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Criteria of using results from proficiency testings for measurement uncertainty calculation on the example of various feeds

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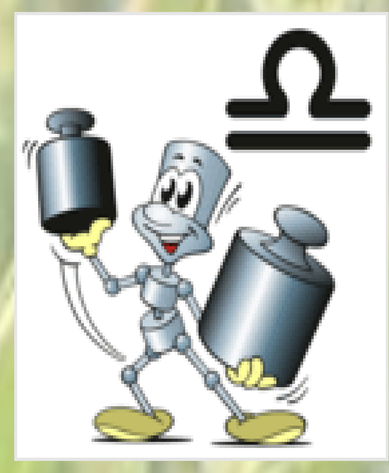

INTRODUCTION

Animal feeding stuffs represent various matrices and components of different homogeneity and stability. Generally, there are not enough feed CRMs for quality control and quality assurance in the laboratory. However, a laboratory can use results from proficiency testings (PTs) for checking its proficiency and checking and/or calculating its bias and measurement uncertainty.

AIM OF THE PRESENTATION

The aim of the paper was evaluation of criteria for using results from PTs for bias and measurement uncertainty calculation.

MATERIALS AND METHODS

An experimental approach based on PTs data was applied in order to calculate bias and measurement uncertainty for some nutrients, feed additives and undesirable substances in feed materials, feed mixtures and premixtures. Several PTs have been organized in the years 2005-2012 by national reference laboratories from Austria, Hungary and Poland. Results of these PTs obtained by the National laboratory for Feedingstuffs were applied to bias *(b)* and measurement uncertainty (u) calculation using the following four formulas [1,2]:

$$b = \sqrt{\Delta^2 + u_{PT}{}^2 + \frac{s_{PT}{}^2}{n}}$$

$$\Delta = \sqrt{\frac{\sum (bias_i)^2}{n}}$$

$$b = \sqrt{\Delta^2 + u_{PT}{}^2}$$

$$u = \sqrt{s_w^2 + b^2}$$

where s_w - within-laboratory reproducibility (intermediate precision); Δ-polled bias of laboratory; u_{PT} - uncertainty of assigned value, calculated according to ISO 13528 (u_{PT} =1.25 $s/\sqrt{n}$).

RESULTS AND DISCUSSION

The results obtained from PTs were successfully used for bias and measurement uncertainty calculations. Some results for feed nutrients and minerals are given in the Table 1 and for feed additives and undesirable substances in the Table 2. Low precision of PTs (H >2), e.g. for sugar in Table 1, caused higher differences in bias and uncertainty calculation obtained from Euralab TR [1] and Nordtest TR [2]. Comparison of uncertainty measurement values obtained from PTs, GUM guide and from Horwitz equation are summarized in the Table 3.

REFERENCES

1. Alternative approaches to uncertainty evaluation. Eurolab TR No 1/2007. Paris, 2007
2. Handbook for Calculation of Measurement Uncertainty in Environmental Laboratories, Nordtest TR 537, Version 3, 2008.

Table 1. Comparison of bias and uncertainty measurement for feed nutrients and minerals calculated by two practical interlaboratory approaches

Item, mean value	n PT	n lab /PT	H mean	s_w (%)	Ref [1], Euralab TR			Ref [2], Nordtest TR		
					b (%)	u (%)	U (%)	b (%)	u (%)	U (%)
Protein, 200 g/kg	21	27	0.48	0.76	2.23	2.36	4.72	2.21	2.34	4.68
Fiber, 36 g/kg	9	21	1.21	3.2	4.76	5.74	11.5	4.65	5.65	11.3
Starch, 400 g/kg	15	16	0.93	1.59	3.33	3.69	7.38	3.26	3.63	7.25
Sugar, 50 g/kg	11	10	2.27	1.12	6.48	6.58	13.2	6.11	6.21	12.4
Ca, 10 g/kg	11	18	1.11	2.4	3.7	4.4	8.8	3.5	4.2	8.4
Na, 1.5 g/kg	10	17	0.96	2.7	5.3	6.0	12.0	5.1	5.8	11.6

nPT - number of PTs; nlab -mean number of labs in PTs; H -Horwitz ratio (HorRat); U (k=2)

Table 2. Comparison of bias and uncertainty measurement for feed additives and undesirable elements calculated by two practical interlaboratory approaches

Item, mean value	n PT	n lab /PT	H mean	s_w (%)	Ref [1] Euralab TR			Ref [2] Nordtest TR		
					b (%)	u (%)	U (%)	b (%)	u (%)	U (%)
Vit A, 2000 IU/g	9	8	1.45	3.4	8.9	9.5	19.0	7.9	8.6	17.2
Vit E, 8 g/kg	9	8	1.93	1.6	7.3	7.5	15.0	6.3	6.5	13.0
Lys, 19 g/kg	21	9	0.77	3.1	3.7	4.8	9.6	3.5	4.6	9.2
Meth, 7 g/kg	9	8	1.01	5.4	5.6	7.7	15.4	5.2	7.5	15.0
Thr, 12 g/kg	16	7	0.76	2.7	4.1	4.9	9.8	3.9	4.7	9.4
Urea, 38 g/kg	4	7	1.05	2.5	5.6	6.1	12.2	5.4	5.9	11.8
Zn, 170 mg/kg	15	30	0.62	2.5	4.3	5.0	10.0	4.2	4.9	9.8
Cu, 20 mg/kg	12	28	0.60	3.5	5.1	6.2	12.3	4.8	5.9	11.8
Co, 1.0 mg/kg	8	18	0.81	7.2	10.6	12.8	25.6	9.8	12.1	24.2
Se, 0.47 mg/kg	9	12	1.04	4.4	11.1	11.9	23.8	9.7	10.6	21.2
As, 4.3 mg/kg	7	11	0.44	6.1	6.7	9.0	18.0	6.2	8.6	17.2
Cd, 0.70 mg/kg	13	19	0.53	7.8	8.3	11.4	22.8	7.8	11.1	22.2
Pb, 4.0 mg/kg	11	16	0.79	4.7	12.1	12.9	25.8	11.3	12.2	24.4

nPT - number of PTs; nlab -mean number of labs in PTs; H -Horwitz ratio (HorRat); U (k=2)

Table 3. Comparison of expanded uncertainty measurement (k=2, %) for feed constituents and undesirable elements obtained by three ways

Item, mean value	From PT	From GUM	From Horwitz	Item, mean value	From PT	From GUM	From Horwitz
Protein, 200 g/kg	4,7	4,0	5,1	Co, 1,0 mg/kg	25,6	24,0*	31,8
Fiber, 36 g/kg	11,5	7,0	6,6	Se, 0,47 mg/kg	23,8	15,0*	35,6
Starch, 400 g/kg	7,4	3,0	4,6	Lys, 19 g/kg	9,6	10,0 a	7,2
Sugar, 50 g/kg	13,2	6,0	6,2	Thr, 12 g/kg	9,8	17,0 a	7,8
Ca, 10 g/kg	8,8	10,0	8,0	Urea, 38 g/kg	12,2	10,0	6,6
Na, 1,5 g/kg	12,0	12,0	10,6	As, 4,3 mg/kg	18,0	25,0*	25,5
Zn, 170 mg/kg	10,0	10,0	14,7	Cd, 0,70 mg/kg	22,8	24,0*	33,5
Cu, 20 mg/kg	12,4	18,0 h	20,3	Pb, 4,0 mg/kg	25,8	16,0*	25,8

* calculated by practical approach with CRM using; a – calculated from PT in years 2004-08

CONCLUSION

Criteria of using results from PTs for measurement uncertainty calculation depends on number of PT (generaly >6), Horwitz' ratio of PT in accepted range ($0.5 < H < 2$), number of participants in each PT – generally ≥10 (depends on PT precision and trueness) and satisfactory result of participant (z-score ≤ 2). Normally with the number of results >10 and H values ≤ 1, the term s^2/n which presents bias uncertainty in Eurolab TR eq. [Ref 1] can be neglected and equation from Nordtest TR [ref 2] can be used. The obtained measurement uncertainty values from PTs can be used for quality assurance in a feed laboratory.