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Calf Note #122 – Calculating ME in milk and milk replacers

Introduction

Knowing how much milk replacer to feed to calves – especially in cold weather requires that we know the amount of energy in that milk replacer or whole milk. In [Calf Note #121](#), we looked at the amount of energy required for young calves in cold weather conditions.

The amount of metabolizable energy (**ME**) in whole milk or in a calf milk replacer (**CMR**) depends on the ingredients and how digestible those ingredients are. For milk and CMR, the sources of energy are protein, fat and lactose. In the 2002 edition of the Nutrient Requirements for Dairy Cattle, the NRC used the following equations to estimate the amount of ME in milk replacer:

$$\text{Gross energy (Mcal/kg)} = 0.057 \times \text{CP}\% + 0.092 \times \text{Fat} + 0.0395 \times \text{Lactose}\%$$

Let's calculate...

To calculate ME, the equation is based on the above equation of gross energy:

$$\text{ME (Mcal/kg)} = \text{Gross energy} \times 0.97 \times 0.93.$$

To express ME on a Megajoule per kg basis,

$$\text{ME (MJ/kg)} = \text{ME (Mcal/kg)} \times 4.184.$$

Note that the values (CP, Fat, Lactose) are expressed on a 100% dry matter (DM) basis. So, if you have a CMR that contains about 5% moisture (95% DM), and 20% CP and 20% fat, then the 100% DM basis is $20 / 0.95 = 21.05\%$ CP and 21.05% fat on a 100% DM basis.

What about lactose? In their calculations, the NRC assumes that whatever is not protein, fat, or ash is lactose. Note, that these calculations are made on a 100% DM basis. So, if you have a 20% CP, 20% fat (as fed basis) CMR that contains 5% moisture and 7% ash (as fed), your lactose is calculated as follows:

1. Calculate all nutrients on 100% DM basis
 - a. $\text{CP} = 20 / 0.95 = 21.05\%$
 - b. $\text{Fat} = 20 / 0.95 = 21.05\%$
 - c. $\text{Ash} = 7 / 0.95 = 7.37\%$
2. $\text{Lactose} = 100 - 21.05 - 21.05 - 7.37 = 50.53\%$

So, you can then use the equation above to determine the concentration of ME in your CMR. If you're using whole milk, the NRC estimates that whole milk contains 6.3% ash on a 100% DM basis. You can assume that milk is about 12.5% DM or 87.5% moisture.

What about ash? Of course, CMR manufacturers add minerals to the formulation and these all contribute to the overall ash content. However, some ingredients used in CMR often contain significant amounts of ash. For example, whey powder can contain 8 to 10% ash, and delactosed whey (whey powder with most of the lactose removed) can contain more than 15% ash. If your formulation contains skim milk or casein, then the ash concentration will be somewhat lower. Casein usually contains about 4% ash and skim milk contains about 7% ash. So, how do you know what the ash content of the CMR is if it's not available on the label? You don't. You can estimate it to be about 7% on a DM basis (which is what the NRC used as a "standard" ash level) or you can ask the manufacturer. Their formulation experts should be able to provide you with the exact amount of ash in your product.

A special note to producers that use CMR formulas containing non-milk ingredients – the NRC equations used in these examples assume that all of the ingredients have similar digestibility. Specifically, the NRC assumed that all ingredients were 97% digestible and 96% of the digestible energy was captured as ME. Some CMR formulas contain soy protein concentrate, soy flour, pea or wheat isolate, animal plasma and other non-milk ingredients. In these situations, the digestibility and metabolizability of energy may not be similar to the values in the equations. So, check the label! If your CMR contains any of these ingredients, the estimate of ME in the CMR may be incorrect. The deviation from the NRC calculations will depend on the quality of the ingredient (soy flour has lower digestibility than soy isolate, for example) and how much is included in the formula. Indeed, some very inexpensive formulas may have most of the protein in the formula as soy flour and very high quality formulas may only have 1 or 2% of the formula as soy isolate. It's very difficult to generalize how much error will be introduced into the estimate of ME if you use these equations. For more information, you should contact your feed supplier.

Let's make this easier!

There are lots of calculations in this Calf Note needed to calculate the ME in whole milk or in CMR. To make these calculations a bit easier, I've put together an Excel 2003 spreadsheet that you can use to calculate the ME in milk or milk replacer. Click on this [link](#) to download the file. Table 1 are examples of the calculations that you can do using the spreadsheet.

Table 1. Examples of ME in CMR of various compositions and whole milk.

CMR #	CP	Fat	Ash	ME
	% as fed basis			MJ/kg DM
1	20	20	7	19.97
2	20	10	7	17.82
3	22	18	7	19.68
4	28	17	8	19.74
Milk	3.2	3.5	0.8	21.86

NOTE: Assume that dry matter % is 5% for all formulas.

The above information can be used to calculate the ME and include in your estimates of how much milk or milk replacer should be fed during various times of the year – particularly important in cold weather.

Best of luck!

Written by Dr. Jim Quigley (03 March 2007)
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