Evaluation of homogeneity in feed by method of microtracers®

Olivera Djuragic[1], Jovanka Levic[1], Slavica Sredanovic[1], Ljubinko Lević[2]

[1]*Institut for Food Technology, 21000 Novi Sad, Bulevar cara Lazara 1*
[2]*Faculty of Technology, 21000 Novi Sad, Bulevar cara Lazara 1*

SUMMARY

The mixture homogeneity is an issue of serious concern in the course of adding insignificant amount of feed components in the mixture. Several different methods for determining animal feed homogeneity are used worldwide. In this paper are shown results for mixture homogeneity obtained by the physical method with “Microtracer” (coloured iron particles), during which the process of adding components in certain mixing ratio has been simulated. Due to the fact that the particle size plays the most important role in achieving homogeneity, two groups of feed mixtures with different particles size have been examined. Study results show that the satisfactory mixture homogeneity has been attained in the mixtures with more uniform particles size, whereas it was not possible in the mixtures with less uniform particles size.

Key words: homogeneity, feed, mixing, particle size

INTRODUCTION

The worldwide formula feed industry manufactures more than 400 million tons annually. Manufacturers waste labor, energy and capital when they mix feeds longer than necessary to achieve a complete blend. Excess mixing may also cause degradation of vitamins and medications. If feed is not completely mixed, portions of the feed will contain either too much or too little of the formulated ingredients. This excess variability causes economic losses to users of the feed and may increase the incidence of illegal drug residues. Periodic routine mixer testing is both economically and ethically justified. Starting in the mid-1990s regulatory authorities in many countries have become more concerned in assuring medicated feeds are mixed completely and that all micro ingredients are added as formulated (Barashkov at all, 2007).

Mixing is one of the most essential and critical operations in the process of feed manufacturing. The objective in mixing is to create a completely homogeneous blend. In other words, every sample taken should be identical in nutrient content. A functional definition of uniform mixing can be summarized in one sentence. “All nutrients will be present in sufficient quantity in the daily feed intake of the target animal to meet minimum growth requirements’’.

The size uniformity of the various ingredients that comprise the finished feed can directly impact final ingredient dispersion (Herrman and Behnke, 1994). If all the physical properties are relatively the same, then mixing becomes fairly simple. As the physical characteristics of ingredients begin to vary widely, blending and segregation problems are compounded.

Measuring uniformity involves evaluation of the physical, chemical and visual properties of a mix. These are critical for maintaining product consistency as well as for improving product quality and mixer performance (Allen, 1990; Herzog, 1993).

Particle characterization is as central to understanding feed uniformity as animal performance measurement is to understanding dietary affects. At the simplest level, information on the physical properties of particles can help to maintain a consistent product. At a more complex level, the information can help to improve product quality and performance. This type of information and its usefulness has not yet fully penetrated the feed industry. Furthermore, ingredient and feed manufacturers frequently produce materials with little regard to their physical properties (Allen, 1990).

Those involved in quality control should include monitoring particle characteristics to maintain product uniformity. They can also help modify existing products to improve their handling properties, thus enhancing their end-use value. They can also play detective in determining why one batch performs better than another (Djuragic, 2006).

Several different methods for determining animal feed homogeneity are used worldwide. For many years, the colored iron tracer particles which can be separated from the formula feeds magnetically have been successfully used in practice. Patents assigned to Micro Tracers, Inc. [Eisenberg, 1969, 1977, 1979, 1980, 1987] disclose the composition of tracers consisting of iron or other ferromagnetic material coated with certified FD&C dyes.

Iron-based Microtracers^{TM} include the following: 1. Microtracer F (Colored Iron grit, 25,000 particles per gram); 2. Microtracer FS (Colored Stainless steel grit, 50,000 particles per gram); 3. Microtracer RF (Colored Reduced iron powder > 1,000 000 particles per gram). These tracers may be detected and quantified using a Rotary Detector - laboratory magnetic separator or by use of special magnetic probe (Arlet, 2003; Barashkov at all, 2007).

At least five issues must be considered in validating the mixing process (Barashkov at all, 2007):

1. Selection of the tracer.
2. Addition of the tracer to the test feed.
3. Sampling the feed.
4. Analyzing the samples.
5. Interpreting results.

At least the following criteria should be considered in selecting the tracer: 1. The tracer should be contributed from only one source; 2. The tracer should be a microingredient; 3. There should be an analytical procedure to determine the tracer of known or determinable accuracy and precision; 4. The analytical procedure should be inexpensive; 5. The analytical procedure should be quick: ideally one that may be performed "on-the spot"; 6. One should be able to interpret results objectively (Barashkov at all, 2007).

In this paper are shown results for mixture homogeneity obtained by method with “Microtracer” during which the process of adding components in certain mixing ratio has been simulated.

It is also determined granulometric analyse of two different groups of mashes, regarding of major influence of particle size and particle size distribution.

MATERIAL AND METHODS

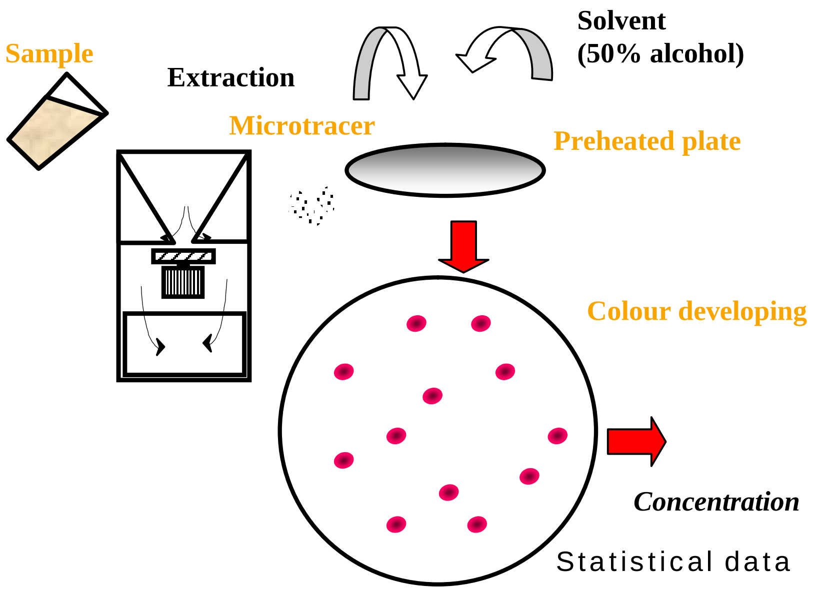
Granulometric analyse was performed by method of Test sieving (ISO 1591-1 1988 (E)).

Homogeneity of mashes was determined by Microtracer® method (Micro Tracers, Inc., San Francisco, CA 94124) as a physical method of homogeneity testing. A sufficient amount of iron filings (Microtracer F, blue) , colored with a water soluble die, is added to the mix in mixing ratio 1:20.000 (50g/t) which results in 125 counts (particles) per sample, with the sample size of 100 grams.

Feed mashes were mixed in horizontal ribbon mixer, under the same conditions and time of mixing was 5 minutes. After mixing, samples were taken directly from mixer. Sample size was about 100-150 g, and after analyzing of samples all values were calculated on 100 g sample size.

Microtracer particles were separated from the feed sample with rotary magnet where iron particles were fixed on the magnetic surface of rotary detector. The iron particles are demagnetized and then sprinkled onto a large filter paper. The filter paper is then moistened with 50 % ethanol. When spots begin to develop, the paper is transferred to a preheated hot plate and dried (Arlet, 2003).

All particles are counted. Number of spots presents concentration of added tracer in sample. All data are calculated by statistical program (Poison statistic) to determine mixing homogeneity. The value of PROBABILITY was criteria for homogeneity where it means that $P<1$ % mixture is not homogenous, when $P>5\%$ mixture is homogenous and in range of $1\%<P<5\%$ tracer results indicate mixing is marginal (Eisenberg, 1992).



RESULTS AND DISCUSSION

In the Figures 1 and 2 are shown results of granulometric analysis of two different groups of mashes.

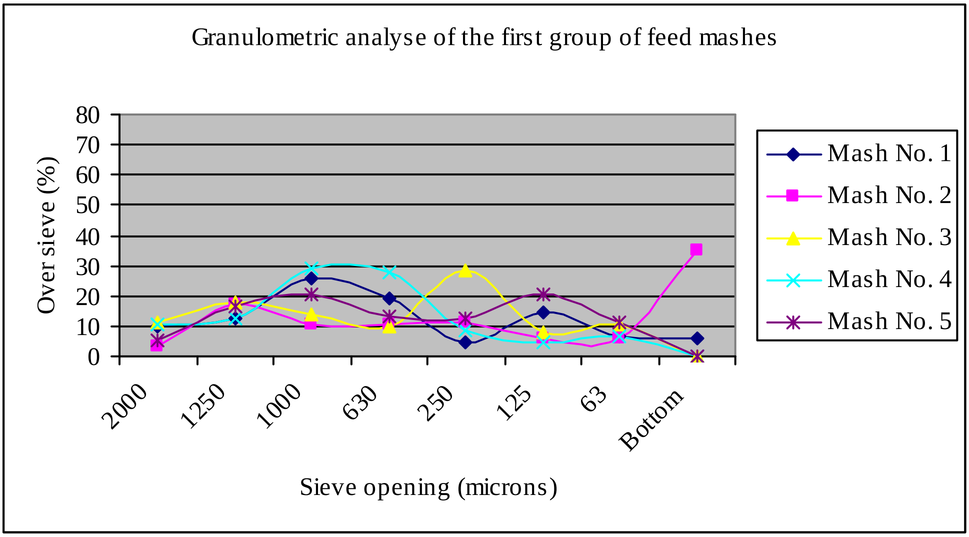


Figure 1

The first group of feed mashes have nonuniform particles, with significant part of coarse and fine particles. This fact has great influence to achievement of homogeneity because there are differences between particle size so it is more difficult to perform uniform mashes.

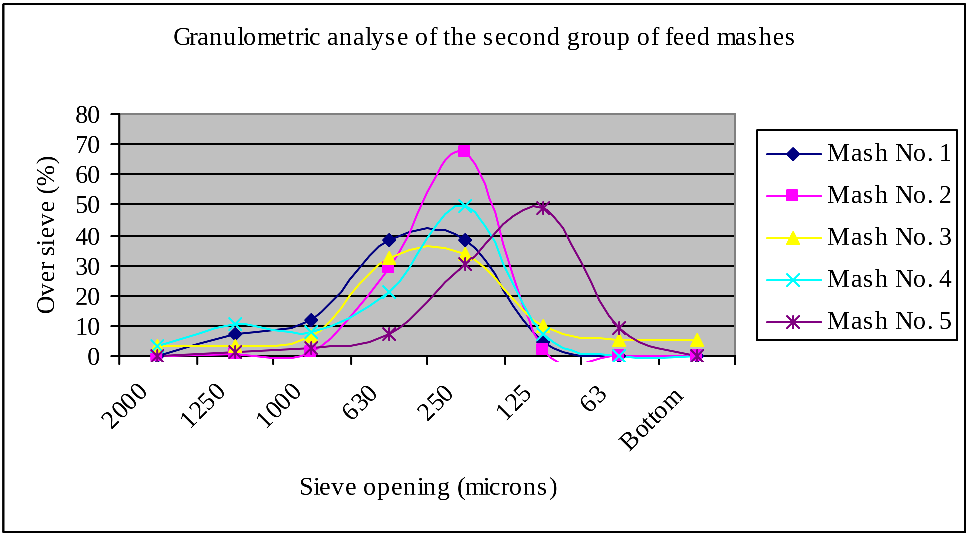


Figure 2.

In the second group of mashes, particle size distribution is more beneficial and the most of particle size is in range 125-500 microns. It makes mixing more uniform and it is easier to achieve homogeneity.

Due to the fact that the particle size plays the most important role in achieving homogeneity, two different groups of feed mixtures with different particles size distribution have been examined by method of Microtracer. Results are shown in Table 1. According to criteria of homogeneity (Probability value), study results show that the satisfactory mixture homogeneity has been attained in the mixtures with more uniform particles size (P=16,11-79,83 %), whereas it was not possible in the second group of mixtures with less uniform particles size (P= 0,00- 0,45%).

Table 1. Results of analysis of feed homogeneity by using Microtracers method

Mashes	Particle number									
	First group of mashes					Second group of mashes				
	1	2	3	4	5	1	2	3	4	5
Sample 1	61	90	98	122	142	104	127	121	126	118
Sample 2	92	136	107	133	106	101	124	115	118	120
Sample 3	92	93	123	123	108	129	117	95	110	114
Sample 4	85	117	109	151	133	134	149	107	126	99
Sample 5	110	78	181	86	98	135	134	105	108	126

Sample 6	84	108	123	138	92	115	107	109	105	125
Sample 7	100	113	114	168	110	120	112	105	119	133
Sample 8	73	118	128	144	101	120	120	95	125	130
Sample 9	115	80	130	136	98	130	132	90	112	101`
Sample 10	103	106	137	156	125	136	112	103	120	111
Number of data	10	10	10	10	10	10	10	10	10	10
Degree of freedom	8	8	8	8	8	8	8	8	8	8
Mean	91.50	103.90	125.00	135.70	111.30	122.40	123.40	104.5	116.9	119.56
Standard deviation	16.57	18.44	22.98	22.58	16.58	12.66	12.63	9.44	7.74	10.55
Coefficient of variation, % = +/-	18.11	17.74	18.38	16.64	14.90	10.34	10.24	9.04	6.62	8.82
Coefficient of variation (POISSON), % = +/-	10.45	9.81	8.94	8.58	9.48	9.04	9.00	9.78	9.25	9.15
χ^2(CHI-SQUARE) =	27.00	29.44	38.02	40.59	22.23	11.78	11.64	7.68	4.61	8.27
Probability P, % =	0.07	0.03	0.00	0.00	0.45	16.11	16.80	46.54	79.83	40.72

CONCLUSIONS

Typically, the physical characteristics of feedstuffs may sometimes affect ration uniformity. Factors like particle size and shape, particle density, electrostatic charge, hygroscopicity and flowability of ingredients are characteristics that have the potential to impact ration uniformity. Of these, particle size is considered to be the most important factor. Characterization of powders is essential to quality control of raw materials, in order to maintain final product uniformity. Nutritionists and feed mill operators should work together to closely monitor feed preparation, and final feed specifications.

REFERENCES

Allen,T (1997), Particle size measurement,Vol. I&II, 5th Edition, Chapman and Hall.

Arlet, Sabine, (2001), Information About Micro Tracer, Micro Tracers Services Europe.

ASAE S303, Test Procedure for Solids-Mixing Equipment for Animal Feeds

Axe, D. (1995), Factors Affecting uniformity of a mix, Animal Feed Science and Technology, 53, s.211-220.

Barashkov Nikolay, Eisenberg David, Eisenberg Sylvan, Mohnke Joseph**,** Ferromagnetic microtracers and their use in feed applications, XII International Feed Technology Symposium, Novi Sad, 13-16th November, 2007.

Djuragic Olivera, Determination of working accuracy in feed manufacturing process by different methods, Master thesis, 2006.

Eisenberg, S., Iron-based tracers, US Pat.3, 469, 990, 1969.

Eisenberg, S., Tracers, US Pat.4, 029, 820, 1977.

Eisenberg, S., Tracer-containing composition, US Pat.4, 152, 271, 1979

Eisenberg, S., Protected iron tracer composition and method of making, US Pat. 4,188,408, 1980.

Eisenberg, S., Microingredient containing tracer, US Pat.4,654,165, 1987.

Eisenberg, D. (1992), Markers in Mixing Testing: Closer to Perfection, Feed Menagment, 43, s.8-11.

Feed Manufacturing Technology, (2005) Appendix C, Determining and Expressing Particle Size, Second Edition, AFIA inc.

Herman, T., Behnke, Keith (1994), Testing Mixer Performance, Publication MF-1172 of Kansas State University. www.oznet.ksu.edu

Herzog, S.M. (1993), Producing uniform dry mixtures, Powder and Bulk Engineering, January, p.37.

ISO 1591-1 (E) (1988) Method of test sieving.