Fish Feed Technology

PhD. student

Dr.A.Y.Al-Dubakel

1- **Introduction: Chemical composition and ingredients.**
2- **Feed categories.**

Semipurified Diet Formulation for salmonids (H-440) and Oregon Test Diet (OTD) and Guelph Test Diet for Trout

Ingredient	H-440	OTD	Guelph (100)
Vitamin-free casein	38.0	49.5	40.0
Gelatin	12.0	8.7	4.0
Dextrin	28.0	15.6	9.0
Starch	—	—	11.5
α-Cellulose	—	7.7	3.0
Carboxymethylcellulose	—	1.3	—
DL-Methionine	—	—	0.5
L-Arginine	—	—	1.0
Fish oil (marine origin)	—	10.0	15.0
Vitamin E	—	0.2	In vitamin premix
Choline chloride	—	1.0	In vitamin premix
Mineral mix	4[a]	4.0[d]	8.0
Vitamin premix	9[b]	2.0[e]	3.0
Oil premix	9[c]	—	

Nutrient and Other Components of Feedstuffs

The major components of feedstuffs are moisture, lipids, protein, fiber, carbohydrate, minerals and vitamins.

Moisture

Moisture (water) is an important diluents of the nutrients in feedstuffs. It is necessary to know the moisture content of raw materials and compound feeds as a check on their feeding requirements, for use in calculating analytical data on a dry matter basis and also because moisture has an important function in determining the form of the diet. It also has an effect on its stability and its shelf life.

The feed may be dry (about 10% moisture), moist (about 30-45% moisture) or wet (>50% moisture) or an intermediate between these. Normally, only mixtures of wet materials (e.g., trash fish) would come into the wet category. Most compounded aquaculture feeds fall into the dry category or the moist group.

Usually the data in feed compositional tables has been obtained in locations different to the one for which diets are to be formulated. Being able to look up the analysis of a similar ingredient to the one being considered for inclusion in a diet depends on having an accurate name for the product and an understanding of the method by which it was produced (if it is a by-product), grown (if a plant), or the species (plants and animals)from are being made to which it came. Thus feed terminology is important and efforts establish internationally recognized feedstuff names and descriptions and to relate these to the common names used in each country.

Moisture Content

One basic confusion relates to whether the analyses given in feed composition tables is based on the dry matter (DM) content of the feed or on an 'as-fed' (or as received) basis. Some tables clearly state which method is being used - others do not. Most dried ingredients contain 7-12% of moisture. The use of data which is based on DM content in a ration being formulated on an as-fed basis will therefore lead to errors of the same order. Tables which present information on a DM basis do so because moisture content can be so variable, particularly for cereals; this therefore gives an easier means of comparison. However, if analyses based on a DM basis are to be used for formulation on an as-fed basis, they have to be converted to that basis by using the known moisture content of the local material.

Analytical Information Needed About Feeds

Moisture Content
Crude Lipid Content
Crude Protein Content
Crude Fiber Content
Carbohydrate (NFE) Content (by difference)
Ash Content (necessary, if the NFE level is to be calculated by difference) Ca/P Ratio
Available Phosphorus Content
Lysine Content
Methionine and Cystine Content
(Level of Poly-unsaturated Fatty Acids (n-3 and n-6 series

Feed Composition Table

When compound feeds are formulated for any animal it is necessary to know the composition (analytical characteristics) of each of the raw materials which are to be considered for use. There is no true substitute for recent analytical data on the actual material to be used, for the analysis of ingredients varies widely according to the method and place of growth or manufacture. However such data is not often available and to obtain it quickly and accurately enough to use for formulation can place an intolerable burden on local analytical facilities. The nutritionist in the field therefore almost always has to resort to published data on feed composition in tables prepared for formulation purposes.

For example, if the protein content of an ingredient in a compositional table is given as 45% on a DM basis and the actual material being considered for use locally is known to have a moisture content of 9%, the as-fed protein content can be calculated as follows:
As-fed protein content = DM% protein × (100 -moisture content)

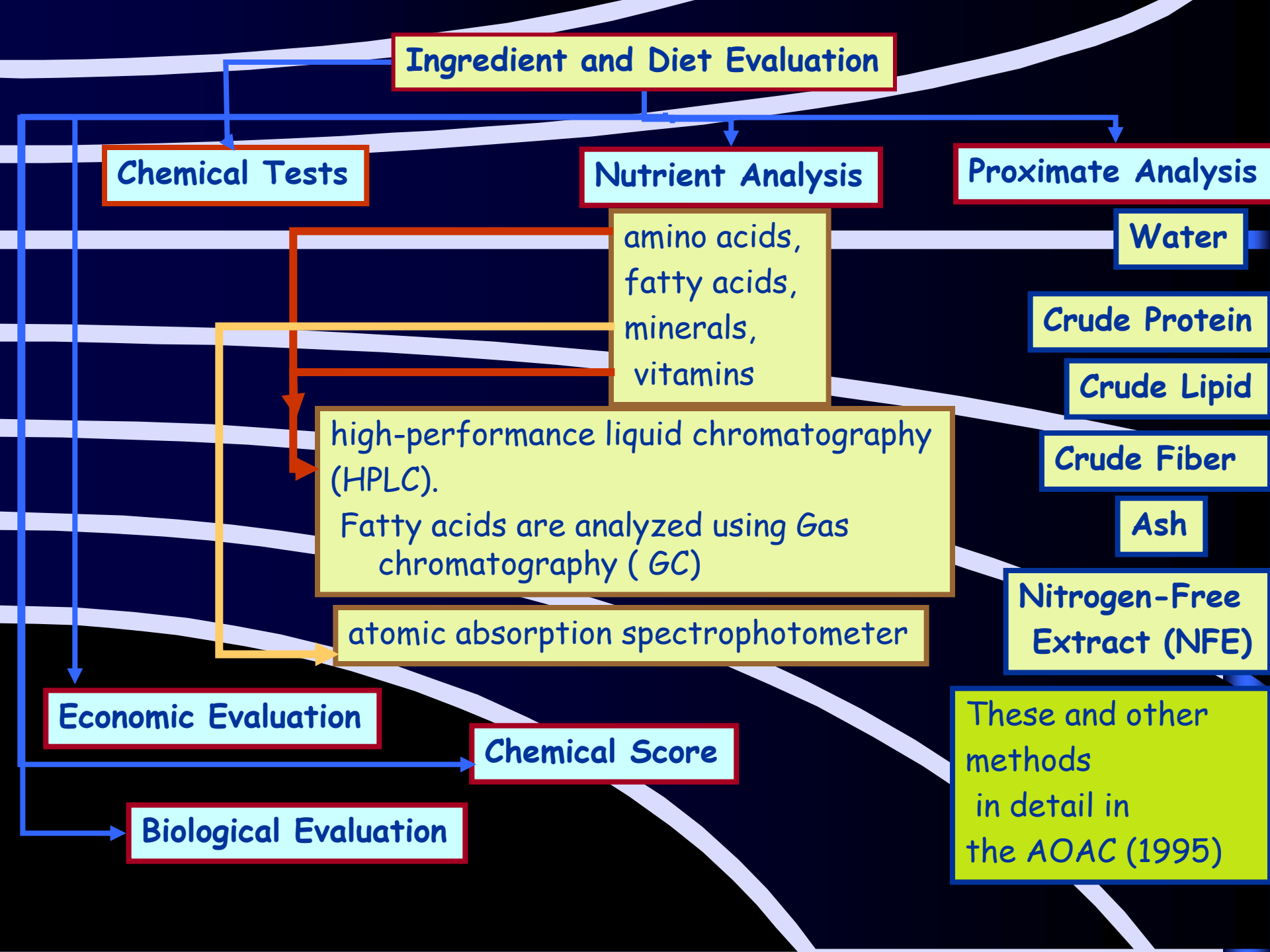
$$\text{As-fed protein content} = 45 \times \frac{(100-9)}{100} = 40.95\%$$

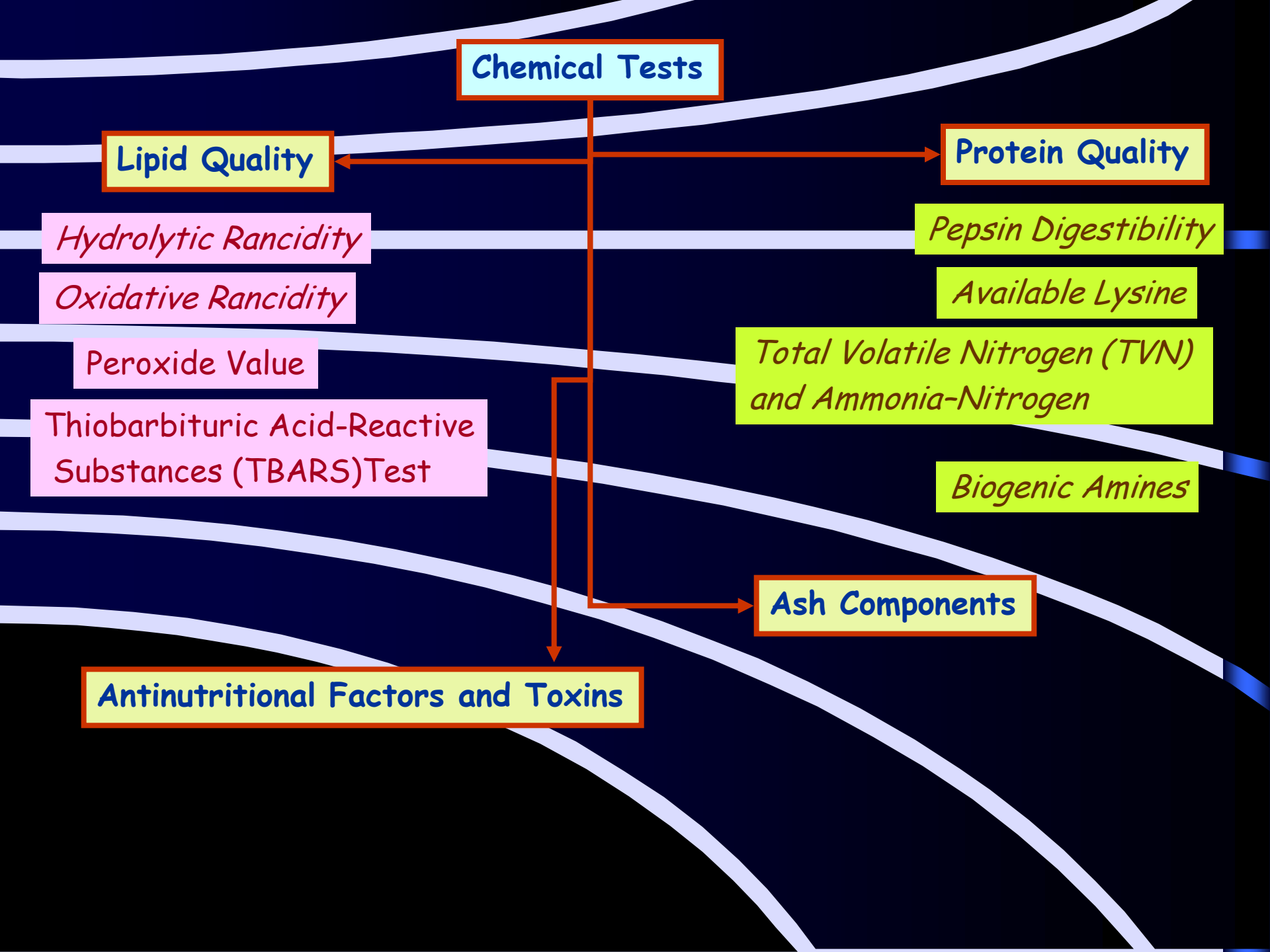
Similarly, as-fed analyses can be converted to a DM basis by the following means if the moisture content is known. Suppose an ingredient is known to have a moisture content of 12% and an as-fed protein content of 23%. The protein level of this feed on a DM basis can be worked out as follows:

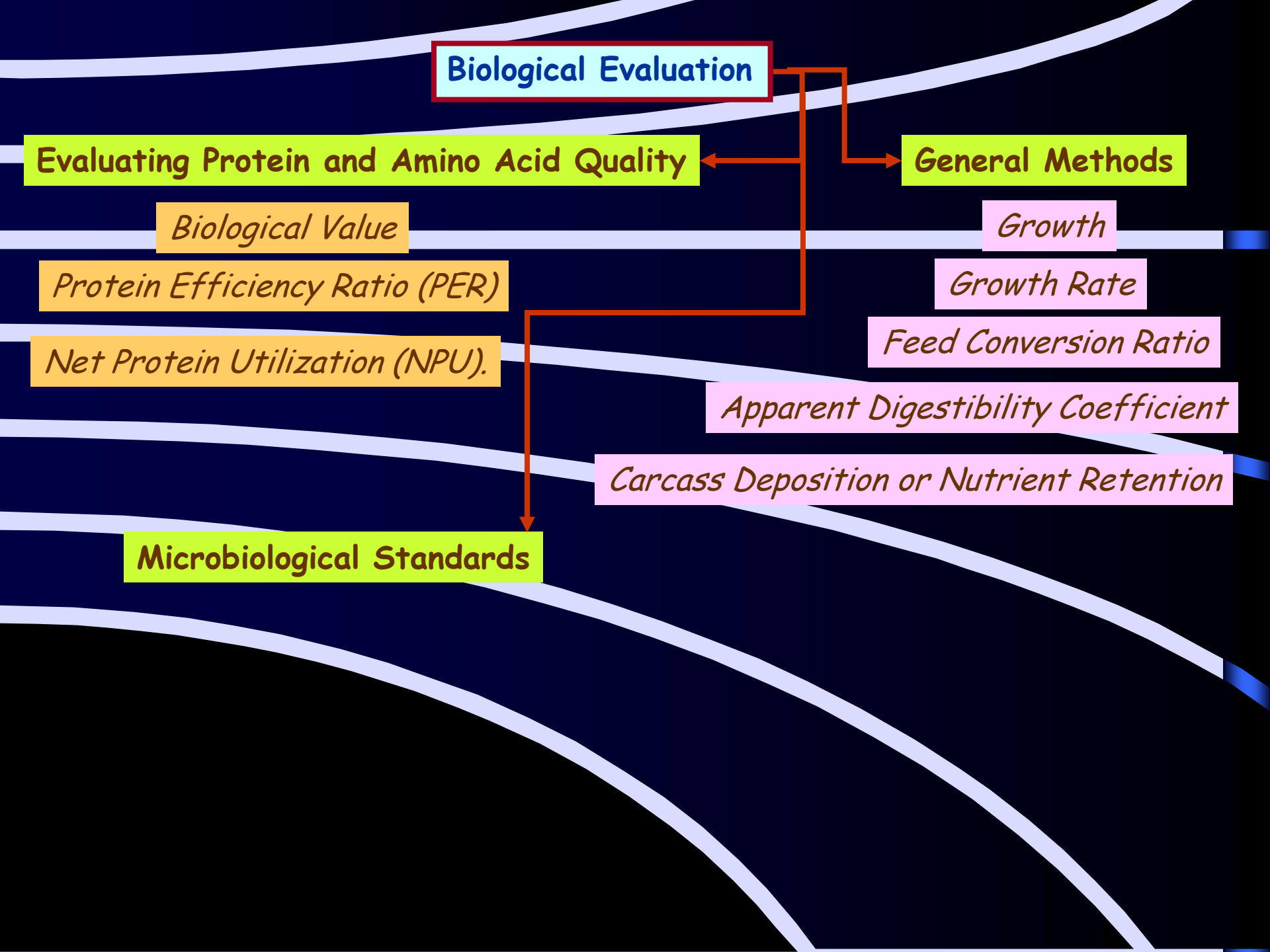
$$\text{DM\% protein} = 23 \times \frac{100}{(100-12)} = 26.14\%$$

An alternative to calculating the formulation of a compound feed from analytical information of the as-fed type is to calculate it all on a DM basis. The final analysis can then be converted to an as-fed basis using the expected moisture content in the same way as in the first example above. In all cases data should always state whether they are being reported on an as-fed or a DM basis. Some feed manufacturers state the analysis of their product on a DM basis, giving a maximum moisture content as well.

Example 1		Example 2	
Moisture	15.7%	Dry matter	84.3%
Lipid	3.6%	Lipid	3.6%
Protein	8.6%	Protein	8.6%
Fiber	2.1%	Fiber	2.1%
Ash	1.2%	Ash	1.2%
NFE	68.8%	NFE	68.8%
Total	100%	Total	84.3%


Ingredient and Diet Evaluation
Chemical Tests
Nutrient Analysis
Proximate Analysis
amino acids,
fatty acids,
minerals,
vitamins
Water
Crude Protein
Crude Lipid
Crude Fiber
Ash
Nitrogen-Free Extract (NFE)
high-performance liquid chromatography (HPLC).
Fatty acids are analyzed using Gas chromatography (GC)
atomic absorption spectrophotometer
Economic Evaluation
Chemical Score
Biological Evaluation
These and other methods in detail in the AOAC (1995)


Chemical Tests
Lipid Quality
Protein Quality
Hydrolytic Rancidity
Oxidative Rancidity
Peroxide Value
Thiobarbituric Acid-Reactive Substances (TBARS)Test
Pepsin Digestibility
Available Lysine
Total Volatile Nitrogen (TVN) and Ammonia-Nitrogen
Biogenic Amines
Ash Components
Antinutritional Factors and Toxins


Biological Evaluation
Evaluating Protein and Amino Acid Quality
General Methods
Biological Value
Protein Efficiency Ratio (PER)
Net Protein Utilization (NPU).
Growth
Growth Rate
Feed Conversion Ratio
Apparent Digestibility Coefficient
Carcass Deposition or Nutrient Retention
Microbiological Standards

Ingredient Types

1- Grasses
2- Legumes
3- Miscellaneous Fodder Plants
4- Fruits and Vegetables
5- Root Crops
6- Cereals
7- Oil-Bearing Seeds and Oil Cakes
8- Feeds of Animal Origin
9- Miscellaneous Feedstuffs
10- Additives

Grasses Dried grass is a potential minor ingredient in fish and shrimp feeds, as a source of carotenoids. Being characteristically very high in fiber content, are of limited value in fish feeds except for herbivorous fish

Legumes: The leaves and stems of legumes have successfully been used in feeds for aquaculture. Legume fodder is rich in protein and minerals. The seeds of legumes have a great potential value as aquaculture feed ingredients though many contain anti-nutritive factors when raw; processing (heat treatment) usually renders them safe for use. Leguminous seeds are often **rich in lysine** though **poor in methionine**. Whole beans and peas are used extensively as human food therefore usually expensive ingredients and their use in aquaculture feeds may only be justified in diets for high-value export-oriented species. Some leguminous plants have the ability to convert gaseous nitrogen into protein e.i. acacia, clover, groundnut (peanut), locust beans, chickpea, beans, field peas, mung bean, cowpeas, and soybean

Some leguminous plants produce high-oil seeds which are processed for the extraction of vegetable oil. The by-products of oil extraction processes are used.

Miscellaneous Fodder Plants :The leaves and other aerial parts of many plants, other than those specifically grown for fodder, are used. While these may have local significance as aquaculture feed ingredients, nutrient digestibility is low.

Fruits and Vegetables: Waste fruits and vegetables and the by-products from their processing or harvesting have not been used much in compound feeds for aquaculture. However, they are sometimes used, fresh, for feeding or manuring ponds. As both types of products are usually seasonal, large quantities of wastes and by-products are available intermittently but they are not normally preserved for later use by ensiling or drying. The leaves of these plants are usually more nutritious than the stems.

Root crops : are excellent sources of energy for many classes of livestock, being **rich in carbohydrates**. Their value as ingredients for aquaculture feeds is limited however, **1-** partly because of their high value for human food and **2-** partly because most aquatic species cannot digest carbohydrates well. Root crops, with some exceptions, are **very deficient in protein, calcium and phosphorus, and vitamins**. Waste from root crops can be utilized in small quantities in compound feeds. **Many contain toxins** which need destruction by heating before use. Some root crops have special value in aquaculture because of their ability to increase the water stability of diets, e.g., potato and sugar beet molasses.