FISH FEED FORMULATION METHOD

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Formulation of feed means

- Determining the quantity of various ingredients in the feed mixture based on the specific requirements of the specific nutrients by the fish as per their stage of growth and development
- Feed formulation involves selecting a combination of ingredients which will produce a mixture containing levels of essential nutrients at or above the minimum requirements of the fish

Why feed formulation?

- No single feed ingredient can supply all the nutrients and energy required for optimal growth; therefore, a mixture of feed ingredient is combined to produce a diet with the desired nutrient profile

Main objectives in feed formulation

- Satisfy all known nutrient requirements for growth of the species
- Minimize feed cost
- Select and use ingredients that will result in products that are readily utilized to minimize wastage.

Formulation of feed involves knowledge of

- nutritional required of the species
- Their physiology
- Nutritional values of various ingredients used in the feed mixture
- The chemistry of various nutrients and sub-nutrients
- Their specific functions in the metabolism
- The availability of nutrients in feed formulation
- Other dietary components
- Certain ingredients are added for physiological or economic reasons, binders and antioxidants.

Dietary interactions

- Micronutrient-diet composition interactions
- Mineral-mineral interactions
- Vitamin- mineral interactions
- Vitamin- vitamin interactions
- Flavour quality
- Other physical factors (e.g. temperature, photoperiod)

Least-cost feed formulation

Least-cost feed formulation: a feed formula that is both nutritionally-complete (within limits) and with a minimum ingredient cost (within limits).

Now a days is developed and completed through the use of computers using linear-programming software.

typical packages for Least-cost feed formulation : Brill, Mix-it, Agridata which is used by most feed mills/manufacturers.

Least-cost feed formulations require that the following information be provided:

- cost of feed ingredients
- nutrient content of feed ingredients
- nutrient requirement of the animal
- availability of the nutrient to the animal
- minimum-maximum restrictions on levels

Feed ingredient	Carnivorous fish			Omniv/Herb. fish			Carnivorous shrimp			Omniv/Herb. shrimp[2]		
	Observed		Max. level	Observed		Max. level	Observed		Max. level	Observed		Max. level
	Range	X		Range	X		Range	X		Range	X	
Alfalfa meal	1–5	3	5	3–5	4	10	-	-	5	4–4	4	10
Blood meal (spray dried)[3]	2–10	7.5	10	1–6	3	10	2–11	6	10	2–11	6	10
Cassava/Tapioca meal	-	-	15	-	-	35	5–10	8	15	5–15	10	25
Coconut oilcake/oilmeal	-	-	15	-	-	25	5–10	7	15	5–50	21	25
Corn grain, meal	2–15	8	20	10–33	26	35	5–15	10	15	8–57	30	35
Corn gluten meal	4–20	10	15	4–10	8	20	5–7	6	15	5–8	6	20
Cottonseed meal, solv ext.[4]	10–34	10	15	10–35	15	20	-	-	10	-	-	15
Corn distillers dried solubles	3–8	7	10	5–8	6	15	5–6	6	10	-	-	15
Dicalcium phosphate	1–2	1.5	3	0.5–3	1	3	1–3	1.5	3	1–3	1.5	3
Hydrolyzed feather meal[5]	3–7	5.5	10	2–8	5	10	-	-	10	-	-	10
Fish meal	5–65	36	No limit	5–60	20	No limit	15–25	20	35	7–30	16	35
Fish protein concentrate	5–10	8	15	2–8	3	10	1–15	5	15	2–15	4	15
Groundnut meal, solv. extr.[6]	5–20	10	15	11–25	20	25	5–17	7	15	2–26	13	25
Liver meal	5–65	25	50	5–45	20	50	-	-	25	-	-	20
Meat & Bone meal, solv ext.[7]	5–30	10	20	5–25	10	25	5–10	7	15	5–12	9	20
Poultry by-product meal[8]	4–7	5	15	4–15	7	20	-	-	15	-	-	20
Rapeseed meal, solv. extr.[9]	10–30	15	20	10–45	20	25	-	-	15	-	-	20
Rice bran, solv. extr.	5–15	10	15	3–65	15	35	10–15	12	15	10–50	26	35
Shrimp meal	5–30	10	25	5–10	7	25	11–45	23	No limit	10–51	20	No limit
Squid meal	-	-	No limit	-	-	No limit	10–47	25	No limit	5–20	11	No limit
Sorghum grain, meal[10]	-	-	20	10–57	18	35	-	-	15	-	-	35
Soybean meal, solv. extr.	6–30	16	25	4–50	25	35	8–25	10	20	3–40	15	30
Soybean, full fat	10–73	42	35	10–50	35	40	-	-	20	-	-	30
Wheat grain, meal	4–33	15	20	4–25	15	35	5–20	10	20	8–42	18	35
Wheat bran	2–25	10	15	10–40	25	30	5–10	7	15	5–15	10	30
Wheat gluten meal	5–10	7	15	2–10	5	15	3–15	11	20	4–14	8	20
Wheat middlings	2–38	16	25	2–38	17	40	-	-	20	-	-	35
Whey, dried (delactose)	2–10	7	10	2–8	6	10	-	-	10	-	-	10
Yeast, dried brewers	2–19	5	15	5–30	8	15	4–14	8	15	5–16	10	15

As mentioned, most least-cost formulae are derived by linear programming it has its disadvantage in that it uses data out of the NRC handbook for fixed, maximum growth rates it does not take into consideration optimum return on growth for various feed nutrient concentrations this requires regression analysis regression analysis is now being integrated into poultry formulae, probably not yet available for fish.

LINEAR PROGRAMMING

- Linear programming (LP) is the most common type of mathematical programming. LP seeks to maximize or minimize a linear objective function subject to a set of linear constraints. It assumes all relevant input data and parameters are known with certainty (deterministic models).Computers play an important role in the solution of LP problems.

It consists of 3 parts namely

(i) The function whose value is to be minimized (or maximized if it is a profit function) called the objective function

(ii) Structural constraints to take care of the minimum requirements and

(iii) The non-negativity condition.

Liner programing in Fish Diet Formulation

- Linear programming (LP) is a mathematical procedure by which limited resources are allocated, selected, scheduled, or evaluated to achieve an optimal solution to a particular objective. These resources may be capital, raw material, manpower, or production facilities and the objectives may be minimum cost or maximum profit
- Linear programming, therefore, has wide application in industrial operations such as blending, mixing, and machine tooling; and in business activities such as purchasing, planning, bidding, transportation, and distribution. In formulating feeds by LP, the nutritionist first lays down a set of constraints.
- He then lists all available raw materials which he wishes to be considered for selection by the computer to achieve his objective. This objective is a least-cost ration that will satisfy all the constraints.
- Development and solution of all LP models can be examined in a four step process:

(1) Identification of the problem as solvable by LP.

(2) Formulation of the mathematical model.

(3) Solution.

(4) Interpretation.

Feed formulation by Pearson square methods

- **The simplest method to calculate the ration,**
- **It can be used for 2 and more ingredients,**
- **It can be balanced only one nutrient (make your choice for crude protein or crude fat)**

Sample Calculation

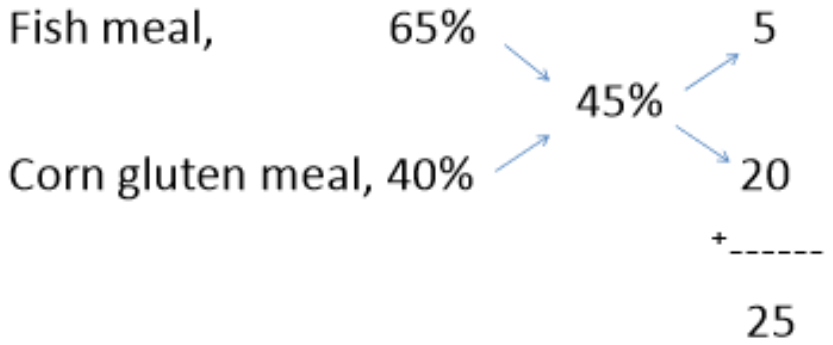
Please calculate to prepare a fish feed that includes 45% crude protein, using fish meal and corn gluten meal

the nutrient value of the ingredients…

Fish meal includes 65% crude protein,

Corn gluten meal includes 40% crude protein…

What will be the solution to reach 45% crude protein using fish meal and corn gluten meal?



- % of Fish meal is calculated as:

(5 x 100) / 25 = 20

- % of Corn gluten meal is calculated as:

(20 x 100) /25 = 80

The protein % contribution from fish meal is: 20% x 65 = 13

The protein % contribution from corn gluten meal is: 80% x 40 = 32

- **The total is; 13 + 32 = 45**

What will we do if we have more than 2 ingredients?

- example prepared fish feed 40% crude protein using fish meal, corn gluten meal, wheat meal and soybean meal

The crude protein % of ingredients:

Fish meal: 65%

Corn gluten meal: 38%

Soybean meal: 42%

Wheat meal: 17%

Make two groups into the ingredients

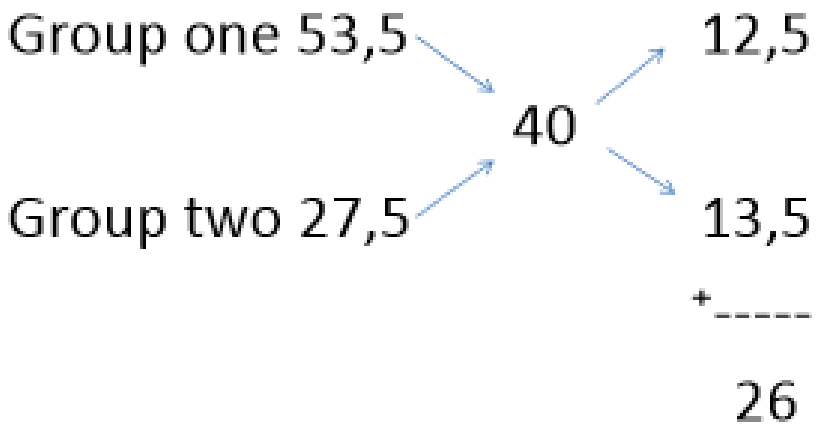
- the first should be consisted of ingredients whose crude protein % is higher than the requested
- the second should be consisted of ingredients whose crude protein is lower than the request.

The solution is to make two groups into the ingredients, the first should be consisted of ingredients whose crude protein % is higher than the requested and the second should be consisted of ingredients whose crude protein is lower than the request

First group average: (65 + 42) / 2 = 53.5

Second group average: (38 + 17) / 2 = 27.5

Now you should apply Pearson Square as if you have 2 ingredients that were called group one and group 2.



% of group one: (100 x 12.5) / 26 = 48.07
% of group two: (100 x 13.5) / 26 = 51.92

First group's ingredients %: • 48,07 / 2 = 24.035
Second group's ingredients %: • 51,92 / 2 = 25.96

- % of Fish meal: 65 x 24.35% = 15.83
- % of Soybean meal: 42 x 24.35% = 10.23
- % of Corn gluten meal: 38 x 25.96% = 9.86
- % of Wheat meal: 17 x 25.96% = 4.41