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SOME HANDS-ON TIPS IN CALCULATING AND FORMULATING PROTEIN CONCENTRATE SUPPLEMENTS FOR POULTRY

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ABSTRACT

A guide to calculating and utilizing locally available feed ingredients in producing cheap protein concentrate supplements is discussed.

Key words: *feed formulation, protein concentrate supplements,choice feeding, poultry*

INTRODUCTION

There are a number of agro by -products (e.g. copra meal, rice bran, etc..) available in the country which can play a major role in developing feeds for the animals and birds. Also, we grow crops in our food gardens, many of which (e.g. wing bean and yawa banana) can be used as feed sources.

Occassionally, sufficient quantities of these ingredients may be available and one would like to make use of them by feeding them to the birds. This, could be of particular relief during times when the local feed supplier has no feed in stock and, one has to obtain feed from other sources to maintain the birds until the new stocks arrive. This communication is intended to assist when one encounters such suitations, in particular in enabling anyone interested in using a method of feeding known as choice or self - selection feeding method (see Bakau 1988, 1997).

MATERIALS REQUIRED

In addition to the feed ingredients, other materials required include a suitable floor space for mixing the feed, a balance which can give readings in gram, a 100-300 kg slater scale, spades or shovels for mixing the feed, storage bins and storage space or rooms.

FORMULATING PROTEIN CONCENTRATE SUPPLEMENTS

Although this discussion centres around protein concentrate formulation, the principles are essentially the same and can be used in formulating complete rations.

Some general considerations

When all the feed ingredients have been assembled, the next process is to determine the nutrient composition of the protein concentrate supplement. As a rule of thumb, animal nutritionists usually proceed by first considering the protein and energy composition of the feeds. We know that a good protein concentrate supplement is one that contains between 30 to 40% crude protein supplying between 9-10 MJ/kg metabolisable energy, ideally derived from both plant and animal sources. We also know that in a choice feeding system, the birds eat one part protein concentrate supplement to 2-3 parts energy feed sources. Since vitamins, minerals, amino acids, salt, etc. will be added to the concentrate supplement, it is important to add 2 to 3 times more of the recommended amounts of these minor nutrients to the protein concentrate. This is necessary because when the birds eat one part of the protein concentrate supplement, they should eat adequate amounts of these nutrients. Otherwise, the minor nutrients the birds consume will not be enough to maximise their performance.

Several task-groups such as the Agricultural Research Council (ARC; United Kingdom) and the National Research Council (NRC; United States) have collated most of the details of the nutritive composition of common feed ingredients and the nutrient requirements for poultry. Because new data are constantly generated, the most recent publication on the subject should be consulted when formulating

the diets. Tables 1 and 2 contain the basic information which one needs to consult before mixing any feed. Note that the nutritive composition of feeds are average values and should be used as a guide rather than as definite values. The same is also true for the nutrient requirement values for poultry. These are values which have been accepted as the best we have got in terms of our understanding of the nutrition of the birds.

Another factor to consider is the cost of the feed ingredients involved. Most high protein feed ingredients (e.g. soya bean and meat and bone meals) are more expensive. Usually, no more than three of such ingredients are used in formulating protein concentrates; two ingredients with high (e.g. meat and soya bean meals) and one with medium (e.g. copra meal and rice bran) protein contents. In addition to protein, these ingredients will also provide energy, vitamins and minerals, but they are in lower amounts so additional sources will have to be added to the protein concentrates.

Calculations

Suppose we have in store soya bean meal, meat and bone meal, copra meal and rice bran. We intend to mix a concentrate supplement which will supply 33 % crude protein and 9-10 MJ metabolisable energy/kg using only three of these ingredients. Two examples will be used to demonstrate how to go about in doing the calculations, and they are as follows:

Example 1

Based on:- meat and bone meal (50 % crude protein), soya bean meal (35 % crude protein), copra meal (20 % crude protein) and vitamins, minerals etc. (assuming they will make-up 4 % of the mixture)

As a general rule we start by considering the least major ingredient. In this case it is the copra meal followed by the soya bean and meat and bone meal.

Copra meal has high fibre (12 %) content. If we use a lot of it (more than 20 %) this will affect the intake of protein concentrate supplement and therefore those nutrients contained in it. We will hence settle for the maximum level (20 %) which can be used without affecting the concentrate intake. Copra meal contains 20 % crude protein, so by multiplying 20 % composition x 20 % crude protein and dividing by 100, we find that 20 % copra meal will supply 4 % crude protein to the concentrate supplement. Since we have planned to mix a 33 % crude protein concentrate, this will leave us with 29 % (33 - 4 = 29) protein which we will have to take out from 76 % (100 % total composition - 20 % copra meal - 4 % vitamins etc. = 76) of meat and bone and soya bean meals.

However, we do not know how much each of these two ingredients should be added to the final mixture. To work these out we will use a mathematical model called Dairymen's Square. It is simply a way to work out how much each ingredient will be required in the end by first converting the amounts into proportions and later expressing them as proportion or part of the composition. In this example, we had intended to make a 33 % crude protein concentrate but will only require to make up 29 % more protein from 76 % of meat and bone and soya bean meals. By dividing 76 into 29 we get 38.2, which is the target protein that will be taken out from 76 % of the two ingredients. Place the protein contents of the two ingredients to the left of the target protein of 38.2 thus:

Meat and bone meal	50	
		38.2
Soya bean meal	35	

The next step is to cross subtract, subtracting 38.2 away from 50 and 35 away from 38.2 and place the differences to the right of the target protein. The square will look like the following:

Meat and bone meal	50		3.2
		38.2	
Soya bean meal	35		11.8
	15		15.0

When the figures to the right of the target protein (3.2 + 11.8 = 15) are added the answer should be the same as the difference of the figures on the left side (50 - 35 = 15); in this case both work out to 15. The figures on right side however, are proportions and not the % composition of the mixture. To determine how much each ingredients should be added to the mixture, for example, meat and bone meal, we have to divide 3.2 by 15 and multiply by the total percent (76 %) of these materials represented in the mixture; thus 3.2/15 x 76 = 16.2 % meat and bone meal.

The same can be done for soya bean meal; thus 11.8/15 x 76 = 59.8 % soya bean meal. It can also be calculated by taking the difference; 76-16.2 = 59.8 % soya bean meal.

We have now determined how much the meat and bone (16.2 %) and soya bean (59.8 %) meals will be incorporated along with 20 % copra meal and 4 % vitamins etc. to the final mixture. However, the question now is has there been any change to the intended protein (33 % crude protein) and energy (9-10 MJ energy/kg) contents of the protein concentrate. To check this out, we will list all the feed ingredients along with their protein and energy contents and check as follows:

Ingredient	Protein Content (%)	Energy Conten (MJ/Kg)	Composition (%)	Calculated Protein (%)	Calculated Energy (MJ/Kg)
Meat and bone meal	50	10.6	16.2	50 x 16.2/100 = 8.1	10.6 x 16.2/100 = 1.7
Soya bean meal	35	10.7	59.8	35 x 59.8/100 = 20.9	10.7 x 59.8/100 = 6.4
Copra meal	20	11.0	20.0	20 x 20/100 = 4.0	11.0 x 20/100 = 2.2
Others (vitamins etc.)	-	-	4.0	-	-
Total			100.0	33.0	10.3

Our calculations show that we are spot-on with what we had set out to formulate with respect to protein (33 % crude protein) and energy (10.3 MJ energy/kg) contents of the protein concentrate supplement.

Example 2

Most of what has been done in the first example will be retained, except that this time we will list all the minor ingredients which will be incorporated in the mixture to produce an adequately balanced protein concentrate. Also, we will take into account the type of energy and protein feed sources which we will offer to the birds. For this example, we will consider cassava root meal and soya bean meal as the main suppliers of energy and protein respectively.

Cassava has a low protein content (less than 3 %) and low levels of sulphur-containing amino acids (methionine, cystine and cysteine). These amino acids besides being necessary for growth are also the sources of sulphur which the birds use in breaking down toxic substances contained in cassava, called cyanoglycosides. In other words, when using cassava as the main energy supplier these two factors have to be considered. Birds can use methionine (essential amino acid) to produce other sulphur -containing amino acids (e.g. cystine). Methionine is commercially produced and can be purchased and incorporated in the concentrates. Previous work suggests a 1 % methionine inclusion rate in the protein concentrate is beneficial for cassava -based energy diets (Bakau 1986). In this example we will also use the same level in our calculation.

Other factors which we have to consider include:

- We want a practical, cheap diet but a nutritively adequate diet. We will only increase the cost of the mixture if we use many types of ingredients.
- Lysine is an essential amino acid (also produced commercially) but is not readily available in some crops such as the grain legumes e.g. soya bean. It is also the reference amino acid in poultry nutrition.
- Table salt besides being the source of the minerals, sodium and chloride, is also an appetizer i.e. it assists in feed consumption.
- Vitamins and minerals are available as pre-

mixes. There is no need to buy small bottles of individual vitamins and minerals for use in mixing feed. Manufacturers of the premixes usually indicate how much should be added to the mixture. The broiler type premixes (rapid growing poultry) contain higher levels of these nutrients than those for layer birds.

We may now proceed to list the ingredients required in making an adequate protein concentrate, using Tables 1 and 2 as guides in determining the nutritive composition of the protein concentrate. Some small adjustments may be necessary but these should not drastically alter the level of nutrients in the protein concentrate. For this example, all the minor ingredients added to the concentrate will be increased from the National Research Councial (1994) recommendations by three times.

Thus,

	% Composition	
Meat and bone meal	14.0	(16.2 in Example 1)
Soya bean meal	56.2	(59.8 in Example 1)
Copra meal	17.0	(20.0 in Example 1)
Vitamin - Mineral Premix*	7.3	(8.3) **
Salt	2.0	(1.5) **
Lysine	2.8	(3.3) **
Methionine	0.7	(1.0) **

Chemical analysis (calculated)

Crude protein (%)	30.14
Methabolisable Energy (MJ/kg)	8.74
Methionine (%)	1.54
Lysine (%)	3.01

* To be calculated according to manufacturers directions.
** Compositions as recommended (NRC 1994) but the values have been increased approximately three times.

As can be seen from this second example, we have ended -up formulating a 30.14 % crude protein protein concentrate to supply 8.74 MJ/kg metabolisable energy. This is slightly in contrast to the first example, providing 33 % crude protein and 10.3 MJ/kg metabolisable energy. This is quite normal because some adjustments have been made so that a well balanced concentrate can be mixed. When adjusting the proportions, it is always a good idea to consider reducing the ingredients which are expensive. In this example, they are meat and bone and soya bean meals. Both have high protein content and therefore cost a lot. The underlying reason in adjusting the minor ingredients (vitamin-mineral premix, salt etc.) is to enable one to adjust the composition of the major ingredients.

Note that the nutrient levels of the concentrate are based on calculated and not determined values. To get such values the feed ingredients or feed samples have to be sent to a laboratory for analysis.

FURTHER READING

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Table 1: **Nutrient requirements (feeding standards) for different types of poultry production (adapted from McDonald *et al.* 1987)**

	Broiler starter	Broiler finisher	Growing chicks 0-6	6-12 wks	Pullets 12-18 wks	Laying hens	Breeding hens
Met. Energy (MJ/kg)	12.6	12.6	11.5	10.9	10.9	11.1	11.1
Crude Protein (g/kg)	230	190	210	145	120	160	160
Amino Acids (g/kg)							
Arginine	12.6	9.5	11	7.1	6.7	4.9	4.9
Glycine+Serine	12	11	13.2	9.4	8	-	-
Histidine	5	5	5.1	3.3	2.4	1.6	1.6l
soleucine	9	8	9	5.9	4.5	5.3	5.3
Leucine	16	13	14.7	9.9	8.4	6.6	6.6
Lysine	12.5	10	11	7.4	6.6	7.3	7.3
Methionine+Cystine	9.2	8	9.2	6.2	4.5	5.5	4.6
Phenylalanine+Tyrosine	15.8	14	15.8	10.8	8	7	7
Threonine	8	6.5	7.4	4.9	4.2	3.5	3.5
Tryptophan	2.3	1.9	2	1.4	1.2	1.4	1.4
Valine	10	9	10.4	6.6	5.3	5.3	5.3
Major Minerals (g/kg)							
Calcium	12	10	12	10	8	35	33
Phosphorus	5	5	5	5	5	5	5
Magnesium	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sodium	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Potassium	3	3	3	-	-	-	-
Trace Minerals (mg/kg)							
Copper	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Iodine	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Iron	80	45	80	80	80	80	80
Manganese	100	100	100	100	100	100	100
Zinc	50	50	50	50	50	50	50
Selenium	0.15	-	0.15	0.15	-	-	-
Vitamins (i.u/kg)							
Vitamin A	2000	2000	2000	2000	2000	6000	6000
Vitamin D_3	600	600	600	600	600	800	800
Vitamin E	25	25	25	25	25	25	25
Vitamins (mg/kg)							
Vitamin K	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Thiamin	3	-	3	-	-	-	2
Riboflavin	4	4	4	4	4	4	4
Nicotinic acid	28	28	28	28	28	28	28
Pantothenic acid	10	10	10	10	10	10	10
Choline	1300	1300	1300	-	-	-	1100
Vitamin B	-	-	-	-	-	-	0.01

Table 2: **Nutritive value of some feed ingredients for poultry (modified from McDonald *et al.* 1987)**

Feed Ingredients	Fresh Basis						Dry Matter Basis	
	Dry Matter (g/kg)	Crude Protein (g/kg)	Ether Extract (g/kg)	Ash (g/kg)	Digest Crude Prot. (g/kg)	Metabol. Energy (MJ/kg)	Digest Crude (g/kg)	Metabol. Energy (MJ/kg)
Green crops and tubers								
Dried grass	921	178	37	77	156	5.82	169	6.32
Dried lucerne	887	145	27	73	123	4.60	139	9.19
Potato meal	913	87	2	32	63	12.1	69	13.3
Cassava	880	30	< 1	35	-	-	-	12.8
Sweet potato	320	39	5	29	-	-	-	12.7
Sago	880	6	4	5	-	-	-	-
Leucaena leaves	915	258	62	172	-	-	-	-
Cassava leaves	906	224	86	99	-	-	-	-
Cereals and by-products								
Barley	891	113	15	27	90	11.1	101	12.5
Malt distillers' dried solubles	949	268	2	172	-	6.82	-	7.19
Brewers yeast, dried	867	425	21	89	374	11.0	431	12.7
Maize	882	82	32	12	67	13.2	76	15.0
Maize gluten feed	897	250	19	53	223	9.75	249	10.9
Millet	856	119	39	29	82	12.0	96	14.0
Oats	876	100	49	27	85	11.1	97	12.7
Rice, brown	907	101	21	8	84	15.0	93	16.5
Rice bran	910	135	130	151	109	-	-	8.4
Rye	846	85	11	19	67	12.1	79	14.3
Sorghum (milo)	867	107	29	18	88	12.2	97	15.0
Wheat	891	104	14	18	84	13.0		
Wheat germ meal	889	248	73	43	198	11.1	223	12.5
Wheat middlings, coarse	874	149	39	42	127	9.75	145	11.2
Wheat middlings, fine	875	177	52	32	150	11.8	171	13.5
Oilseed by-products								
Coconut meal	887	195	67	64	109	6.90	123	7.78
Cottonseed meal, dec.	901	378	61	67	280	10.9	311	12.1
Groundnut meal, dec.	912	454	51	64	408	13.2	447	14.5
Linseed meal	888	341	63	53	300	8.66	338	9.75
Palm kernel meal	900	190	20	40	171	6.74	190	7.49
Soya bean meal	873	499	15	47	428	10.7	490	12.3
Sundflower seed meal, dec.	916	321	27	64	248	8.83	270	9.6
Legiminous seeds								
Bean meal	866	250	13	39	211	10.4	244	12.0
Pea meal	871	271	17	28	206	11.1	237	12.7
Wing bean	980	330	169	41	-	-	-	-
Animal by-products								
Blood meal	869	800	8	35	720	13.0	829	15.0
Fish meal	910	655	42	215	590	11.5	648	12.6
Herring meal	905	740	70	95	666	13.4	736	14.8
Meat meal	902	722	132	38	650	15.7	721	17.4
Meat and bone meal	935	515	112	275	412	11.0	441	11.8
Milk, dried skim	934	340	9	80	275	12.3	294	13.2
Milk, dried whey	937	125	7	85	101	12.0	108	12.8