Germany
LUFA Nord-West	Germany
BWZ der BFV	Germany
Futtermittelinstitut Stade (LAVES)	Germany
Veravis GmbH	Germany
LTZ Augustenberg	Germany
LUFA-Speyer	Germany
Bayerisches Landesamt fur Gesundheit und Lebensmittelsicherheit	Germany
Universität Hohenheim, LA Chemie (710)	Germany
Staatliche Betriebsgesellschaft für Umwelt und Landwirtschaft, GB6-Labore Landwirtschaft / LUFA, FB62	Germany
Thüringer Landesanstalt für Landwirtschaft Jena	Germany
MIPAAF – ICQRF – LABORATORIO DI MODENA	Italy
Nutreco Nederland BV - Masterlab	Netherlands
Nutrilab BV	Netherlands
Cargill Poland	Poland
Instytut Zootechniki PIB, Pracownia w Szczecinie	Poland
Trouw nutrition Espana	Spain
Agroscope (ALP), Swiss Research Station	Switzerland

Annex 6   Results

Ingredient	correct	range:	lab:	1	2	3	4	8	9	10
corn gluten				36.0%	40.0%	22.0%	10.0%	15.3%	1.5%	
corn								3.9%	22.0%	22.5%
corn total	30.0%	20.0-	40.0%	36.0%	40.0%	22.0%	10.0%	19.2%	23.5%	22.5%
beet pulp	15.0%	7.5-	22.5%	12.0%	25.0%	12.0%	27.0%	19.6%	37.0%	27.5%
citrus pulp	15.0%	7.5-	22.5%	16.0%		12.0%	15.0%	23.4%		3.0%
beet and citrus pulp										
Palmkernelmeal	15.0%	7.5-	22.5%	16.0%	9.0%	14.0%	12.0%	8.6%	10.0%	7.5%
rapeseed meal	8.5%	3.5-	13.5%	6.5%	9.0%	18.0%	10.0%	9.5%	17.0%	12.5%
Wheat	5.0%	0.0-	10.0%		3.0%			8.9%		
wheat semolina (and bran)	5.0%	0.0-	10.0%		5.0%			6.9%		
wheat products	10.0%	5.0-	15.0%	7.0%		16.0%	18.0%		9.0%	12.5%
soy meal	5.0%	0.0-	10.0%	4.0%	5.0%	2.0%	5.0%	2.7%	2.0%	7.5%
Minerals	1.5%	0.0-	3.0%	2.5%		4.0%	3.0%	1.2%	1.5%	3.0%
fat and minerals					4.0%					
DDGS										
potato pulp										3.0%
barley										
rye										1.0%
sunflower										
Other										
Total	100%			100%	100%	100%	100%	100%	100%	100%
Final conclusion on feed type				cattle	ruminant	cattle	ruminant	cattle		cattle

ingredient	correct	range:	lab:	11	13	14	17	21	22	23
corn gluten					25.0%	17.0%		25.0%		17.0%
corn				37.0%			23.0%			
corn total	30.0%	20.0-	40.0%	37.0%	25.0%	17.0%	23.0%	25.0%	14.0%	17.0%
beet pulp	15.0%	7.5-	22.5%	11.0%	27.0%	12.0%	20.0%	16.0%	20.0%	20.0%
citrus pulp	15.0%	7.5-	22.5%				13.0%			19.0%
beet and citrus pulp										
palmkernelmeal	15.0%	7.5-	22.5%	19.0%	20.0%	18.0%	20.0%	25.0%	14.0%	12.0%
rapeseed meal	8.5%	3.5-	13.5%	9.0%	10.0%	14.0%	6.5%	16.0%	15.0%	9.0%
wheat	5.0%	0.0-	10.0%				4.5%	5.0%		
wheat semolina (and bran)	5.0%	0.0-	10.0%			10.0%		6.0%		
wheat products	10.0%	5.0-	15.0%	17.0%		31.0%	6.5%		17.0%	15.0%
soy meal	5.0%	0.0-	10.0%	5.0%	4.0%	4.0%	4.5%	5.0%	9.0%	6.0%
minerals	1.5%	0.0-	3.0%	2.0%	2.5%	2.0%	2.0%	2.0%		2.0%
fat and minerals										
DDGS										
potato pulp										
barley										
rye										
sunflower										
Other					1.5%	2.0%			11.0%	
Total	100%			100%	100%	100%	100%	100%	100%	100%
Final conclusion on feed type				ruminant	ruminant	cattle			ruminant	cattle

Ingredient	correct	range:	lab:	24	27	28	30	32	41
corn gluten				17.0%			11.2%	15.0%	
corn					5.0%	23.0%			
corn total	30.0%	20.0-	40.0%	17.0%	5.0%	23.0%	11.2%	15.0%	23.0%
beet pulp	15.0%	7.5-	22.5%	24.6%	32.0%	15.0%	24.2%	20.0%	13.0%
citrus pulp	15.0%	7.5-	22.5%	17.5%		13.0%	22.4%	25.0%	9.0%
beet and citrus pulp									
Palmkernelmeal	15.0%	7.5-	22.5%	15.0%	15.0%	16.0%	15.4%	10.0%	20.0%
rapeseed meal	8.5%	3.5-	13.5%	6.0%	10.0%	12.0%	9.1%	7.0%	14.0%
Wheat	5.0%	0.0-	10.0%						
wheat semolina (and bran)	5.0%	0.0-	10.0%	10.0%	5.0%				0.2%
wheat products	10.0%	5.0-	15.0%		4.0%	13.0%	10.0%	18.0%	15.0%
soy meal	5.0%	0.0-	10.0%	7.5%	5.0%	6.0%	5.2%	4.0%	5.0%
Minerals	1.5%	0.0-	3.0%	2.4%	0.5%	2.0%	2.3%	1.0%	0.2%
fat and minerals									
DDGS					22.0%				
potato pulp									
barley									
rye									
sunflower									
Other					1.0%				
Total	100%			100%	100%	100%	100%	100%	99%
Final conclusion on feed type				cattle	ruminant	cattle	ruminant	ruminant	

ingredient	correct	range:	lab:	42	43	44	48	51	
corn gluten				20.0%	18.0%			15.5%	
corn					6.0%	25.0%			
corn total	30.0%	20.0-	40.0%	20.0%	24.0%	25.0%	0.0%	15.5%	
beet pulp	15.0%	7.5-	22.5%		21.0%	15.0%	15.0%	21.5%	
citrus pulp	15.0%	7.5-	22.5%		18.0%	15.0%		25.7%	
beet and citrus pulp				20.0%					
palmkernelmeal	15.0%	7.5-	22.5%	20.0%	9.0%	15.0%		6.4%	
rapeseed meal	8.5%	3.5-	13.5%	8.0%	8.0%	10.0%	15.0%	8.3%	
wheat	5.0%	0.0-	10.0%						
wheat semolina (and bran)	5.0%	0.0-	10.0%	5.0%	4.0%			6.8%	
wheat products	10.0%	5.0-	15.0%		10.0%	10.0%	30.0%	7.3%	
soy meal	5.0%	0.0-	10.0%	25.0%	4.0%	7.5%		4.2%	
minerals	1.5%	0.0-	3.0%	2.5%	2.0%	2.0%		2.6%	
fat and minerals									
DDGS									
potato pulp						0.5%			
barley							20.0%		
rye									
sunflower							5.0%		
other									
total	100%			101%	100%	100%	85%	98%	
Final conclusion on feed type					ruminant	ruminant	pig		

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