Application Note EDXRF3198

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App Note EDXRF3198 - Animal Feed Analysis

Scope

This application note demonstrates the analysis of premixes, finished feeds, salt lick, and heavy metal screening using energy dispersive X-ray fluorescence (EDXRF). The NEX CG II EDXRF analyzer, an indirect excitation system, and Fundamental Parameters software were used for the measurements. Demonstrated are sheep, dairy, and beef cattle finished feeds. This methodology is also suitable for pigs, chickens, ducks, and other fowl and livestock.

Background

The production and use of animal feeds is a global industry estimated in the hundreds of billions of dollars. Monitoring feeds and premixes is critical to ensure proper nutrient balance for the animal lifecycle, but also to ensure toxic metal constituents are below maximum concentration levels allowed by local regulations. While NIRS (near-infrared spectroscopy) is a widely accepted technique for measuring protein, amino acids, fat, oil, moisture, and fiber, it does not provide a complete solution.

EDXRF is a simple, non-destructive analysis technique that is ideal for measuring elemental concentration. EDXRF spectroscopy can be used for qualitative screening or feed characterization by elemental quantification. The method is useful in quantifying the elements that occur in premixes and finished feed formulations.

Capable of measuring elements from sodium through uranium, EDXRF can measure both the elemental composition of the formulations and simultaneously screen

for the presence of toxic metals such as chromium, lead, arsenic, and cadmium. The Rigaku NEX CG II analyzer meets this challenge by using secondary targets and polarization to remove background, thus allowing for the measurement of major, minor, and trace elements in complex feed applications.

Rigaku RPF-SQX fundamental parameters (FP)

Rigaku RPF-SQX FP software estimates elemental concentration based on XRF theory called Fundamental Parameters (FP) without the need for any known standards. Rigaku Profile Fitting (RPF) automatically deconvolutes spectral peaks and models the sample matrix using fundamental XRF. Standardless semi-quantitative results are often used for screening, comparative measurements, failure analysis, and investigations of new formulations in R&D.

Rigaku user-defined matching library

The user can easily tune the results using Matching Libraries by measuring one or more samples of the actual material with known elemental assay values from a referee technique such as ICP. In this way, the XRF is tuned to the actual products and ICP referee numbers, allowing Rigaku RPF-SQX FP to reliably model variations in base materials, whether inorganic premixes or organic base finished feeds, to ensure optimum accuracy and high-quality data.

The use of Matching Libraries is demonstrated here for the nutrient label claims. A single multi-point Matching Library was used for the premix sample. The Matching Libraries for finished feeds were made in three families: one Matching Library for sheep, another for dairy cattle, and a third for beef cattle. Semi-quant standardless analysis was used to measure the other elements present for informational purposes.

Tolerance

Due to the heterogeneous nature of the material and errors associated with ICP analysis, an accuracy tolerance of ±10% is acceptable in the industry.

$$x = 100\frac{(Result - ICP)}{ICP}$$

Results – premixes

Premixes are inorganic mixtures of various raw materials. The premixes were measured using the FP Powder template with the unmeasurable balance component set to oxygen.

Unknown Premix A **Using Matching Library for Label Claim**				
Element	**Units**	**ICP**	**Result**	**Tolerance**
Na	%	14	15.2	+8.65
P	%	8.8	8.9	+1.1%
Ca	%	16	15.7	-1.9%
Mn	mg/kg	---	2275	---
Co	mg/kg	---	44	---
Cu	mg/kg	2797	2561	-8.4%

Zn	mg/kg	3995	4358	+9.1%
Se	mg/kg	34	34	0%

Unknown Premix A **Informational Semi-quant**		
Element	**Units**	**Result**
Fe	mg/kg	2124
Br	mg/kg	24
I	mg/kg	269
S	%	0.478
Cl	%	18.8

Unknown Premix B **Using Matching Library for Label Claim**				
Element	**Units**	**ICP**	**Result**	**Tolerance**
Na	%	15	13.7	-8.7%
Mg	%	7.4	7.32	-1.1%
Ca	%	11	11.4	+3.6%
Mn	mg/kg	13748	13034	-5.2%
Co	mg/kg	72	79	+9.7%
Cu	mg/kg	3002	3130	+4.3%
Zn	mg/kg	14080	13954	-0.9%
Se	mg/kg	56	54	-3.6%

Unknown Premix B **Informational Semi-quant**		
Element	**Units**	**Result**
Fe	mg/kg	5809
Br	mg/kg	2.9
I	mg/kg	418
S	%	11.4
Cl	%	0.113

Results – finished feeds

Rigaku Scattering FP was used to analyze the finished feeds. Scattering FP estimates the percentage of the sample made of unmeasurable organic components and is ideal for measuring finished feeds with various grain and silage bases.

Sheep
Using Matching Library for Label Claim

Element	Units	ICP	Result	Tolerance
Na	%	0.4	0.43	+7.5%
P	%	0.6	0.57	-5.0%
Ca	%	0.7	0.74	+5.7%
Mn	mg/kg	31	28	-9.7%
Cu	mg/kg	<3	<0.4	---
Zn	mg/kg	58	54	-6.7%

Sheep
Informational Semi-quant

Element	Units	Result
Fe	mg/kg	63
Br	mg/kg	6
Si	%	0.218
S	%	0.431
Cl	%	0.871

Dairy
Using Matching Library for Label Claim

Element	Units	ICP	Result	Tolerance
Na	%	0.6	0.56	-6.7%
Mg	%	0.9	0.89	-1.1%
Mn	mg/kg	66	67	+1.5%
Cu	mg/kg	53	49	-7.5%
Zn	mg/kg	81	85	+4.9%

Dairy
Informational Semi-quant

Element	Units	Result

Fe	mg/kg	658
Br	mg/kg	6
Si	%	0.122
P	%	0.491
S	%	0.375
Cl	%	0.771
Ca	%	0.931

Beef Cattle **Using Matching Library for Label Claim**				
Element	**Units**	**ICP**	**Result**	**Tolerance**
Na	%	0.4	0.38	-5.0%
Mg	%	0.3	0.32	+6.7%
P	%	0.5	0.51	+2.0%
Ca	%	0.7	0.75	+7.1%
Mn	mg/kg	105	108	+2.9%

Beef Cattle **Informational Semi-quant**		
Element	**Units**	**Result**
Fe	mg/kg	379
Zn	mg/kg	114
Br	mg/kg	6
Si	%	0.115
S	%	0.318
Cl	%	0.881

Results – salt lick

A typical salt lick was analyzed using standardless semi-quant FP for informational purposes. If desired, a salt lick sample can be assayed by ICP, and a Matching Library can be made for optimum accuracy.

Salt Lick **Informational Semi-quant**		
Element	**Units**	**Result**

Na	%	14.5
Mg	%	0.387
P	%	0.0718
S	%	0.330
Cl	%	17.5
Ca	%	26.3
Mn	mg/kg	3214
Fe	mg/kg	4553
Co	mg/kg	72
Cu	mg/kg	214
Zn	mg/kg	3306
Se	mg/kg	24
Br	mg/kg	33
Sr	mg/kg	119
I	mg/kg	177

Heavy metal screening

Standardless semi-quant FP is suitable for screening heavy metal content. No heavy metals were detected in the premixes and finished feeds.

Conclusion

The Rigaku NEX CG II using the RPF-SQX Fundamental Parameters method yields excellent performance for the elemental analysis of various premixes, finished feeds, and animal feed products. The use of RPF-SQX Fundamental Parameters eliminates the need for calibration standards. If desired, FP quantification can be optimized with Matching Libraries based on one or more assayed samples of the particular material type. These features make the NEX CG II an ideal EDXRF tool for the elemental identification and characterization of premixes and animal feeds throughout the animal feed industry to ensure proper nutrient balance and to screen for the presence of toxic heavy elements.

Related products

NEX CG II Series

High-performance *indirect excitation* EDXRF for complex ap
plications with trace elements and variable base matrices