

Chapter II

REVIEW LITERATURE

Yeasts and yeast - like organisms belong to the subdivision of the thallophytes designated as the Eumycetes, or true fungi, since they possess no chlorophyll. The individual yeast cells are normally spherical, ovoid or ellipsoid in form and they do not possess flagella. Yeast cells may vary considerably in dimensions, depending on species, nutrition, age, other factors. The usual cell may vary from a little over 1-9 or more microns in width and from about 2-20 or more microns in length (Prescott and Dunn, 1959)

A cell of yeast is covered with cell wall, which protects the cytoplasm and the nuclear materials. Within the cell protoplasm are numerous reserve materials in the form of droplets or granules. These stored foods including some carbohydrate (not starch), fats, protein are normal constituents of all mature yeast cells but especially of older cells, when nutritive conditions are favourable (Prescott and Dunn, 1959)

Yeasts contain 68 - 83 % moisture. The yeast cell is composed of Nitrogen - containing compounds, carbohydrate, lipids, vitamins, minerals and other substances. The usual nitrogen content of yeast varies from 7 - 9%. A large percentage of the total nitrogen (about 64-76%) is found in the pure protein, about 10% of it occurs in the purine basis, and approximately 4% of it occurs in the pyrimidines. About 15% of total nitrogen occurs in the amino acids, nucleic acids and other products (Prescott and Dunn, 1959)

Protein content of yeast is about 40 - 60% on dry basis (Prescott and Dunn, 1959) This is evident that, provided it is well digested, it could be regarded as concentrate source of protein, quantitatively comparable on a dry matter basis, with fish and meat as shown in Table 4. The use of yeast in its original form for animal feeding is interested for non-ruminant animals (Shacklady and Gatamel, 1972)

Dried, debittered brewery yeast, a by-product of the brewery industry, is used for fodder food and pharmaceutical purposes (Prescott and Dunn, 1959) Amino acid concentration of brewery yeast compares well with the average concentration of another yeasts as shown in Table 5. Several workers have found that brewery yeast is somewhat deficient in sulfur amino acids, ^{i.e.,} methionine, cystine and cysteine, (Prescott and Dunn, 1959) They also observed that supplementation of rat diet with methionine and cystine increased the biological value of yeast. Another possible explanation suggested that yeast as the sole source of protein was somewhat inferior to animal protein in that large quantities of non-protein nitrogen in yeast (purines, pyrimidines, nucleic acids, etc) may decrease the available, or increase the requirement of methionine and cystine (Mateles and Tannanbaum, 1968)

Soy bean meal contains essential amino acids close to amino acid composition of brewery yeast (see Table 1 and Table 5), as high lysine and low methionine content. When methionine was mixed in optimal amount with yeast, the amino acid composition was better balance and nutritional benefit gained was close to fish meal (Mateles and Tannanbaum, 1968) Besides this, vitamin B content in yeast cell is high especially thiamine, as shown in

Table 4

Protein content of some animal meat and brewery yeast.

	Protein content (percentage on dry basis)
Fish (Cod fish)	94.0
Beef (75% lean 25% fat)	40.0
Pork (53% lean, 47% fat)	19.0
Lamb (72% lean, 28% fat)	35.0
Broiler (flesh only)	82.0
*	
Brewery yeast	58.0

* Saccharomyces carlsbergensis 286

Reference - Watt, B.K. and Merrill, A.L. 1963. Composition of Food; raw, processed prepared. United States Department of Agriculture.

Table 5

Amino acids composition of various yeasts. Values are expressed in grams per 16 grams nitrogen.

Amino Acids	Brewer's yeast	<u>Torula utilis</u>	<u>S. fragilis</u>
Lysine	8.7	6.9	11.4
Threonine	5.4	4.6	5.57
Valine	6.3	4.9	5.72
Methionine	1.8	1.3	1.57
Isoleucine	7.9	4.3	5.05
Leucine	7.5	6.0	-
Phenylalanine	5.1	3.0	5.05
Tryptophan	-	-	-
Histidine	2.8	2.5	3.98
Arginine	7.6	5.4	7.37
Aspartic acid	-	7.2	10.4
Serine	-	4.2	5.21
Glutamic acid	14.5	10.9	15.24
Proline	-	4.0	--
Glycine	0.4	4.0	4.24
Alanine	-	5.5	7.21
Cystine	-	-	-
Tyrosine	-	3.3	4.57

Reference Wasserman, A. E. 1962. The Rapid Conversion of Whey to Yeast, Dairy Eng. vol.89 p.374.

Table 6. This is very desirable as the enrichment with vitamin B complex on commercial feed meal can be reduced, so the production cost is decreased.

The brewery yeast used in this study was Saccharomyces carlsbergensis 286. Size of cell is about 3.6 x 7.2 micron to 10 x 20 micron. It fermented sugar into alcohol and no toxic material was produced (Presscott and Dunn, 1959; Amatavivat, personal communication).

Formulations of feed meal for various animals are not similar because the nutrient requirements are different (Anonymous, 1970). The formulation of feed meal is important not only in creating growth of animal but also in production cost. Requirements and functions of nutrients for broilers are described below.

Proteins are required in the diet for growth and body maintenance. For broilers, requirement of protein in initial feeding period (1-35 days) is about 23%, and 20% in final feeding period (35 - 56 days) (Anonymous, 1970). When proteins are digested, the amino acids obtained are used by the animal to form either new body protein or for energy if excess protein is available. The requirement for essential amino acids by broilers is shown in Table 7. The use of various protein sources having different amino acid compositions make it possible the balance of protein quality. High quality fish meal is one of the best protein supplements available to the feed industry because of its well balance amino acid composition (See Table 1). Soy bean meal is a very outstanding protein source but it is deficient in sulfur amino acids, methionine and cystine (See Table 1). The high level of lysine available in soy bean meal could be used to

Table 6

The vitamin B content of some food yeasts. Values are expressed in micrograms per gram of dried yeast.

	Brewery Yeast	<u>Torula</u>	<u>Hansenula</u>	<u>S.cerevisiae</u>
Thiamine	104-253	5.2	8.5	28-41
Riboflavin	25-80	42.7	5.4	39-62
Nicotenic acid	300-627	417.3	590	277-538
Pantothenic acid	72-86	39.2	180	-
Pyridoxine	23-40	33.4	-	-
Folic acid	19-30	21.5	1.7	19-39
Biotin	1.1	2.3	1.7	0.45-3.6
p-Amino benzoic acid	15-40	-	16	11-62

Reference Prescott, S.C. and Dunn, C.G. 1959. Industrial Microbiology
3d ed. McGraw - Hill Book Company, Inc. New York P. 27.

Table 7

Requirement of essential amino acids by broiler.

Amino Acids	% of Ration
Arginine	1.20
Lysine	1.10
Histidine	0.40
Methionine	0.40
Cystine	0.35
Phynylalanine	0.70
Tyrosine	0.60
Leucine	1.40
Isoleucine	0.75
Threonine	0.70
Valine	0.85
Tryptophan	0.20
Glycine	1.00
Protein level	20

Ref: Feed Manufacturing Technology, American Feed Manufactures Association
 Feed Production Council, 1970

correct deficiencies in a low lysine meal such as corn (Anonymous, 1970).

Energy is necessary in animal feed formulation to enable the animal to utilize protein and other materials, perform work, and produce meat. Energy is required for all metabolic processes, for body heat and to meet energy demands for digestion. Most of the energy is supplied by starches, simple sugars, complex carbohydrates and fats. Grains which are primarily supplier of energy, make up the majority of many formulas. Energy also normally determines the quantity of other nutrients required since the animal tends to eat them to meet energy demands. Therefore, the requirements for other nutrients such as amino acids, vitamins and minerals are related to the energy of the ration (Anonymous, 1970; เสนี วรรณกุล, 2517). Common high energy feed sources include grains, fat and grain by - products. Materials such as protein sources and brewery by - product can supply varying amounts of energy. Fats are concentrated energy sources which serve as important sources of essential fatty acids, and facilitate transport of fat-soluble vitamins. Fats are normally included in feeds at a level of not less than 4% (Chairavanont, personal communication). Fiber does not provide an available source of energy for nonruminant animals. High fiber diet, therefore, limits the energy available to these animals. Accordingly, fiber is provided not more than 5% in feed meal (Chairavanont, personal communication).

Minerals are classified as macro-and micro-elements. Minerals often considered in practical formulations are calcium, phosphorus, salt, and trace minerals, i.e., magnesium, manganese, zinc, copper, iron cobolt, and selenium. Calcium is needed in animal diet primarily for

skeletal growth which phosphorus is used both for skeletal growth and for many metabolic reactions. The ratio of calcium to phosphorus should be approximately from 1:1 to 2:1 respectively. It is usually not less than 1% of calcium contained in feed meal (เชนรี แอล ฟูลเลอร์, 2517). Salt is normally included in feeds at a level of 0.5%. This level usually supplies adequate amount of sodium for animal (Anonymous, 1970). The requirement of the trace minerals are shown in Table 8. 004308

Vitamin is a potent organic compound occurring in minute proportions in natural foods. It must be available to animal from the diet or other sources, in order that a specific metabolic process or reaction may proceed normally. Requirement of vitamins for broiler is shown in Table 9

Drugs or antibiotics are added in feeds to improve the health or performance of animals. Drugs can be classified as a) nutritive, when improvements in feed efficiency or gain in body weight is desired; b) preventive, when certain levels are added to feeds to inhibit or prevent an outbreak of disease; and c) therapeutic, when added to feeds to treat a specific outbreak of disease. Levels which can be used for these specific purpose can be found by consulting the Feed Additive Compendium (Anonymous, 1970).

A little amount of chemicals used in feed meal are antioxidants, preservatives, and certain essential amino acids. The common antioxidants are butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA). The preservative used is chlorotetracycline. Essential amino acid added in the feed meal is methionine. All trace minerals, vitamins, drugs or antibiotic, and some additives are added in term of enrichment. The total level of these nutrient is not more than 1% of feed meal (Chairavanont, personal communication)



Table 8

Requirement of minerals by broiler

Minerals	gram per 100 kilogram Feed
Calcium	960
Phosphorus	480
Sodium	150
Potassium	420
Chloride	150
Manganese	5.4
Magnesium	54
Iron	9
Copper	1.08
Zinc	4.2
Selenium	0.015
Iodine	0.035

Reference - ดร. เสนีย์ แอด พูลเลอร์ ๒๕๑๖ การสร้างสูตรอาหารพลังงานสูงของสัตว์ปีก สัมมนาเรื่องพัฒนาการค่านอาหารและการป้องกันโรคสัตว์ปีก ณ ห้องประชุมสถาบันค้นคว้าและพัฒนาผลิตภัณฑ์อาหารมหาวิทยาลัยเกษตรศาสตร์, ๑๘ พฤษภาคม

Table 9

Requirement of vitamins by broiler

Vitamins	per 100 kg Feed
Vitamin A (IU)	1,050,000
Vitamin D ₃ (IU)	105,000
Vitamin E (IU)	1,071
Vitamin K ₁ (mg)	210
Thiamine (mg)	210
Riboflamin (mg)	420
Pantothenic acid (mg)	1,360
Nicotenic Acid (mg)	3,300
Pyridoxine (mg)	4,200
Biotin (mg)	13.5
Folic Acid (mg)	129
Choline (g)	127.5
Vitamin B ₁₂ (mg)	1.08
Linoleic acid (kg)	1.17

Reference - ดร. เฮนรี แอล ฟูลเลอร์ 2516 การสร้างอาหารพลังงานสูงของ
 สัตว์ปีก สัมนาเรื่องพัฒนาการคานอาหารและการป้องกันโรคสัตว์ปีก ณ ห้อง
 ประชุมสถาบันคนควาและพัฒนาผลิตภัณฑ์อาหาร มหาวิทยาลัยเกษตรศาสตร์
 18 พฤษภาคม

In general, commercial feed meal for broiler is composed of many ingredients, the percentage used is summarized in Table 10. The percentage of every ingredient is changable, but the total nutrients must be supplied. Application of any raw materials for protein source, it ought to know protein content and amino acid composition in that materials.

Feeding was carried out with broilers in order to assess the nutritional quality of feed meal comprising yeast compared with the commercial formulation. The acceptability of the meal, activities of broilers, and characteristics of their growth were observed. Nutritive value was evaluated by comparing protein efficiency of feed meal containing brewery yeast and the commercial feed meal.

Table 10

Percentage of ingredients used in commercial feed meal for broiler

Ingredient	%
Fish meal	8-12
Soy bean meal	20-24
Corn	60-70
Oyster shell	≥ 0.75
Calcium diphosphate	≥ 0.75
Salt	≤ 0.5
Enrichment	≤ 1

Reference - Chairavanont, Personal communication