**CANINE AND FELINE FEED FORMULATION**

**Chapter 1. Basic concepts of feed formulation**

Feed formulation is a task that meets the animal nutrient requirement with combinations of various feed ingredients. It is a very important because the balanced nutrition feeding is essential for the animal health. A good knowledge of animal nutrition, feeding, physical and chemical characteristics of feed ingredients is need for a proper feed formulation.

**Two pieces of essential information are needed:**

1. Nutrient requirement of animal
2. Chemical composition of the available feed ingredients

**1. Nutrient requirement of animal**

* The first step is to know the nutrient requirements of the **particular animal species** (e.g. canine, feline, and so on) for a **particular physiologic function** (e.g. growth, gestation, lactation, or geriatric).
* Nutrient requirement of animal is expressed in terms of energy (e.g. TDN, GE, **ME**, NEl, NEm, and so on), fiber (e.g. NDF, ADF, and CF) fat (e.g. EE), protein (e.g. CP and amino acids), mineral elements, and vitamins.
* There are some publications for standard animal requirement estimation (e.g. AAFCO, NRC, FDA, and Pet Food Institute), however, these standards are not working always correctly because actual requirements are extremely vary with animal’s breed, individual performance which caused by genetic potential, and/or environments.
* For these reasons, estimating the accurate nutrient requirement by their geographic region, breed, performance and environment is the best. However, this test is so difficult because it is laborious and need a cost-expensive facility.
* Therefore, if you are unavailable to test the accurate requirement, then use the already existing standards first and continuously modify for suit your individual conditions.

**2. Chemical composition of the available feed ingredients**

* Accurate analysis of chemical composition of the available feed ingredients is very important because the nutrient requirement experiments are estimated using the accurately analyzed feedstuffs.
* It is best to obtain the nutrients composition from a laboratory analysis.
* However, there are two disadvantages to determine the chemical composition from laboratory: 1) extra cost and 2) the time delayed in getting the results
* The nutrient composition of the feed ingredients also can be estimated from published values. If you want to use these values, then you must be recognized that published values generally represent the average from a number of samples.
* **There are some standard for chemical composition of feed ingredients:**1) Nutrient requirement series for dog and cat, swine, poultry, small ruminant, beef or dairy cattle which published at NRC (National research council, US)

\*Available at <https://www.nap.edu/>

2) Feedipedia which published at FAO, INRA, and CIRAD

\*Available at <http://feedipedia.org/>

* Some feed ingredients (e.g. urea, cottonseed, molasses and so on) are limited due to their palatability, cost, or toxicity. Therefore, the maximum or minimum dose (%) should be considered.

**3. As-fed basis vs. Dry-matter basis**

* Nutrient requirement and chemical composition are usually expressed as a percent (%) or percent of dry matter (%DM or % of DM).
* As-fed refers to feed as normally fed to animals (containing water).
* On a dry-matter (DM) basis, feed contains 0% water.
* Converting the feed composition data  
  %nutrient (DM basis) = %nutrient (as-fed basis)/%DM  ×  100

%nutrient (as-fed basis) = %nutrient (DM basis) × %DM/100

If maize silage contained both 30% of DM and 3% of CP (as-fed basis), then it can convert into 10%DM of CP.

* The percentage of a nutrient on a DM basis is always higher than an as-fed basis.

**4. Calculation example**

* If only two ingredients were used:   
  Beef meat (Protein = 20%) and Wheat flour (Protein = 10%)

X = % of soybean meal in diet

Y = % of timothy hay in diet

X + Y = 100

If you want to mix the diet that contains 15% of protein, then equation for total protein (%) in diet is that:

0.20\*X + 0.10\*Y = 15 [1] target equation

0.10\*X + 0.10\*Y = 10 [2] derived from X + Y = 100

0.10\*X = 5 [1] – [2]

X = 50 5/0.1

Y = 50 100 – 50

0.20\*50 + 0.10\*50 = 15 Check the calculation

**5. Mathematical program**

* As above calculation method is very complex when number of nutrient are increased, mathematical program can be used for feed formulation.
* Least-cost formulation program is used extensively to minimize the cost of the diet.

**REFERENCE**

Basic animal nutrition and feeding 5th edition

**Time and experience will help provide the answers that cannot be covered in this handout.**

**QUIZ**

1. 종건이는 돼지고기(단백질10%)와 당근(단백질 2%)을 이용해 총 단백질이 6%인 사료를 만들고 싶다. 문제) 돼지고기와 당근을 각각 몇 % 배합해야 하는가?

2. 하리는 돼지고기(단백질10%)와 당근(단백질 2%)을 이용해 총 단백질이 8%인 사료를 만들고 싶다. 문제) 돼지고기와 당근을 각각 몇 % 배합해야 하는가?

3. 윤선이는 소고기(단백질15%)와 배추(단백질 4%)를 이용해 총 단백질이 10%인 사료를 만들고 싶다. 문제) 소고기와 배추를 각각 몇 % 배합해야 하는가?

4. 연희이는 소고기(단백질15%), 배추(단백질 4%), 닭고기(단백질 12%)를 각각 40%, 30%, 30%씩 배합해 사료를 만들었다. 문제) 배합된 사료의 단백질 함량은 몇 %인가?

5. 건휘이는 소고기(단백질15%), 배추(단백질 4%), 닭고기(단백질 12%)를 각각 10%, 50%, 40%씩 배합해 사료를 만들어 딴지에게 30g의 사료를 먹였다. 문제) 딴지가 먹은 단백질은 총 몇g인가?

6. 해섭이는 소고기(단백질15%), 배추(단백질 4%), 닭고기(단백질 12%)를 각각 20%, 40%, 40%씩 배합해 사료를 만들어 켈베로스에게 100g의 사료를 먹였다. 문제) 켈베로스가 먹은 단백질은 총 몇g인가?

**Chapter 2. Terms of energy**

Energy is defined as the potential to perform work where work is the product of a given force acting through a given distance. However, broad definition is not directly applicable to animals because we usually are more concerned with the utilization of chemical energy (calorie or joule). Energy is very important because it is 1) the most important item in an animal’s diet and 2) nutrient requirement standards are based on energy needs.

**1. Units of energy**

Although a joule (J) is a more precise means of expression, a calorie (cal) is generally used as well.

* 1 cal = 4.184 J
* Kcal = 1,000 cal KJ = 1,000 J
* Mcal = 1,000 Kcal MJ = 1,000 KJ

**2. GE, DE, ME, and NE**

* GE (gross energy)
* DE (digestible energy) = GE – energy in feces
* ME (metabolizable energy) = DE – energy in urine and gases
* NE (net energy) = ME – energy in heat increment
* NEm = NE for maintenance
* NEg = NE for growth
* The most accurate way to measure the energy concentration in feed ingredient is animal experiment trial, however, it is too laborious and cost-expensive to do. Therefore, there are some equations for energy calculation using the chemical composition data.
* Equation for ME  
  ME (kcal) = (4 × g protein) + (9 × g fat) + (4 × g NFE)