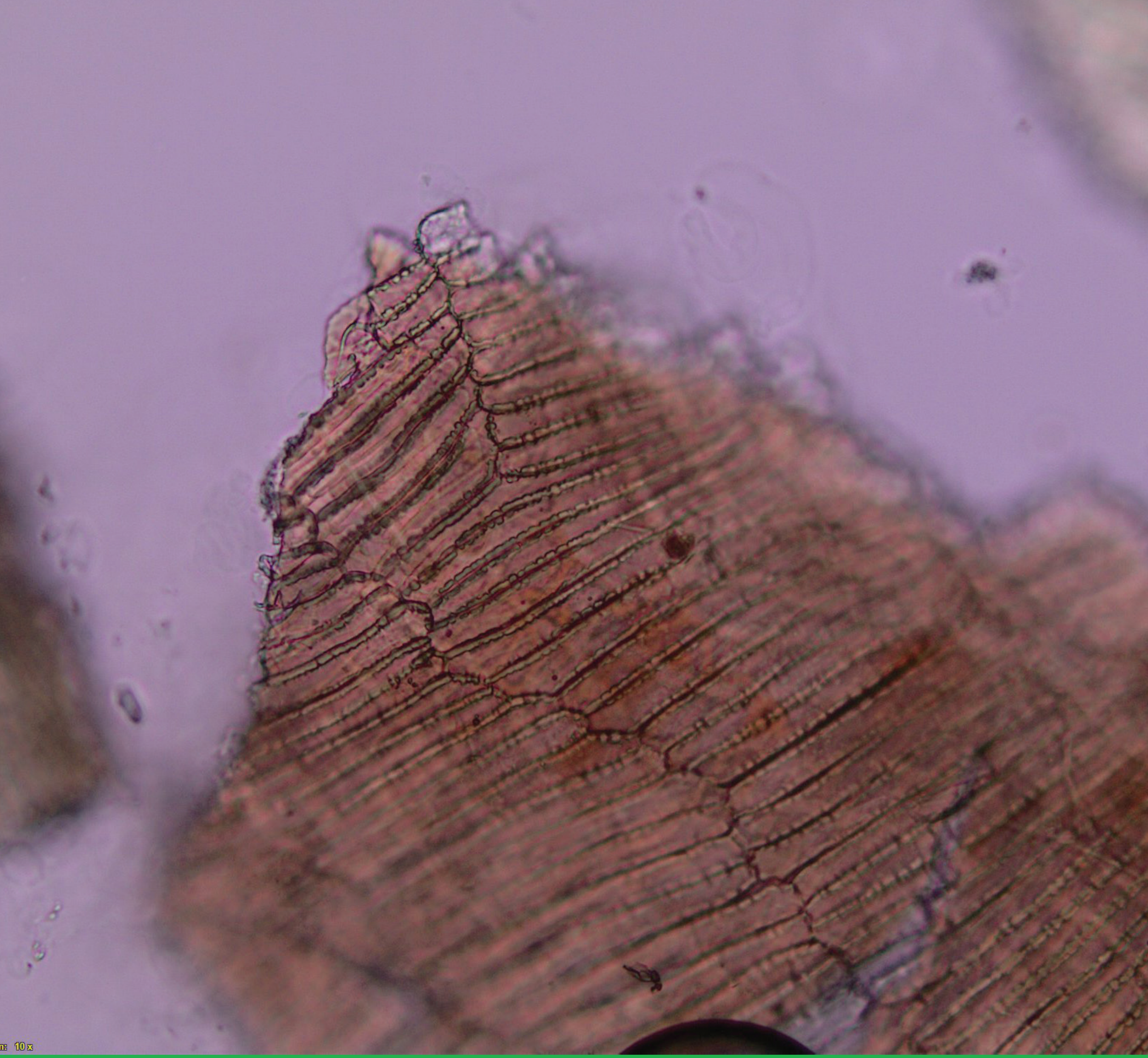

IAG ring test feed composition 2015

L.W.D. van Raamsdonk, N. van de Rhee, V.G.Z. Pinckaers and J.J.M. Vliege

RIKILT
WAGENINGEN UR

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RIKILT Wageningen UR
Wageningen, december 2015

RIKILT report 2015.017

Van Raamsdonk, L.W.D., N. van de Rhee, V.G.Z. Pinckaers and J.J.M. Vliege, 2015. *IAG ring test feed composition 2015.* Wageningen, RIKILT Wageningen UR (University & Research centre), RIKILT report 2015.017. 26 pp.; 3 fig.; 3 tab.; 7 ref.

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RIKILT report 2015.017

Cover photo: wheat bran, 100x, lye

Distribution list:

- International Association for Feeding stuff Analysis (IAG), Section Feeding stuff Microscopy (I. Paradies-Severin, J. Vancutsem, G. Frick, R. Weiss)
- European Union Reference Laboratory, Animal Proteins (CRA-W; G. Berben, P. Veys, V. Baeten)
- Joint Research Centre, Geel (IRMM-JRC; C. von Holst, A. Boix-Sanfeliu)
- All participants of the ring test
- Competent authorities of EU member states

Contents

Summary

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 a pig feed produced at a pilot plant dedicated to produce animal protein free test feeds 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 were returned. The percentage of under- or over-estimations was 20.4% for the seven main ingredients. In the overview of results all three wheat ingredients and all three soy products were pooled to one ingredient each. There is a general overestimation, also for the ingredient (wheat products) with the highest share (51.7%). The maximum overestimation for soy products (share 11.5%) and for beetpulp (share 5.0%) is 32% in both cases. In addition to the usual ingredients which cannot be detected using a microscope, such as fat and molasse, the pig feed contained bakery by-products and whey powder up to a total of 8.4%. Overestimation can be more serious for samples in which a higher share of microscopically undetectable ingredients is present than expected. After adjusting the composition for these ingredients, the share of overestimations was lower.

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.

The current results indicate that feed ingredients can be identified and shares can be estimated successfully. Besides a proper method, maintenance and dissemination of expertise of technicians are vital for a good performance. An evaluation of the IAG uncertainty model can help to improve its application.

1 Introduction

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 basal steps of the procedure for identifying feed ingredients and establishing the feed composition are discussed in a protocol of IAG section Feeding Stuff Microscopy (IAG, s.n.).

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 objective might be the transparency of trade activities, with emphasis on the prevention of economic fraud and a sufficient monitoring of feed safety.

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 priority.

In this report the ring test for composition 2015 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 2015 was chosen to be based on a compound feed produced in the framework of the EU funded project STRATFEED with a composition intended for pig. The formulation consisted of wheat (31.0%), wheatbran (20.7%), bakery by-products (7,5%), soya hulls (7.5%), sunflowerseedmeal (6.5%), palmkernelmeal (5.0%), beetpulp (5.0%), soyabeanmeal (3.0%), rapeseedmeal (3.0%), whey powder (1.1%), barley (1.0%), mineral mix (1.5%) and microscopically undetectable materials (fat, molasse: 7.2%).
The IAG ring test for botanic composition 2015 was combined with the IAG ring test for animal proteins (sample 2015-C). The results of this ring test are being published in a separate report (van Raamsdonk *et al.*, 2015). 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 2015. In all cases an invitation letter (see Annex 1), a participation form and an invoice were distributed. Until the beginning of March a total of 29 participants for the microscopic composition analysis were listed. The samples with an accompanying letter were sent to all participants on Thursday 5th of March 2014. On Monday March 9th an E-mail message was sent to all participants, together with a file containing a sheet with instructions (see Annex 2) and the electronic report forms (see Annex 3 and 4), 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 5.
The closing date for reporting results was fixed at April 6th. 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 June 3rd.

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
– 50.0%	+/- 10% absolute
> 50%	+/- 20% relative

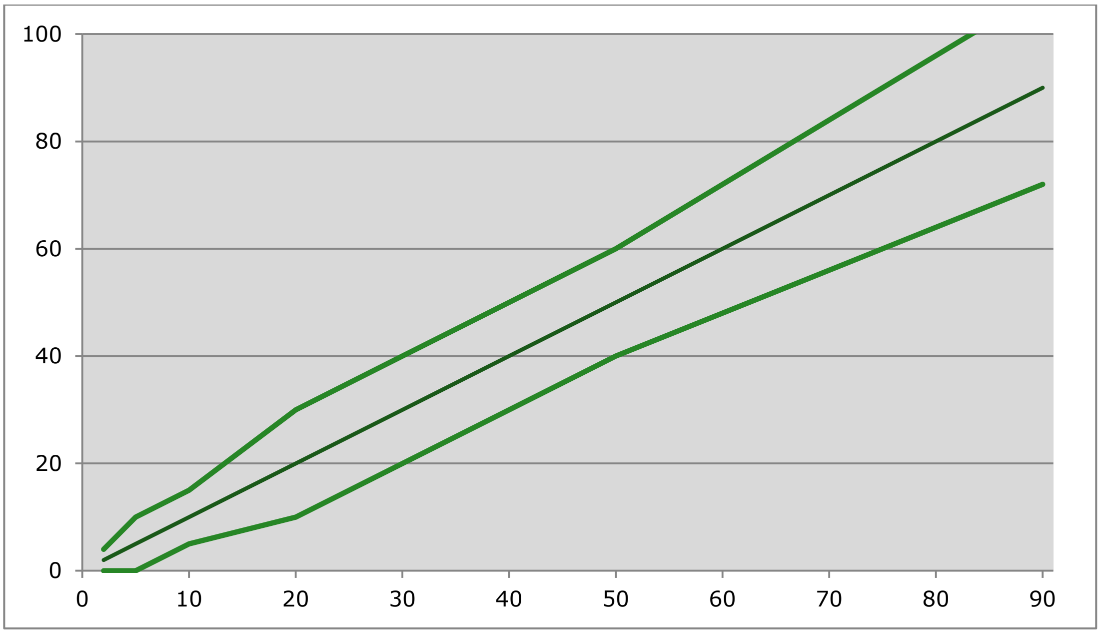

Figure 1. *IAG model for estimating uncertainty. X-axis: correct portion of ingredient in %, Y-axis: estimated portion of ingredient in %. Inner line: correct estimation, outer lines: limits for uncertainty interval at a given percentage.*

3 Results

Twenty-nine samples were sent to all participants, of which 25 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 microscopic results, originated from 10 countries: 9 member states of the European Union, and one other country. The list of participants is presented in Annex 6. More than half of the participants originated from Germany (14).

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 18 participants. Other applied methods include a VD LUFA method and internal laboratory procedures.
The results of the 25 participants are fully presented in Annex 7 and summarised in Table 2. The evaluations will be based on the pooled results per participants for the wheat products and for the soy 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 uncertainty range, and the numbers of participants that under- or overestimated the share of the ingredients. N = 25.

	correct	range:	# (%) under est.	# (%) over est.
wheat total	51.7%	41.4-62.0%	5 (20%)	6 (24%)
soy total	10.5%	5.3-15.8%	3 (12%)	6 (24%)
sunflowerseedmeal	6.5%	1.5-11.5%	0 (0%)	5 (20%)
palmkernelmeal	5.0%	0.0-10.0%	NA	2 (8%)
beetpulp	5.0%	0.0-10.0%	NA	4 (16%)
rapeseedmeal	3.0%	0.0-6.0%	NA	3 (12%)
minerals and vitamins	1.5%	0.0-3.0%	NA	0 (0%)

The estimated amounts were correct in 79.6% of the estimations of the seven major ingredients as listed in Table 2. Nine out of 25 participants made one error, five participants made two errors and five participants made three errors. There is no clear correlation with the method applied.
There is a general overestimation, also for the ingredient (wheat products) with a share as high as 51.7%. The maximum overestimation for soy products (11.5%) and for beetpulp (5.0%) is 32% in both cases. In principle, underestimations cannot occur for ingredients with the lower limit of the range at 0.0%.
In addition to the usual ingredients which cannot be detected using a microscope, such as fat and molasse, the pig feed contained bakery by-products and whey powder up to a total of 8.6%. Since these ingredients can be assumed to be not part of the set of detectable ingredients, an alternative overview was made correcting for these ingredients. This overview is presented in Table 3. Especially the number of overestimations for wheat products is lower. In three reports where the bakery products are correctly found (participant 22: 14%, participant 29: 10%, participant 40: 5%) an almost correct estimation of wheat and/or wheat products was established.
The indications of the target animal for this type of feed included ruminant (8), sow (4), cattle (3), pig (2) and one indication each for calf, broiler and laying hen. Five participants did not provide an indication.

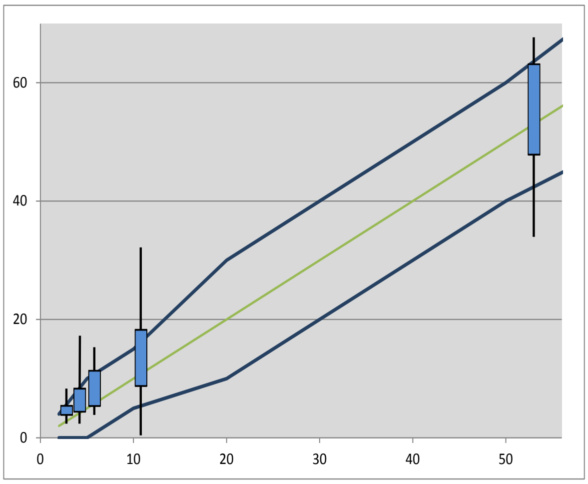

Figure 2. *The results of the IAG ring test composition 2013 projected on the uncertainty limits of the IAG model. Bars: P25 – P75 percentile interval, vertical line: minimum – maximum range.*

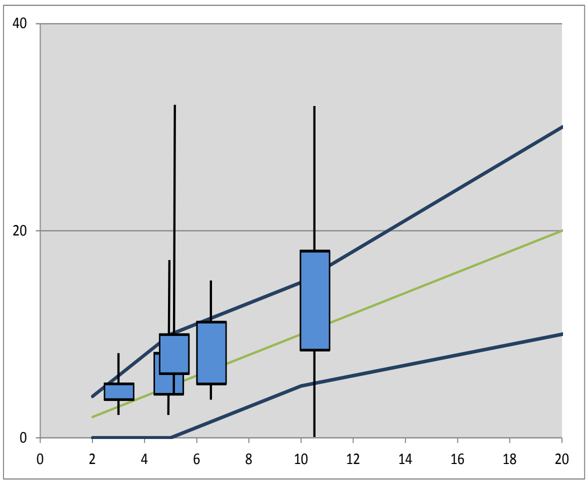

Figure 3*.* *The results of the IAG ring test composition 2015 projected on the uncertainty limits of the IAG model with emphasis on the ingredients with a lower share. Bars: P25 – P75 percentile interval, vertical line: minimum – maximum range.*

Table 3
overview of the main ingredients of the analysed sample, the composition adjusted for the share of bakery products and whey powder, the uncertainty range, and the numbers of participants that under- or overestimated the share of the ingredients. N = 25.

	adjusted	range:	# (%) under est.	# (%) over est.
wheat total	56.6%	45.3-67.9%	5 (20%)	2 (8%)
soy total	11.5%	5.7-17.2%	4 (16%)	6 (24%)
sunflowerseedmeal	7.1%	2.1-12.1%	0 (0%)	3 (12%)
palmkernelmeal	5.5%	0.5-10.5%	NA	2 (8%)
beetpulp	5.5%	0.5-10.5%	NA	4 (16%)
rapeseedmeal	3.3%	0.0-6.6%	NA	3 (12%)
minerals and vitamins	1.7%	0.0-3.4%	NA	0 (0%)

4 Discussion

4.1 Method application

The method IAG-A2 is based on a procedure of sieving the sample and applying several embedding and staining methods. 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 and assumes a high level of skill of the technician.
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. In the view of this complicated procedure and compared to the established limits (Figure 2) the current results are good, although the number of under- and over-estimations was lower last year (7.7%, van Raamsdonk *et al.*, 2014). It has to be noted that the test of last year was aiming at label control, i.e. a declaration was given, which means that a direction towards the composition was given. This year the test was blank, without any indication of a composition.
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 2) 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.

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 feed ingredients can be identified and shares can be estimated successfully. There is a tendency for overestimation, especially for ingredients at shares between 5% and 20%. Overestimation can be more serious for samples in which a higher share of microscopically undetectable ingredients is present than expected. Besides a proper method, well developed skills of technicians are vital for a good performance.

5.2 Recommendations

- 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

The board of IAG section Feeding Stuff Microscopy (dr. I. Paradies-Severin (LUFA, Hameln), dr. G. Frick (ALP, Posieux) and ir. J. Vancutsem (FAVV, Tervuren), dr. R. Weiss (AGES, Vienna)) supported this study as advisory board for communication with the scientists and laboratories working in this research field, and in the final report activities. Their contributions are greatly acknowledged.

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Annex 1 Basic instructions for the test procedure

IAG ring test 2015 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 you 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 6th, 2015.

RIKILT Institute of food safety, Wageningen, the Netherlands

Annex 2 Report form for procedure details

Please complete at least all the pink cells with a drop down list that apply to your procedure	select your choice from a drop down list	type in your answer if necessary
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

Please complete the necessary pink cells for showing your composition of the ingredients; add your sample number, the sediment amount and the final conclusion on feed type.

IAG ring test 2015 composition

lab number	
sample number	
	estimated %
Total:	0.0
Final conclusion on feed type:	-- select --
Comment if necessary	

Signature:

Date: 3-6-2015

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
Inovalys-Nantes	France
IPL Atlantique	France
Bayerisches Landesamt fur Gesundheit und Lebensmittelsicherheit	Germany
BWZ der BFV	Germany
CVUA-RRW	Germany
Futtermittelinstitut Stade (LAVES)	Germany
Landesbetrieb Hessisches Landeslabor, Landwirtschaft und Umwelt	Germany
Landeslabor Berlin-Brandenburg	Germany
LLFG Landesanstalt für Landwirtschaft	Germany
LTZ Augustenberg	Germany
LUFA Nord-West	Germany
LUFA-Speyer	Germany
SGS Germany GmbH	Germany
Staatliche Betriebsgesellschaft für Umwelt und Landwirtschaft, GB6-Labore Landwirtschaft / LUFA, FB62	Germany
Universität Hohenheim, LA Chemie (710)	Germany
Veravis GmbH	Germany
MIPAAF – ICQRF – Laboratorio Di Modena	Italy
Nutreco Nederland BV - Masterlab	Netherlands
Cargill Poland	Poland
Instytut Zootechniki PIB, Pracownia w Szczecinie	Poland
Trouw nutrition Espana	Spain
Agroscope (ALP), Swiss Research Station	Switzerland

Annex 6 Results

	correct	range:	lab:	1	3	4	5	7	8	9
wheat	31.0%	21.0-	41.0%	55.0%	23.0%		34.0%	29.0%	60.0%	34.0%
wheatbran	20.7%	10.7-	30.7%		13.0%		19.0%			
cereal product/residues						60.0%	12.5%	20.0%		
bakery byproducts	7.5%	2.5-	12.5%							
soyahulls	7.5%	2.5-	12.5%					8.0%		
soy (constituents)				18.0%	23.0%				9.0%	32.0%
sunflowerseedmeal	6.5%	1.5-	11.5%	14.0%	5.0%	12.0%	4.0%	4.0%	8.0%	11.0%
palmkernelmeal	5.0%	0.0-	10.0%	2.0%	8.0%	3.0%	8.0%	3.0%	7.0%	6.0%
beetpulp	5.0%	0.0-	10.0%		7.0%	7.0%	7.0%	4.0%	8.0%	4.0%
molasses	4.0%	0.0-	8.0%					2.0%		
soyabeanmeal	3.0%	0.0-	6.0%			13.0%	9.0%			
rapeseedmeal	3.0%	0.0-	6.0%	7.0%	7.0%	4.0%	5.0%	2.0%	5.0%	8.0%
fat animal	2.2%	0.0-	4.4%							
wheypowder	1.1%	0.0-	2.2%							
barley	1.0%	0.0-	2.0%			traces	traces	22.0%		
fat vegetable	1.0%	0.0-	2.0%							
limestone *(mentioned by participants as minerals)*	0.8%	0.0-	1.6%		0.9%	1.0%	1.5%		2.0%	3.0%
salt	0.3%	0.0-	0.6%							
lysine	0.2%	0.0-	0.4%							
vit/min mixture	0.2%	0.0-	0.4%							
maize					14.0%	traces	traces		traces	2.0%
tapioka starch				1.0%						
remaining (overig)				3.0%						
weeds/paper					<0.01					
whey powder						presen t			1.0%	
lineseed						traces				
oat						traces				
alufoil							traces			
oil/fat *(not defined)*								2.0%		
citrus pulp									traces	
cellulose									traces	
	100%			100%	101%	100%	100%	96%	100%	100%
Final conclusion on feed type						sow	cattle	rum.	pig	broiler

	correct	range:	lab:	10	11	12	15	19	22	23
wheat	31.0%	21.0-	41.0%	33.0%	40.0%	35.3%		45.0%	32.0%	25.0%
wheatbran	20.7%	10.7-	30.7%		20.0%				20.0%	15.0%
cereal product/residues				33.0%			48.0%			25.0%
bakery byproducts	7.5%	2.5-	12.5%				present		14.0%	
soyahulls	7.5%	2.5-	12.5%							
soy (constituents)							18.0%		9.0%	15.0%
sunflowerseedmeal	6.5%	1.5-	11.5%	6.5%	12.0%	8.8%	8.0%	15.0%	4.0%	5.0%
palmkernelmeal	5.0%	0.0-	10.0%	4.5%	5.0%	9.5%	4.0%		8.0%	2.0%
beetpulp	5.0%	0.0-	10.0%			9.8%	13.0%	32.0%	7.0%	5.0%
molasses	4.0%	0.0-	8.0%		0.5%					
soyabeanmeal	3.0%	0.0-	6.0%	8.5%	5.0%	24.8%				
rapeseedmeal	3.0%	0.0-	6.0%	3.5%	6.0%	4.0%	3.0%	5.0%	5.0%	5.0%
fat animal	2.2%	0.0-	4.4%							
wheypowder	1.1%	0.0-	2.2%							
barley	1.0%	0.0-	2.0%			4.0%	<2.0%		present	
fat vegetable	1.0%	0.0-	2.0%	3.0%						
limestone *(mentioned by participants as minerals)*	0.8%	0.0-	1.6%	1.0%	1.0%	1.0%	3.0%	3.0%	1.0%	1.0%
salt	0.3%	0.0-	0.6%							
lysine	0.2%	0.0-	0.4%							
vit/min mixture	0.2%	0.0-	0.4%							
maize					10.0%	2.0%	<2.0%		present	
Potato protein concentrate				7.0%			<2.0%			
remaining (overig)						<2.0%				
weeds/paper							present		present	
alufoil									present	
oil/fat *(not defined)*					0.5%					
lactose/sugar										2.0%
	100%			100%	100%	99%	97%	100%	100%	100%
Final conclusion on feed type					rum.	rum.	sow	rum.	rum.	

	correct	range:	lab:	24	28	29	30	32	34	36
wheat	31.0%	21.0-	41.0%	36.0%	38.0%	35.0%	52.0%	32.7%	35.0%	45.0%
wheatbran	20.7%	10.7-	30.7%	23.5%	30.0%			17.0%		15.0%
cereal product/residues								13.7%	33.0%	
bakery byproducts	7.5%	2.5-	12.5%			10.0%				
soyahulls	7.5%	2.5-	12.5%						9.0%	6.0%
soy (constituents)					15.0%			8.4%		6.0%
sunflowerseedmeal	6.5%	1.5-	11.5%	3.5%	6.0%	10.0%	15.0%	4.5%	5.0%	7.5%
palmkernelmeal	5.0%	0.0-	10.0%	17.0%	2.0%	5.0%		8.3%	6.0%	7.5%
beetpulp	5.0%	0.0-	10.0%	6.0%	4.0%	8.0%	15.0%	8.9%		6.0%
molasses	4.0%	0.0-	8.0%							
soyabeanmeal	3.0%	0.0-	6.0%	5.5%		25.0%	5.0%			
rapeseedmeal	3.0%	0.0-	6.0%	5.0%	3.0%	3.0%	5.0%	3.9%	6.0%	3.0%
fat animal	2.2%	0.0-	4.4%							
wheypowder	1.1%	0.0-	2.2%							
barley	1.0%	0.0-	2.0%				2.0%	<1.0%	1.0%	
fat vegetable	1.0%	0.0-	2.0%				5.0%			
limestone *(mentioned by participants as minerals)*	0.8%	0.0-	1.6%		1.0%	1.0%	1.0%	1.6%	1.0%	1.0%
salt	0.3%	0.0-	0.6%						1.0%	
lysine	0.2%	0.0-	0.4%							
vit/min mixture	0.2%	0.0-	0.4%							
maize				2.5%	1.0%	3.0%		<1.0%		traces
Potato protein concentrate										traces
remaining (overig)				1.0%	traces					
lineseed										traces
alufoil						traces		presen t		
lactose/sugar									3.0%	
rye						traces				
	100%			100%	100%	100%	100%	99%	100%	97%
Final conclusion on feed type				rum.	rum.	calf	rum.	laying hen	sow	pig

	correct	range:	lab:	40	43	50	53
wheat	31.0%	21.0-	41.0%		57.0%	38.0%	35.0%
wheatbran	20.7%	10.7-	30.7%				15.0%
cereal product/residues				55.0%			
bakery byproducts	7.5%	2.5-	12.5%	5.0%			2.0%
soyahulls	7.5%	2.5-	12.5%	15.0%			
soy (constituents)							
sunflowerseedmeal	6.5%	1.5-	11.5%	10.0%	6.0%	9.0%	4.0%
palmkernelmeal	5.0%	0.0-	10.0%	3.0%		15.0%	4.0%
beetpulp	5.0%	0.0-	10.0%	5.0%	6.0%	7.0%	15.0%
molasses	4.0%	0.0-	8.0%		1.0%		3.0%
soyabeanmeal	3.0%	0.0-	6.0%		14.0%	11.0%	8.0%
rapeseedmeal	3.0%	0.0-	6.0%	5.0%	5.0%	4.0%	
fat animal	2.2%	0.0-	4.4%				
wheypowder	1.1%	0.0-	2.2%				
barley	1.0%	0.0-	2.0%		5.0%	11.0%	
maize				0.5%		2.0%	
fat vegetable	1.0%	0.0-	2.0%				
limestone *(mentioned by participants as minerals)*	0.8%	0.0-	1.6%	1.0%	1.0%	3.0%	0.1%
salt	0.3%	0.0-	0.6%				
lysine	0.2%	0.0-	0.4%				
vit/min mixture	0.2%	0.0-	0.4%				
Potato protein concentrate				0.5%			
weeds/paper						traces	
whey powder							3.0%
alufoil				traces			
oil/fat *(not defined)*					3.0%		
cocoa husks					2.0%		
canola meal							10.0%
rye						traces	
	100%			100%	100%	100%	99%
Final conclusion on feed type				sow	cattle		cattle

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The mission of Wageningen UR (University & Research centre) is 'To explore the potential of nature to improve the quality of life'. Within Wageningen UR, nine specialised research institutes of the DLO Foundation have joined forces with Wageningen University to help answer the most important questions in the domain of healthy food and living environment. With approximately 30 locations, 6,000 members of staff and 9,000 students, Wageningen UR is one of the leading organisations in its domain worldwide. The integral approach to problems and the cooperation between the various disciplines are at the heart of the unique Wageningen Approach.

To explore the potential of nature to improve the quality of life

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