Premixing

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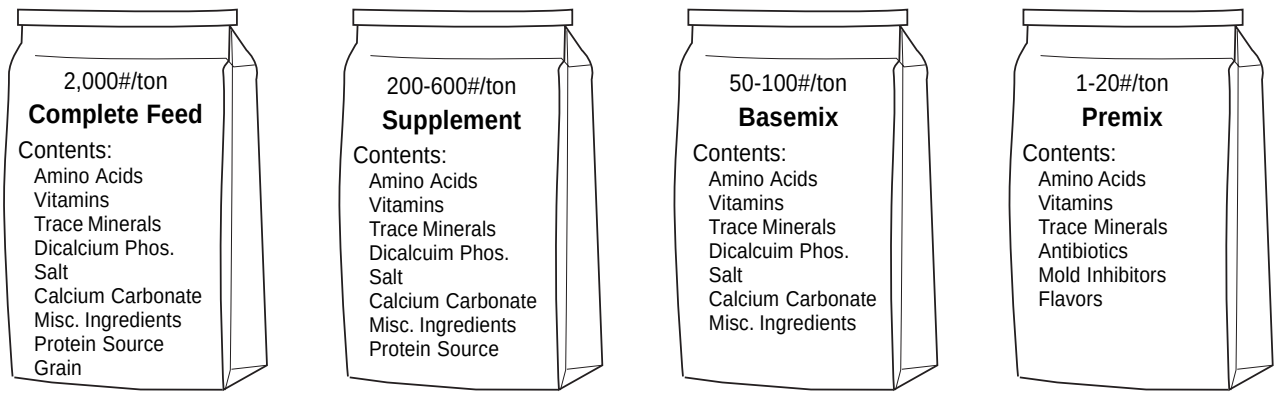
A properly mixed feed should contain consistent levels of each ingredient throughout the batch. The success of the mixing process depends on many factors such as: type of mixer, mixing time, particle size variation, binding agents, carryover from the previous mix, premixing of micronutrients, sequence of ingredients added to mixer, sequencing of mixes, nutritional profile of the mix, and quality assurance program. This bulletin will address premixing and its importance to manufacturing a quality feed.

Consider the example of a 2,000-pound batch that contains 1 gram of a microingredient. The microingredient is the active ingredient and is critical to the final mix and animal performance. If you add the microingredient directly to the batch, the 1-gram quantity can be lost before or during mixing by becoming airborne or during mixing by becoming electrostatically charged and clinging to the mixer or migrating to dead spots in the mixer. Furthermore, dispersion can be reduced by this limited quantity.

Premixing of micronutrients with a suitable carrier is a common method used to ensure proper distribution of these nutrients in the final feed. This dilution must be done accurately and carefully under a strict quality control program. Vitamins, trace minerals, antibiotics, mold inhibitors, and flavors are predominately added to feeds in the form of premixes. Inclusion rates of one to twenty pounds per ton of complete feed are common and depend on the mixing equipment available and type of feed being produced. Figure 1 is a feed type profile sheet that helps define the term premix in relationship to other feed components.

Premixing also helps reduce animal and human exposure to potentially harmful compounds by diluting them to approved and safe concentrations. Providing a safe and wholesome product is another

Figure 1. *Feed Type Profile Sheet*



important goal for any feed processor. FDA provides strict guidelines for premixing certain compounds to ensure safety and potency.

Premixing is also used to standardize potency of several products. This is widely used with fermentation products such as certain antibiotics and vitamins that have variable potency coming out of the fermenters. Standardizing potency of these products allows for more efficient use in the feed manufacturing process.

The premix process requires careful attention to each of the following to ensure success:

- formulation of premix
- selection of carriers or diluents
- use of dust control and binding agents
- type of mixer used
- sequence of ingredients added to the mixer
- sequence of mixes and mixer clean-out
- selection of packaging material
- labelling
- date coding
- storage

Formulation

This initial step is extremely critical and should be done by a qualified nutritionist or other technically trained person. Whether one is given a set of specifications or is responsible to generate a set of them, this is a necessary first step. Many premixes are incorrect because of improper interpretation on the part of the formulator. Many people, given the task of writing a set of specifications, fail miserably at the job. Figure 2 is an example of information needed in a set of specifications for a premix.

Proper conversions involving units of measure are many times taken for granted. The conversion chart provided in Figure 3 can prove useful. The formulator also has to consider source of ingredients, bulk density and particle size variations of ingredients, cost comparisons, handling characteristics, and possible interactions before final decisions are made. Nutrient availability and potency of vitamins and minerals will vary between sources and these factors need to be considered in formulating high quality premixes.

Some low cost vitamin sources have entered US markets at below market prices, but are of questionable quality and stability - sometimes these sources are used in bid situations. A thorough knowledge as to source and potency of the vitamin sources would be advisable.

Formulators must consider stability and possible interactions when putting together their specifications. Much discussion about the combination of vitamins and trace minerals in the same premix continues among nutritionists. Vitamin producers have made efforts to maintain potency and stability of their products by: synthesis of stable derivatives; addition of stabilizing agents; coatings; absorption of liquid vitamins on suitable carriers; use of water-soluble or water dispersible forms; standardization of content; including some overage (2-10%); and providing high bioavailability.

If wise decisions are made on types of carriers, packaging and storage times, and conditions, as well as using quality vitamin suppliers, combinations of vitamins and trace minerals are no problem. Convenience, cost savings, and mixing efficiency can be the advantages to such premixes containing both vitamins and trace minerals.

Carriers or Diluents

The purpose of a carrier is to physically accommodate fine-powdered microingredients and provide a uniform distribution in the process. Rice hulls are a commonly used carrier in vitamin premixes because of their uniformity, pore shape, and degree of porosity, which permits fine particle stabilization. Other common carriers include calcium carbonate, corn cob fractions, wheat midds, and corn distillers dried grain with solubles.

Diluents, on the other hand, are used to extend or dilute the microingredients. They effectively act as a flow agent, affect the density of the mix, and provide volume to the premix. One of the most common diluents used in a premix is calcium carbonate. Combinations of various carriers are often used to obtain desired bulk density, for cost considerations, and to maximize stability. The different carriers, diluents, and their combinations are varied in their use depending on the purpose of the premix and its inclusion use in the mixed feed.

Low priced premixes often use a high proportion of calcium carbonate and call for a high use level in the mixed feed. Nutritionally, this could have a negative effect on the calcium to phosphorus ratio and thus, performance, even though it was a lower priced premix. Cost should not be the driving force in making a decision on which carrier or diluent to use. Rather, emphasis of these components in a premix should be related to their ability to carry microingredients and their compatibility with other ingredients and mixes.

Dust Control/Binding Agents

Fats and oils serve a very important function in quality premixes. They act as an adhesive on the surface of a carrier to improve holding capacity of that

carrier for microingredients. Binding agents also reduce dustiness, improve the integrity and uniformity of the premix, and reduce electrostatic charges and random loss of microingredients.

Mineral oil, vegetable oils, and fats can all be used in selected premixes. Intended purpose of the premix, type of carrier, amount of carrier, and cost of oil or fat all influence one's choice. Mineral oil is the most widely used dust control agent for concentrated premixes while other oils and fats are used in the more diluted products. Many times the type and amount of dust control/binding agent used is compromised because of cost competitiveness, which can result in poorer quality premixes. Some fats, if not stabilized, can cause destruction of vitamins.

Application of oils to mixes under pressure to create an atomized oil droplet is the preferred method of application. This will ensure uniform application and a better quality mix.

Type of Mixer

Horizontal or rotary drum mixers are necessary for proper premixing because they handle better a wide range of bulk densities, produce less friction and, therefore, less heat in mineral mixes, and provide for a greater surface area exposure when adding liquids. Ease of loading, suitability for applying liquids, mixing efficiency, ease of discharge, and clean-out requirements must all be considered. Short cuts in these areas can result in major problems. Manufacturing premixes is not the same as manufacturing complete feeds. The same equipment is not always suitable for both, especially to ensure mix uniformity and minimize any carryover.

Sequence of Ingredients Added to the Mixer

In loading a mixer, proper sequencing of the various ingredients can affect the quality of the final product. Oil balls, chemical interactions, and particle segregation can all result if proper mixer loading sequencing is not followed. These considerations are even more important with premixes.

Poor quality premixes are costly to the premixer and also the feed manufacturer and ultimately the producer. During the premixing process, the following procedure should be used: charge the mixer with the carrier, then thoroughly disperse the oil (binder) onto the carrier. This preconditioning step will maximize the carrying capacity of the carrier. The diluent can be added anytime in the process. The microingredients will be added after the preconditioning phase to minimize oil balls and dustiness. Depending on the specific makeup and characteristics of the premix, the addition sequence may have to be modified.

Sequence of Mixes and Mixer Clean-out

Mixers do not completely empty and, therefore, present a potential carryover from one mix to the next. Mixers vary in clean-out efficiency and steps must be carried out to minimize the carryover from one mix to the next. Physical clean-out using air or brushes may be needed between mixes. In specific situations, it may be necessary to flush the entire system with rice hulls between mixes to decrease contamination.

Proper sequencing of mixes is a practical way to minimize the potential negative effects of such a carryover. Drugs that require a withdrawal and compounds that are toxic to some species are prime examples where sequencing is key. These feeds should not be followed by mixes intended for market animals or for mixes designed for animals that the previous mix contains ingredients that are not approved for, or are detrimental to that animal.

All drug mixes should have a sequencing schedule. Premix manufacturers especially must follow strict sequencing even after proper clean-out as high potency and potentially dangerous ingredients or compounds are involved.

In selecting a premix supplier, this quality procedure of minimizing carryover from one mix to the next is extremely important. Site visitation before making one's final decision would be advisable.

Selection of Packaging Material

Packaging material should be selected based on the type of premix involved. Moisture can be very detrimental to the stability of certain vitamins or other compounds; therefore, a vapor barrier in the packaging material is important. Some ingredients used in premixes are hygroscopic and require a vapor barrier. Length of storage and type of handling may also require special packaging consideration. For example, premixes intended for exporting may require stronger packaging materials because of handling concerns and weather variations.

Labeling

This area is extremely important for regulatory purposes and also to ensure proper use. Too many times this area is poorly handled. Labeling guidelines

are currently in force throughout the feed industry that have helped standardize this area, however, each state controls internal feed sales and therefore, labeling is also state regulated. Be sure all products are accompanied by a label.

Date Coding

This should be a uniform requirement in the industry; however, it is not. Clear and easily determined date coding is useful in product rotation, biopotency concerns, and expiration dates. Insist on a thorough explanation of the date coding used by your premix supplier.

Storage

Purchasing of premixed products that are easily obtained should be done at least monthly. Stability and cash flow alone should dictate this approach. Dry, cool conditions are most desirable, and an effective insect and rodent control program must be a concern in storage areas. High potency premixes can be expensive products; therefore, proper storage to ensure quality and your company's investment is extremely critical. For further information, see *Bagged Ingredient Storage*, MF 2040.

Several studies with properly formulated and blended vitamin and trace mineral premixes have shown good stability up to 90 days in storage using accepted analytic assays[1]. However, few situations offer advantages to purchasing and storing premixes for more than 30 days. Any savings for quantity purchases have to be balanced with costs associated with storage and possible stability concerns.

[1] Studies conducted by Carl S. Akey, Inc., for use by their quality assurance personnel.

Many purchasers of premixes feel assaying the final product is their assurance of quality and value. This approach can many times lead to frustration and confusion for all involved. Table 1 shows normal accepted analytical variations for various vitamins. With such wide assay variances, it is impossible to judge the value and/or quality of a specific premix with a specific sample. In addition, assay costs can be a significant consideration. This problem with assay variation is an increasing concern with regulatory agencies as standard procedures may not always adequately account for the level of the vitamins; for example: cross-linked vitamin A is not detected by standard assay procedures. When assays are required, one should be aware of analytical variations and do everything possible to minimize these variations. Proper sampling, use of a reliable laboratory consistently, having a routine sampling program, and properly rotating and storing the premixes will help reduce assay variations.

Summary

Quality is best assured by working with suppliers who adhere to the principles outlined in this bulletin. Reputable quality premixers have in place a rigid quality assurance program, do not blend out the overages supplied by the basic vitamin and drug manufacturers, and employ highly qualified technical people who provide or assist with premix formulation.

Premixing is an important part of a quality feed manufacturing process. It allows small inclusion nutrients or compounds to be more uniformly or safely distributed throughout the feed. Premixing is not a simple process. If you do your own premixing, do it correctly. If you depend on others for some premixes, insist on quality and accuracy.

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Figure 2. *Custom Quotation Information*

CUSTOM QUOTATION INFORMATION

Customer Name: _____ Salesman: _____

Contact: _____ Current Customer: ☐ Yes ☐ No

Address: _____

City: _____ State _____ Zip: _____ Phone: ( ) _____

Specifications *(Please circle one)* Base Premix Pellet

Product Name: _____ Package Size: _____

Use Level (lbs/ton): _____ Species: _____

Quantity: _____ Date: _____ Date Needed: _____

Price Desired *(Please circle one)* P/# FOB P/# Delv'd Send Price Monthly: ☐ Yes ☐ No

Nutrient	**Source**	**Guaranteed Potency**	**Units (please specify) (lb; kg; %; ppm; etc.)**
Vitamin A			
Vitamin D_3			
Vitamin D_3 Alt.			
Vitamin E			
Vitamin K Activity			
Menadione			
Vitamin B_{12}			
Riboflavin (B_2)			
d-Calcium Pantothenate			
d-Pantothenic Acid			
Niacin			
Choline Chloride			
Choline			
Thiamine Mononitrate			
Thiamine (B_1)			
Pyridoxine Hydrochloride			
Pyridoxine (B_6)			
Folic Acid			
Ascorbic Acid			
d-Biotin (H)			
Zinc (Zn)			
Iron (Fe)			
Manganese (Mn)			
Copper (Cu)			
Iodine (I)			
Cobalt (Co)			
Selenium (Se)			
Ethoxyquin			
Protein, %			
Calcium (Ca), %			
Phosphorous Total (P), %			
Salt (NaCl), %			
Potassium (K), %			
Magnesium (Mg), %			
Sulfur (S), %			
Drug Ingredient			
Rounding Ingredient			
Other			
Carrier			

Comments _____ .

(A conversion chart is listed on the back of this sheet.)

Figure 3. *Custom Quotation Information*

CONVERSION FACTORS

Units Given	Units Wanted	Convert By
lb (dry)	g	lbs × 453.6
lb (dry)	kg	lbs ÷ 2.2046
oz (dry)	g	oz × 28.35
kg	lbs	kg × 2.2046
kg	g	kg × 1,000
kg	mg	kg × 1,000,000
g	mg	g × 1,000
g	µg	g × 1,000,000
ppm	mg/lb	ppm × .4536
ppm	mg/kg	ppm = mg/kg
ppm	m/kg	ppm ÷ 1.000
ppm	m/ton	ppm × .9072
ppm	%	ppm ÷ 10,000
mg/lb	ppm	mg/lb × 2.2046
mg/lb	g/ton	mg/lb × 2
mg/g	mg/lb	mg/g × 453.6
mg/kg	mg/lb	mg/kg ÷ 2.2046
µg/kg	µg/lb	µg/kg ÷ 2.2046
kcal/kg	kcal/lb	kcal/kg ÷ 2.2046
kcal/lb	kcal/kg	kcal/lb × 2.2046
µg/g	ppm	µg/g = ppm
mg/kg	ppm	mg/kg = ppm
mg/kg	%	mg/kg ÷ 10,000
mg/kg	%	mg/g ÷ 10

Units Given	Units Wanted	Convert By
g/kg	%	g/kg ÷ 10
g/kg	ppm	g/kg × 1,000
g/kg	%	g/kg ÷ 10
g/ton	g/lb	g/ton × .0005
%	g/kg	% × 10
%	g/ton	% × 9,072
%	ppm	% × 10,000
g/lb	g/ton	g/lb × 2,000
g/ton	mg/lb	g/ton × .5
g/ton	lb/ton	g/ton × .0022
g/ton	ppm	g/ton × 1.1
g/ton	%	g/ton × .00011
g/ton	g/kg	g/ton × .0011
oz (fluid)	cc	oz × 29.5735
cc	oz (fluid)	cc × .0338
qt	L	qt × .9464
L	qt	L × 1.057
in^3	cc	in^3 × 16.387
cc	in^3	cc × .061
yd^3	m^3	yd^3 × .765
m^3	yd^3	m^3 × 1.308

lb = pound
oz = ounces
g = grams
kg = kilogram
mg = milligram
µg = microgram
ppm = parts per million

kcal = kilo calorie
cc = cubic centimeter
L = liter
qt = quart
in = inch
yd = yard
m = meter

(To make opposite conversions, reverse the conversion procedure.)

Table 1. *Analytical Variations (AV) Based on AAFCO Check Sample Programs*[1]

Determination	Method[a]	AV%[b,c]	Concentration Range
I. Proximate Analysis			
Moisture	7.003, 7.007	12	3 to 40%
	10.136		
Protein	7.015, 7.021	(20/x + 2)	10 to 85%
	7.025, 7.033		
Fat	7.060, 7.063	10	3 to 20%
	7.064		
Fiber	7.066, 7.071	(30/x + 6)	2 to 30%
Ash	7.009	(45/x + 3)	2 to 88%
Pepsin digest, protein	7.053	13	
Total sugar as invert	7.084	12	24 to 37%
NPN protein	7.038, 7.040	(80/x + 3)	7 to 60%
II. Minerals			
Calcium	7.101	(14/x + 6)	.5 to 25%
	7.096	10	10 to 25%
		12	< 10%
Phosphorous	7.123, 7.125	(3/x + 8)	.5 to 20%
	Auto anal.		
Salt	7.106	(7/x + 5)	.5 to 14%
	7.104	(15/x +9)	.5 to 14%
Fluorine	7.114, 7.115	40	ppm
Cobalt	7.096	25	.01 to .16%
Iodine	7.119, 7.120	40	ppm
	33.147		
Copper	7.096	25	.03 to 1%
		30	< .03%
Magnesium	7.096	20	.01 to 15%
Iron	7.096	25	.01 to 5%
Manganese	7.096	30	.01 to 17%
Potassium	3.013, 3.044	15	.04 to 8%
Zinc	7.096	20	.002 to 6%
Selenium	3.102	25	ppm
Sodium	a.a.	20	.2 to 4%
	ICP	15	.2 to 4%
III. Vitamins			
Vitamin A	43.008	30	1,200 to 218,000 IU/lb
Vitamin B_{12}	43.175	45	
Riboflavin	43.039, 43.209	30	1 to 1500 mg/lb
Niacin	43.048, 43.191	25	3 to 500 mg/lb
Pantothenic Acid	43.200, 33.205	25	4 to 190 mg/lb
IV. Drugs			
Amprolium	42.011	20	.01 to .014%
Arsanilic Acid	42.033	20	.01 to .05%
Carbodox	42.047	20	.005 to .5%
Ethopabate	42.069	25	.004 to .04%
Furazolidone	42.075	25	.005 to .022%
Melengestrol Acetate	42.088	30	up to .07%
Nicarbazin	42.098	25	.01 to .02%
Nitarsone	42.035	30	.01 to .02%
Phenothiazine	42.135	20	.1 to .5%
Piperzine	42.137	25	.1 to .4%
Pyrantel Tartrate	42.142	25	.01%
Roxarsone	42.035, 42.160	25	.005 to .5%

[1] Copied by permission: 1995 Official Publication, Association of American Feed Control Officials Inc. Rodney Noel, section editor.

[a] Method References are from 14th Edition, AOAC Official Methods of Analysis.

[b] X = % Guarantee. Example: For a 10-percent Protein Guarantee, AV% = (20/10 + 2) = 4% of Guarantee or 4.0%. This means the low AV is 4% of 10. Therefore, a sample below 9.6% is not acceptable.

[c] The ± signs have been removed from the AV table. The table denotes a true analytical variation and not a tolerance. They apply both above and below the guarantee and are equally correct.

Table 1. *Analytical Variations (AV) Based on AAFCO Check Sample Program (continued)*

Determination	Method	AV%	Concentration Range
IV. Drugs (continued)			
Sulfamethazine	42.172	20	.01 to .033%
Sulfaquinoxaline	42.179	25	.01 to .025%
Sulfathiazole	Colorimetric	20	.008 to .034%
Thiabendazole	42.192	30	up to 1.5%
Zoalene	42.197	25	.004 to .0125%
Bacitracin	42.223	40	10 to 200 g/T
Chlortetracycline	42.236, 42.232	30	10 to 260 g/T
Lincomycin	42.258	25	10 to 200 g/T
Monensin	42.266, 42.271	30	10 to 200 g/T
Neomycin	42.277	45	20 to 250 g/T
Oxytetracycline	42.293	30	10 to 300 g/T
Penicillin	42.299	35	10 to 200 g/T
Streptomycin	42.308	45	10 to 75 g/T
Tylosin	42.316	30	10 to 150 g/T
Virginiamycin	Plate	40	80 g/T

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