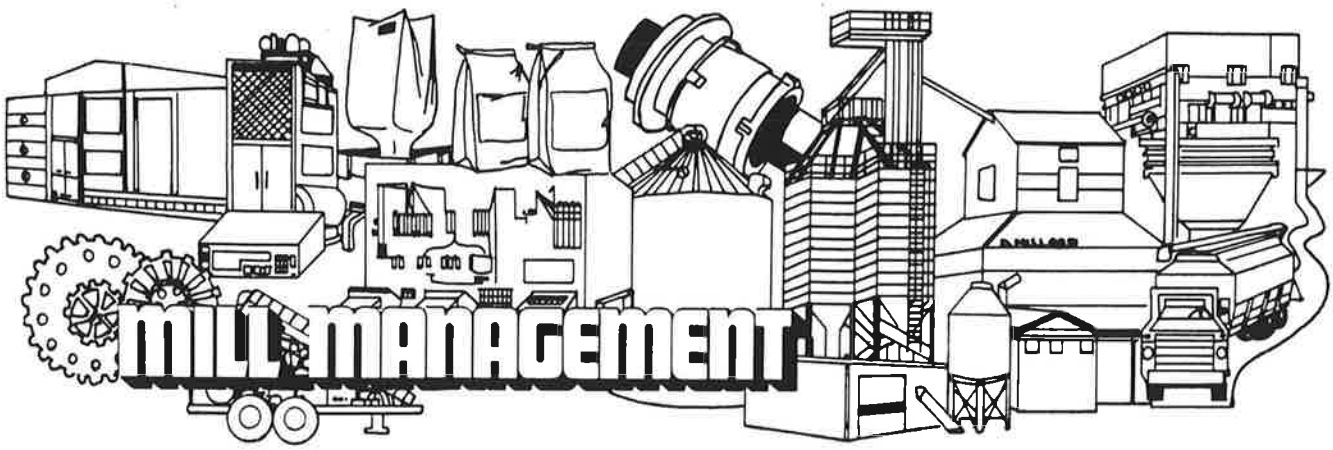

Dilution in a premix

Does it improve micro-ingredient dispersion in feeds?

By Robert R. McEllhiney

Historically, there has been an assumption on the part of feed manufacturers, and other dry materials mixers, that micro-additives will disperse more completely or mix quicker if they have been diluted or premixed prior to addition to a final mix. Konen (1958), for example, stated that proper and efficient handling of highly potent additives in the feed manufacturing operation can only be accomplished through premixing; and Hamilton (1960) said that under no circumstances should any feed manufacturer make a habit of adding minute quantities of trace minerals, potent vitamins or drugs individually into the formula. He added that any ingredient going into a feed at a rate of 0.5%, or less, should be premixed to secure better distribution in the finished feed.

To test this assumption, research was conducted at Kansas State University (McEllhiney and Tangprasertchal, 1983) using a drug, colored iron particle tracers and salt in experiments to determine the effect of dilution on the dispersion of micro-ingredients in animal feeds.

The drug and tracer materials were introduced into the final feed batch mixing process at six dilution levels. As a control, the test materials were added into the final batch undiluted, as supplied by the manufacturers. Premixes were, then, prepared by diluting the drug, tracer, vitamins and trace minerals at one part micro-ingredient to one part diluent (1:1) and, similarly, at dilution levels of 1:5, 1:10, 1:25 and 1:50. Each dilution, or premix, was added to a separate batch of a 32% medicated supplement for feedlot cattle (Table 1). Salt was included in the macro-ingredient portion of the for-

Table 1. Composition of the diet used (a medicated supplement for feedlot cattle, containing 32% protein)

Ingredient	Kg per batch					
	Control	1:1[a]	1:5	1:10	1:25	1:50
Major						
Soya meal (44% protein)	295.70	295.70	295.70	295.70	218.00	73.50
Ground grain sorghum	66.80	61.02	37.90	9.00	0.00	0.00
Wheat middlings	45.40	45.40	45.40	45.40	45.40	45.40
Limestone	30.40	30.40	30.40	30.40	30.40	30.40
Salt	9.50	9.50	9.50	9.50	9.50	9.50
Subtotal (major ingredients)	447.80	442.02	418.90	390.00	303.30	158.80
Micro-ingredients (premix)						
Vitamin A (10,000 I.U. g^{-1})	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin D (15,000 I.U. g^{-1})	0.09	0.09	0.09	0.09	0.09	0.09
Drug[b]	0.91	0.91	0.91	0.91	0.91	0.91
Trace minerals	3.77	3.77	3.77	3.77	3.77	3.77
Microtracer F	0.01	0.01	0.01	0.01	0.01	0.01
Diluent[c]	0.00	5.78	28.90	57.80	144.50	289.00
Subtotal (micro-ingredient premix)	5.78	11.56	34.68	63.58	150.28	294.78
Total diet	453.58	453.58	453.38	453.58	453.28	453.58
Premix (% of total diet)	1.27	2.55	7.65	14.02	33.13	64.99

[a]One part micro-ingredient to one part diluent in the premix portion, 1:5, 1:10, etc.
[b]Each 453.6 g contains 60 g (132.3 g kg^{-1}) active drug.
[c]Ground grain sorghum for 1:1-1:10 ratios, and ground grain sorghum and soya bean meal for 1:25 and 1:50 ratios.

mula and assayed to test the efficiency of the final mixer and to study the effect of the dilution levels of micro-ingredients on the total mixing process.

The Kansas State University pilot feed mill mixing systems were used for these investigations. Prior to the experiments, both the premix mixer and the final mixer were tested by the Quantab[R]* chloride titrator method to determine optimum mixing times and to verify the ability of both mixers to mix efficiently. From the test results, a 3-min. mixing time was selected for both mixers. The premix mixer was a 110-kg capacity, laboratory model, horizontal, double-ribbon mixer driven by a 0.746 kw (1 H.P.) motor at 60 r.p.m. The final mixer was a 454-kg capacity, horizontal double-ribbon mixer driven by a 7.46 kw (10 H.P.) motor at 38 r.p.m.

Tests were conducted for all but the 1:25 and 1:50 dilution treatments by mixing the micro-ingredient portion of the ration and the diluent in the premixer and adding the resultant premix to the final mixer after all major ingredients were in the mixer. For the 1:25 and 1:50 treatments, the micro-ingredients and diluents were mixed in the final mixer for 3 min. then the major ingredients were added. That procedure was necessitated by the disproportionate size of the 'premix' at the high-dilution levels. In all tests, the final batch was mixed for 3 minutes after all ingredients were present.

The mixer was discharged after the appropriate mixing time, and ten 1-kg samples of each batch were collected at equal time intervals during discharge. Hastings (1961) stated that a mixture is not ready for use until it has been taken out of the mixer; therefore, mixer performance should be evaluated by sampling at the point of discharge. The Merck procedure (Larrabee, 1976) for evaluating mixer efficiency requires that a minimum of 10 samples to be taken at equal intervals as the mixed batch passes an access point immediately after discharge from the mixer.

The individual samples were divided in a riffler sample splitter to provide four 225 g portions. One portion of each sample was sent to Kansas State University's Department of Grain Science and Industry laboratory for iron-particle tracer and chloride ion assays. A second portion of each sample was sent to the laboratory of the drug manufacturer for drug assay; a third portion was sent to the laboratory of the iron-particle tracer manufacturer for the tracer assays, and the final portion was retained. The entire six-batch series of tests was duplicated with collection, preparation, and distribution of samples as described. In total, 120 samples were taken and each was assayed by three methods to determine drug salt and tracer levels.

Pierce (1958) stated that, whenever possible, it is preferable to use the analysis for a specific drug or nutrient as a measure of mixing efficiency. Drug assays for this series of experiments were conducted in the drug manufacturer's laboratory using the official microbiological method for activity as published by Kline et al, (1970) and collaboratively supported by Breunig et al, (1972). The drug-assay results are shown in Table 2. Statistical analysis indicated no significant difference among the dilution-level treatments. The means of all test samples were below the expected recovery level; however, they were within the assay limits of ± 15% established by the U.S. Food and Drug Administration for the drug involved in these experiments.

Headly (1967) used a choloride titrator (Quantab[R]) method to measure salt in feeds as a test of mixer efficiency. His method was used in these experiments to study the effect of micro-ingredient dilution levels on the efficiency of the mixer and to ascertain that a 3-min. mixing time was appropriate for all tests.

Results of tests by the chloride ion titrator method (Anon., 1979) are shown in Table 3. Statistical analysis indicated no significant differences among the dilution treatments and showed that the final mixer performed in a statistically acceptable manner. The recovery means were somewhat higher than the expected 2% (9.5 kg per 454-kg batch), presumably because of the additional chloride ions found naturally in feed ingredients (K. Behnke, personal communication, 1981).

Midgley and Eisenberg (1965) evaluated feed-mixer efficiency using colored graphite particles as a tracer, and Eisenberg (1975)

Table 2. Analytical results of drug assays in the final diet at different dilution levels (20 samples per treatment)

Dilution ratio	Analytical results[a] Mean[b] (g t^{-1})	Range (g t^{-1})	Coefficient of variation (%)
Control	249	231-300	6.59
1:1	248	224-265	4.34
1:5	247	212-279	6.56
1:10	244	218-268	6.64
1:25	244	220-280	7.17
1:50	243	227-274	4.97

[a]Expected recovery = 264 g t^{-1}
[b]Treatment means did not differ significantly

Table 3. Quantab® analytical results of chloride ions in the final diet at different dilution levels (20 samples per treatment)

Dilution ratio	Analytical results[a] Mean (%)	Range (%)	Coefficient of variation (%)
Control	2.48	2.1-3.1	9.67
1:1	2.33	2.1-2.7	6.98
1:5	1.65[b]	1.2-2.5	26.42
1:10	2.21	1.4-2.5	9.04
1:25	2.30	1.9-2.7	9.36
1:50	2.10	1.9-2.5	8.74

[a]Expected recovery = 2.0%
[b]Significantly different from other means ($P < 0.05$)

Table 4. Rotary detector[a] analytical results of iron particle counts in the final diet at different dilution levels (20 samples per treatment)

Dilution ratio	Analytical results[b] Mean[c] (count)	Range (count)	Coefficient of variation (%)
Control	14.25	10-21	18.82
1:1	13.85	9-22	23.34
1:5	13.85	8-19	22.67
1:10	13.40	8-24	30.09
1:25	14.00	10-19	21.11
1:50	13.50	7-18	25.38

[a]Micro tracers TM, Microtracers, Inc., San Francisco, California
[b]Expected recovery = 12 counts per 50-g sample.
[c]Treatment means did not differ significantly.

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used iron particles to study micro-ingredient carryover in feeds. Results of the iron-tracer studies in which a magnetic rotary detector device was used are shown in Table 4. Again, statistical analysis indicated no significant differences among the six treatments.

A major problem in working with tracers is interpreting the results. Tracer-particle counts vary among samples taken from uniform feed. Non-uniformity is indicated only when counts vary more than expected from applicable Poisson statistics. The simplest way to interpret results is to determine the average particle count per sample and to establish expected standard deviation ranges about that mean. The standard deviation about the mean should equal the square root of the mean. For example, if the mean sample count is 25, two-thirds of all sample counts should fall in the range of 25 ± 10 (two standard deviations). The coefficient of variation of results (20%) contributed by the limitations of particle statistics is similar to that expected with vitamin or drug analysis (Eisenberg, 1978).

The results of these experiments indicate no significant variation in micro-ingredient dispersion regardless of dilution levels. The results, also, do not indicate a particular quality advantage to feed manufacturers resulting solely from the dilution of micro-ingredients in premixes.

Premixes of micro-ingredients, with or without a diluent, serve as a convenience to animal feed manufacturers. However, premixes, regardless of the dilution level, in these experiments did not appear to have improved the dispersion of micro-ingredients in the final diet prepared by normal feed manufacturing procedures.

If a mixing device is effective, the amount of diluent in a premix or supplement does not alter the ultimate dispersion of the micro-ingredients. Therefore, greater dispersion of drugs in a premix or supplement does not necessarily improve their dispersion in the final feed (Swan, 1981). **FM**

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Cargill acquires feed mill

Cargill, Inc. announced recently that it has acquired an elevator and feed mill in Morrill, Kans., from Morrill Elevator, Inc. The company's Nutrena Feed Division will operate the feed mill which has produced and marketed Nutrena feeds as a toll mill since 1963.