Chapter 5

Feeding

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Additional information is available at the end of the chapter

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Abstract

Animal nutrition and feed science are the main scientific promote for today's modern breeding and feed industries. Animal nutrition is the most important factor affecting performance, reproduction and products quality. Improving productivity through better nutrition is determined by some interrelated considerations such as the availability of nutrients, type of feeding system and the level of feeding management. Poor nutrition affects growth, reproduction and immune system. Besides, feed has financially the largest share in animal production, irrespective of species and production system. Feed accounts for 65–75% of total cost of livestock production. This chapter provides the fundamental concepts of animal nutrition a general awareness on nutrition and feeding of livestock (swine, poultry, beef and dairy cattle, sheep and goat). Besides, feed is financially the single most important element of animal production in most production system.

Keywords: digestive systems, feedstuffs, nutrition, swine, poultry, beef and dairy cattle, sheep and goat

1. Introduction

Feed costs can be as high as 65–75% of the total production costs. The good quality feed also increases the incomes of producers. One way to reduce these costs is to ensure the animal has a balanced diet. A balanced diet is one that meets the nutritional needs requirements of the livestock, based on its age, gender and physiological stage. Adequate nutrients are essential for the metabolic function and health of any animal. Prolonged deficiency of nutrients would result in loss of condition and productive. Poor quality feeds may lead to a shortage of some dietary essentials or other factors may cause the development of serious nutritional diseases. Overfeeding may be disastrous as underfeeding.

On the other hand, the safety and quality of animal feedstuffs are also vital for preventing hazardous substances entering the food chain and affecting human health. Feedstuffs and additives, diet formulation and, in some cases, diet distribution have an influence on both animal well-being and the characteristics and composition of animal products as meat, milk or egg, and so on, for human consumption.

The main constraint to livestock development in many developing countries is the scarcity and inadequate quantity and quality of feed supply, poor quality and nutrient imbalance in many native pastures and crop residues, lack of or limited use of commercial concentrate feeds.

2. Feedstuffs and feed additives

This part provides some details of the feedstuffs and feed additives that are fed to animals, including their main nutritional composition and function that need to be taken into account when they are used in animals diets. Feedstuffs are the edible materials, after ingestion by animals is capable of being digested, absorbed and utilised. The main components of feedstuffs are given in **Figure 1**. Feedstuffs consist of water and dry matter. The water (moisture) content of feedstuffs is very variable and can range from 60 g/kg (in concentrates) to 900 g/kg (in some root crops). Owing to this wide variation, it is generally preferred that the feedstuff composition is specified on dry matter basis. In this perspective, the nutrient contents of feedstuffs might be effectively compared [1].

Nutritional components of a feedstuff can greatly influence production performance of animals. The feed value of a feedstuff is a measure of its main nutritional components. For livestock, the feed value of any feedstuffs depends mainly on the concentration of energy (carbohydrates, fats, proteins and their digestibility), protein (including NPN and aspects of degradability), vitamins and minerals contents in the dry matter, special aspects (like keeping quality, availability, handling, taste, toxins, influence on sensory quality of meat, milk or egg etc.), physical aspects and price.

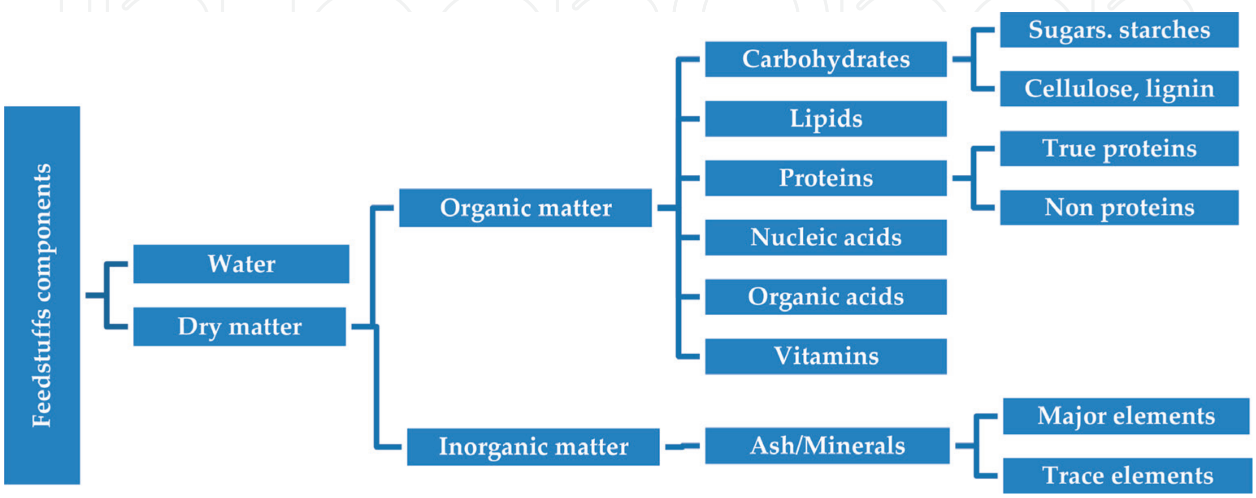

Figure 1. The main components of a feedstuff.

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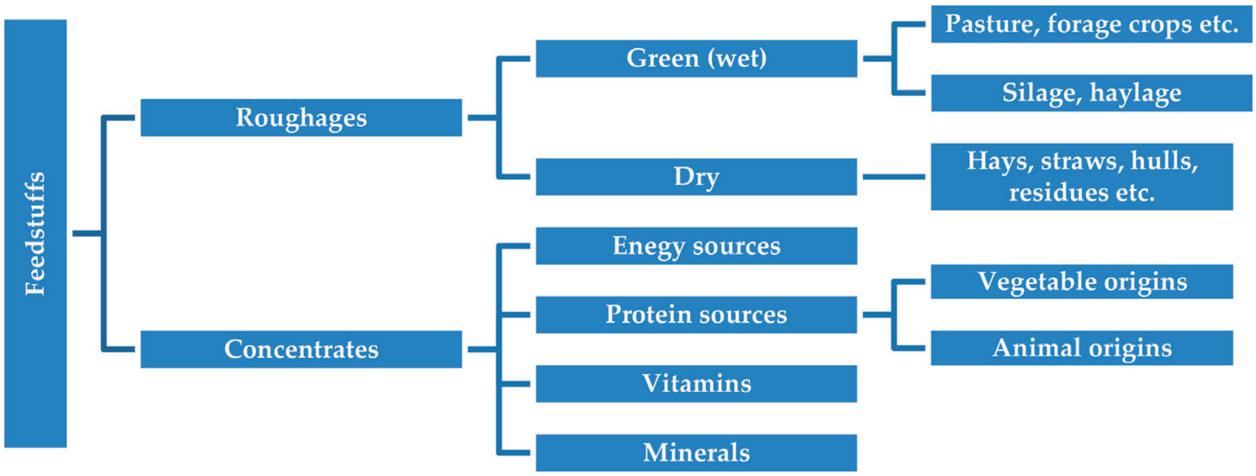

Figure 2. Classification of feedstuffs.

Class	Characteristics
Roughages	Roughages are bulky feeds containing relatively large amounts of poorly digestible material. These groups contain more than 18% crude fibre. They can be two major categories, namely dry and wet based on their moisture content. Wet roughages contain more than 75% moisture and include pasture, range plants and forages fed green, cultivated fodder crops, grasses legumes, tree leaves and silage/haylage while dry roughages contain only 10–15% and include hays, straws, hulls and crop residues as seed coats, pods, bran. Silages/haylages include ensiled forages. The process of ensiling plant materials under anaerobic conditions, which is a common storage method for feeds. The plant material undergoes a controlled fermentation that produces acids that then kill off bacteria, moulds and other destructive organisms. Fermentation uses nutrients and thus reduces nutritive content of the material.
Concentrates	Energy-rich feeds contain less than 18% crude fibre, less than 20% protein. The protein digestibility ranges from 50 to 80%, but the protein quality is generally poor. These are fed to ruminants and cecal fermenters to increase the energy density of their diets, and to monogastrics as the primary source of energy. Examples of energy sources are: cereal grains, for example, corn, wheat, barley, oats, rye, sorghum, triticale; other grains, for example, buckwheat; grain milling by-products, for example, wheat bran, corn gluten meal; roots, tubers, for example, cassava, potatoes; food processing by-products, for example, molasses, bakery waste, citrus pulp, distillers and brewers by-products; industrial by-products, for example, wood molasses, fats and oils. Protein supplements contain 20% or more of protein; some have high-energy contents as well from plant or animal origin. Examples of protein sources are: oilseed meals, for example, soybean, cottonseed, rapeseed, canola, linseed, peanut, safflower, sunflower; grain legumes, for example, beans, peas, lupines; single-cell protein, synthetic amino acids, non-protein nitrogen sources, for example, urea, biuret and by-pass proteins, for example, corn gluten meal for ruminants; animals proteins, for example, meat meal, fish meal, tankage, feather meal, bone meal, dried milk or products as whey, poultry by-products. Depending on the feeds used to balance a ration for the other nutrients, concentrated sources of vitamins and minerals may be needed. Some vitamin supplements include ensiled yeast, liver meal, fish oil, wheat germ oil and purified forms of individual vitamins (A, D, E, K, C and B vitamins like thiamine, riboflavin, niacin, pantothenic acid, biotin, vitamin B_6, vitamin B_{12} and folate). Some common mineral supplements include: salt (often trace mineralised), bone meal, oyster shell, calcium carbonate, limestone and fairly pure forms of other specific minerals (Major elements: Na, Ca, P, CL, K, S, Mg, Trace Elements: I, Mn, F, Co, B, Zn, Fe, Cu, M).

Table 1. Classes of feeds and characteristics.

Categories	Feed additives
1. Technological additives: any substance added to feed for a technological purpose	**a.** Preservatives **b.** Antioxidants **c.** Emulsifiers **d.** Stabilisers **e.** Thickeners **f.** Gelling agents **g.** Binders **h.** Substances for control ofradionucleide contamination **i.** Anticaking agents **j.** Acidity regulators **k.** Silage additives **l.** Denaturants **m.** Substances for reduction of the contamination of feed by mycotoxins
2. Sensory additives: any substance, the addition of which to feed improves or changes the organoleptic properties of the feed, or the visual characteristics of the food derived from animals	**a.** Colorants **b.** Flavoring compounds
3. Nutritional additives	**a.** Vitamins, pro-vitamins and chemically well-defined substances having similar effect **b.** Compounds of trace elements **c.** Amino acids, their salts and analogues **d.** Urea and its derivatives
4. Zootechnical additives: any additive used to affect favourably the performance of animals in good health or used to affect favourably the environment	**a.** Digestibility enhancers: substances which, when fed to animals, increase the digestibility of the diet, through action on target feed materials **b.** Gut flora stabilisers: micro-organisms or other chemically defined substances, which, when fed to animals, have a positive effect on the gut flora **c.** Substances which favourably affect the environment **d.** Other zootechnical additives
5. Coccidiostats and histomonostats	These substances that one or more of the functional groups, intended to kill or inhibit protozoa

EC, No 1831/2003 [2].

Table 2. Categories of feed additives.

On the other hand, for example, production can be significantly restricted by a number of mineral and vitamin deficiencies, such as calcium, magnesium, phosphorus, copper, cobalt, vitamins A or D, and so on. In addition, excesses of particular substances in feedstuffs can cause lowered production and even death. For example, nitrite poisoning from some grasses and weeds, cyanide poisoning from immature sorghums and some weeds, alkaloid poisoning from immature some leguminous and copper toxicity. Feeds are classified according to the number of specific nutrients they supply. Two main classes of feedstuffs are roughages/forage and concentrate. In addition, feeds can be further subclassified as shown in **Figure 2** and characteristics in **Table 1**.

Feed additives are used to increase feed conversion, improve the amount and quality of animal products in terms of hygienic quality and standards, protect animal health and reduced production costs. From the point of view of being able to control the effects of these substances on human health, it is very important that additives should be able to be determined in both feeds and final products. In recent years, animal production has been fundamental changes, particularly, European Union has brought some changes feed additives used feed industry, taking into account animal, human health and environment. A tendency to return to natural methods in animal production and consume healthy products has given rise to discussions concerning feed additives. At the same time, for example, because of problems resulting from the intensive use of antibiotics, the use of alternative feed additives has come to the fore. Categories of feed additives are shown in **Table 2**.

3. Digestive system and digestion

Livestock has a tube-type digestive tract. This tube has different organs that play a specific role in the digestive process. Digestive system mechanically and chemically breaks down from complex macromolecules (lipid, polysaccharide and protein) into their component parts. These nutrients can be absorbed and used for energy, growth and maintenance of body tissues. There are three types of digestive tract in farm animals: monogastric, poultry and ruminant.

3.1. Monogastric digestive system and digestion

The digestive system of monogastric animals (dog, cat, swine, rabbit, horse, etc.) consists of mouth, oesophagus, stomach, small intestine, cecum, large intestine, anus and supportive organs (pancreas, liver and gall bladder). Digestion processes of swine are shown in **Table 3** [3–5].

3.2. Poultry digestive system and digestion

Poultry (chicken, turkey, quail, goose, ducks, etc.) digestive system begins at the mouth/beak and ends at the cloaca and has several important organs in between [oesophagus, crop, stomach (proventriculus and gizzard), small intestine, cecum, large intestine]. Pancreas, liver and gall bladder are accessory organs in digestion. Digestion processes of poultry are summarised in **Table 4** [6, 7].

3.3. Ruminant digestive system and digestion

Ruminant (polygastric) (cattle, sheep, goat, etc.) digestive system includes mouth, oesophagus, stomach (rumen, reticulum, omasum and abomasum), small intestine, cecum, large

Organs	Secretion/Enzyme	Function
Mouth	Teeth	Mechanically reduces particle size and increases surface area
	Saliva	Lubricates and softens feed
	Salivary amylase (ptyalin)	Begins starch digestion
Oesophagus	—	Carries feed from mouth to stomach
Stomach	HCL	Decreases pH, denatures protein, activates pepsinogen, kills bacteria
	Pepsins	Begin protein digestion
	Lipase	Hydrolyses lipid (particularly in milk-fed young swine)
	Rennins	Coagulate milk protein (casein) in postnatal period
Small intestine	Pancreatic amylase and intestinal disaccharidases (maltase, isomaltase, sucrase, lactase)	Hydrolyse starch
	Bile acids	Emulsify lipid
	Pancreatic lipase, cholesterol esterase,and phospholipase	Hydrolyse lipid
	Pancreatic (trypsin,chymotrypsins, carboxypeptidases, elastase) and intestinal (aminopeptidases, dipeptidases, tripeptidases) proteases	Hydrolyse proteins
	Pancreatic and intestinal nucleases	Hydrolyse nucleic acids
	—	Absorbs nutrients
Cecum	—	Ferments undigested nutrients by microbes
Large intestine	—	Absorbs water, volatile fatty acids (VFAs) and minerals and forms faeces
Anus	—	Removes faeces

Table 3. Digestive processes of swine.

Organs	Secretion/Enzyme	Function
Mouth/beak(No lips and teeth)	—	Obtains feed
	Saliva	Lubricates and softens feed
	Salivary amylase (ptyalin)	Begins starch digestion
Oesophagus	—	Carries feed from mouth to crop
Crop	Mucus	Lubricates and softens feed
Proventriculus	HCL	Decreases pH, denatures protein, activates pepsinogen, kills bacteria
	Pepsins	Begin protein digestion
	Lipase	Begins lipid digestion (particularly in carnivore avian species such as raptors)

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Organs	Secretion/Enzyme	Function
Gizzard	—	Mechanically grinds and mixes of ingesta and continues enzymatic digestion
Small intestine	Pancreatic amylase and intestinal disaccharidases (maltase, isomaltase, sucrase)	Hydrolyse starch
	Bile acids	Emulsify lipid
	Pancreatic lipase, cholesterol esterase,and phospholipase	Hydrolyse lipid
	Pancreatic (trypsin,chymotrypsins, carboxypeptidases, elastase) and intestinal (aminopeptidases, dipeptidases, tripeptidases) proteases	Hydrolyse protein
	Pancreatic and intestinal nucleases	Hydrolyse nucleic acids
	—	Absorbs nutrients
Cecum	—	Ferments undigested nutrients by microbes
Large intestine	—	Absorbs water and minerals and storages waste
Cloaca	—	Serves as common opening of the digestive, reproductive and urinary systems

Table 4. Digestive processes of poultry.

Organs	Secretion/Enzyme	Function
Mouth	—	Obtains and chews feeds, releases of fermentation gases (mostly CO_2 and CH_4) and ruminates
	Saliva	Moistens feed to aid in swallowing
Oesophagus	—	Transports feed from mouth to rumen
Rumen	Microbial enzymes	Degradation of carbohydrates, protein and lipids, synthesis of microbial protein/lipid and some vitamins (K and B-complex), absorption of VFAs and ammonia, and biohydrogenation
Reticulum	—	Continues ruminal fermentation
Omasum	—	Grinds feeds and absorbs water and VFAs
Abomasum	HCL	Decreases pH, denatures protein, activates pepsinogen, kills bacteria
	Pepsins	Hydrolyse microbial and by-pass proteins
	Lipase	Hydrolyses lipid (particularly in milk-fed young ruminant)
	Rennins	Coagulate milk protein (casein) in postnatal period

Organs	Secretion/Enzyme	Function
Small intestine	Pancreatic amylase and intestinal disaccharidases (maltase, isomaltase, lactase)	Hydrolyse starch escaping ruminal digestion
	Bile acids	Emulsify lipid
	Pancreatic lipase, cholesterol esterase,and phospholipase	Hydrolyse lipid
	Pancreatic (trypsin, chymotrypsins, carboxypeptidases, elastase) and intestinal (aminopeptidases, dipeptidases, tripeptidases) proteases	Hydrolyse microbial and by-pass proteins
	Pancreatic and intestinal nucleases	Hydrolyse nucleic acids
	—	Absorbs nutrients
Cecum	—	Further microbial fermentation
Large intestine	—	Absorbs water, VFAs and minerals and forms faeces
Anus		Removes faeces

Table 5. Digestive processes of ruminant.

intestine, anus and supportive organs (pancreas, liver and gall bladder). Digestion processes of ruminant are given in **Table 5** [5, 8, 9].

4. Nutrition and feeding of swine

Swine have a long history of providing food for people. Swine require a number of essential nutrients to meet their needs for maintenance, growth, reproduction, lactation and other living functions. However, factors such as growth rate, genetic variation, gender, stage of gestation, feed quality and intake, availability of nutrients in feedstuffs, energy density of the diets, disease, environment temperature, management factors, for example, crowding and other stress factors may change also increase the needed level of nutrients for optimal performance. Performance of weanling, growing and finishing swine, gestating and lactating sows is related to the quality of the diet and the amount consumed daily. The National Research Council (NRC) [10] provides estimates of the amounts of energy, protein, amino acids, minerals and vitamins for various classes of swine under average conditions. Although nutritionists, feed manufacturers and producers may wish to include higher levels of some nutrients than those listed by the NRC to ensure adequate intake of nutrients and for a certain amount of safety commercially, therefore the NRC values are thought of as minimum requirements without any safety allowances. In addition, the dietary concentrations listed in the NRC tables are based on a given amount of feed intake, if feed intake is less than the amount listed, dietary concentration may need to be increased to guarantee an adequate daily intake of the nutrients. In general, swine require six classes of nutrients: energy (carbohydrates, fats), protein (amino acids), minerals, vitamins and water.

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Energy requirements are expressed as kilocalories (kcal) of digestible energy (DE), metabolizable energy (ME), or net energy (NE). DE and ME values are most commonly used; however, NE has been preferred in the industry recently. Energy requirements of swine are basically influenced by their body weight, body weight gain, genetic capacity, lean tissue growth or milk production and the environmental temperature. One of the largest expenses for swine diets is energy. Carbohydrates (sugar, starch and fibre) from cereal grains (corn, sorghum, wheat, barley, triticale, oats, rye) and their by-products and their by-products provide most of the energy in typical swine diets so utilising lower cost alternative feedstuffs or forages for swine can use to lower feed costs. Fats and oils are excellent energy sources in swine diets. Protein sources also provide a significant amount of energy in swine diets. Protein commonly contributes 15–20% of the total energy in the diet. The amount of feed consumed by swine is controlled by the energy content of the diet fed *ad-libitum*. The diet contains high energy and low fibre generally. Protein and amino acids are required for maintenance, muscle growth, development of foetuses, nutrition of gestating and lactating sows both supporting tissue and milk production. Arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine are essential amino acids for swine. The essential amino acids of greatest practical importance in diet formulation especially lysine, tryptophan, threonine and methionine.

Corn is markedly deficient in lysine and tryptophan. Sorghum, barley and wheat are low in lysine and threonine. The first limiting amino acid in soybean meal is methionine. Animal protein sources are good for supplemental essential amino acids. Soybean meal is basic source of amino acids, also used alternative plant origin sources as cottonseed meal, canola meal, sunflower meal and peanut meal, animal sources as meat and bone meal, fish meal, poultry meal, spray-dried whey, egg and blood; grain by-products dried distillers and corn gluten meal or synthetic amino acids. Swine require linoleic acid and other polyunsaturated fatty acids. The requirement is generally met by natural dietary ingredients from oil in corn. Linoleic acid is considered the dietary essential fatty acid so the longer chain fatty acids can be synthesised from the linoleic acid [11]. Swine should have free and convenient access to good quality water. Minerals and vitamins are required for maintenance, metabolic function, development of tissues, health and growth. Mineral and vitamin premixes or complete manufactured supplements are commercially available. Feed additives have commonly been added to swine diets to promote growth. The levels of feed additives and withdrawal requirements should be legal restrictions.

The typical diet containing 3300–3400 kcal of ME/kg based on corn-soybean meal diet for the various weights of growing swine as estimated by the NRC [10]. Feed intakes may be slightly higher for barrows and slightly less for gilts. If the diet containing 3300 kcal of ME/kg based on corn-soybean meal diet for gestating and lactating (during a 21-day lactation) gilts and sows, it provides sufficient energy at the optimum feeding level. However, higher feeding levels will be needed to meet the sow's daily energy requirement used oats, alfalfa meal or other energy diluents on gestation diets. High-energy diets recommended fed *ad-libitum* to sows during lactation. If this is not possible, sows should be hand-fed three times daily. The requirement of energy depends on the number of swine nursed, weight gain and milk production. If sows have lost excess weight and feed consumption is low significantly, there is recommended additional fat approximately 3–6% to lactation diet. Sows need diets containing 16–18% or more crude protein (minimum of 0.9% lysine) [12]. If energy intake is sufficient, high protein diets will minimise weight loss in sows during lactation. Newborn swine should be consumed colostrum during the first 24 h post-farrowing. If the sow is slow in coming into milk, commercial milk replacers can be used. A palatable swine starter diet should be provided beginning at 2–3 weeks if pigs are weaned later than 3–4 weeks of age [12]. It is recommended that the starter diet contains dried whey and/or lactose, dried blood products and a high level of lysine. The nutritional requirements of growing and finishing swine met by full feeding program. Besides, restricted feeding may improve carcass quality of finishing pigs. The nutrient composition of ingredients should be known when formulating diets to meet the recommended nutrient requirements of swine. Compositions of ingredients commonly used in swine diets are given in various tables.

For additional information, see nutrient requirements of swine [10]. The NRC estimates of nutrient requirements for various body weights of swine, requirements for gestating and lactating sows, expressed as dietary concentrations are given in various tables. These nutritional macro and trace minerals and vitamins play many important metabolic functions in the body. The estimated dietary requirements for the essential micronutrients are given by NRC in Tables [10].

5. Nutrition and feeding of poultry

Over recent decades, broiler and layer performances have considerably improved as the result of the advancements of breeding, feeding, disease control, housing and husbandry technologies. Nutrient requirements of the modern layer and broiler strains have changed because of their high production potential.

Nowadays, the fattening period varies between 35 and 42 days in conventional broiler production sector. In this period, it is used different diets (starter, grower and finisher) due to the alteration of nutrient requirements of broiler with age. Not only age, all factors affecting nutrient requirements should be considered together while diet density is adjusted. Corn and soybean meal are used as basal feed ingredients in broiler diets. In corn-soybean meal diet, methionine is the first limiting amino acid followed by lysine. All diets containing low crude fibre are provided adlibitum to birds throughout the production period.

Recently, it is recommended that natural growth promoters, such as organic acids, probiotics, prebiotics, synbiotics, essential oils, enzymes etc., are supplemented to diets to optimise performance. The main purpose of using these feed additives is to maintain and enhance gastrointestinal health [13]. In this context, it is currently being examined the usable potential of various bee products (propolis, pollen, etc.) as natural growth enhancers [14, 15]. Moreover, due to shortening slaughter age, pre-hatch (last phase of incubation) and immediate post-hatch periods in which occur many significant physiological and metabolic changes affecting broiler performance have become increasingly important. Therefore, early feeding practices such as in-ovo feeding, hatching supplement (hydrated nutritional supplement) and pre-starter diets are suggested to apply in these periods in order to achieve maximum growth performance of fast-growing broilers [16–18].

Unlike broiler sector, the laying period of modern brown and white layers has prolonged and they may be kept up to 80 weeks in production, without moulting. During the first half of the rearing period, feeding program needs to focus on an optimal supply of digestible amino acids and minerals to ensure the basic growth of the inner organs, muscles and skeleton. These physiological developments of the pullet continue at a slower rate in the second half of the rearing phase therefore protein and amino acids requirements reduce. On the other hand, it is recommended to increase dietary fibre level (5–6%) in this stage for crop, gizzard and intestinal development. The pullet is started to feed with pre-lay diet about 2 weeks prior to first egg (after 15 weeks of age). On reaching about 5% egg production, the layer diet should be used instead of the pre-layer diet. Common mistakes are feeding pre-lay diet too early or for too long, which may result in poor peak rate of lay [19]. The pre-lay diet contains 2–2.5% calcium while the other nutrients are similar to a layer diet. The purpose of using the pre-lay diets is to build up the medullary reserves [20].

Daily feed intake of layers is relatively low between the onset of egg production and peak egg production (approximately 32 weeks of age). Nevertheless, nutrient requirements increase during this critical stage because bird continues to grow, and the size and production of egg rises. Therefore, the first layer diet should be fairly concentrated. The nutrient requirements of laying hens depend on the daily egg mass in post peaking period. The best way of ensuring proper nutrition is the use of a phase feeding system matched to the changes in nutrient requirements [20].

Layer diets have higher calcium content than per-lay diet since egg weight and production increase for peaking period and the hens' ability to absorb calcium from the diet diminishes for post peaking period. The eggshell contains about 2.2 g calcium. Adequate dietary levels of calcium should be provided to ensure proper calcification of the eggshell. The source and particle size of calcium used in laying hen diets are also of importance. To maintain adequate calcium blood level overnight when feed is not consumed and calcium requirement is high due to eggshell formation, a laying hen's diet needs to include coarse limestone and/or oyster shell with lower solubility [21].

For additional information, see nutrient requirements of broilers and egg layers [22–24]. The NRC [22] and Aviagen Ross 308 [23] estimates of nutrient requirements and essential micronutrients of broilers and NRC [22] and Lohmann LSL-CLASSIC [24] estimates of nutrient requirements and essential micronutrients of egg layers.

6. Nutrition and feeding of large ruminants: Beef and dairy cattle

Feed accounts for over 70% of the cost of beef cattle production generally. If the feeding is efficient, the cost of production is reduced while the productivity and profitability of beef production increases. Grazing amount and management are important to reduce production costs. Cattle are ruminant animals and beneficial relationship with their rumen microorganisms (bacteria, protozoa, fungi) to help those digesting fibrous feedstuffs. Beef cattle require nutrients to meet their needs for maintenance, physical activity, growth, milk production, reproduction and health. These requirements of cattle may change age, sex, breed and production cycle. If mature and young growing cattle consume sufficient high-quality pasture as mixed grasses and legumes, they meet nutrients for maintenance and growth. However, pasture quality will depend on many factors, including geographic location, soil structure and environmental conditions as temperature, humidity, precipitation, type of grass and/or legume, grazing management. The negative harvested condition may be so reduced in nutritive value particularly energy, protein, phosphorus and β-carotene that they are suitable only for a maintenance ration for adult cattle. Such feedstuffs should be supplemented with good quality concentrate, vitamin-mineral mixture, and feed additives if used for any other purposes. Beef cattle except for calves due to pre-ruminant can meet their maintenance energy requirements from good quality forages and roughages. Additional energy sources may be necessary for production. Cattle should be fed an adequate ration may receive the recommended nutrients for optimal performance, reproduction, cow and calf health, and growth of all classes of cattle.

Protein requirements for cattle are stated in terms of metabolizable protein is defined as the true protein absorbed by the small intestine and is composed of rumen undegradable protein (RUP) often has been called "bypass" protein and microbial crude protein (MCP). A portion of the feed protein is used by microorganisms as bacteria and protozoa that use the protein to manufacture microbial proteins. Protein supply to rumen microbes is expressed in terms of rumen degradable (RDP). The metabolizable protein used for maintenance and production. Urea and other sources of non-protein nitrogen (NPN) are used commonly in commercial protein supplements to supply one-third or more of the total nitrogen requirement[25]. Vitamin K and the B complex vitamins are synthesised in sufficient amounts by the ruminalmicroflora and vitamin C is synthesised in the tissues of all cattle in normal condition. Beef and dairy cattle have similar mineral elements requirements in qualitatively except for some exceptions. The salt (NaCl) requirement for cattle is quite low. Water should be free access for cattle. Many factors, including body temperature, body weight, growth, reproduction, lactation, digestion, metabolism, excretion affect water consumption and restricting water intake decreases performance.

Lactation is a major physiological and biochemical undertaking. The yield and composition of milk are affected by many factors such as species, breed, strain within the breed, age and stage of lactation. The efficiencies of metabolizable energy utilisation for maintenance and milk production are concerned with the energy contents of the diet and are very similar. High energy intakes must include a certain level of roughage in the diet if an acceptable rumen fermentation is to be maintained and problems of acidosis, reduced intake and low-fat milk are to be avoided [1]. Lactating dietary requirements differ from non-lactating ones with required higher levels of energy, nearly doubled levels of protein, calcium and phosphorus, but no change in vitamin A [26]. It is very important to regulate the amount and quality of concentrate during lactation. With this arrangement, nutrient requirements should be met adequately as well as no way should the animal be allowed to become too fat. Otherwise, production performance can lower in mid and late lactation. At the same time, feeding should be economical. Especially in early lactation period, at least 30% of the total ration should consist of roughage. Protein levels of concentrates are another important consideration during the different stages of lactation. Extra digestible crude protein (10–15%) would be beneficial for early lactation period, and it should be preferred wider digestible crude protein/energy ratio for milk production during the later phase of lactation cycle with inclusion of dry period [27].

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Since the cow herd is still growing, as well as producing a calf, first-calf heifers should receive high-quality forage and protein-energy supplement. Calves graze forage and suckle cows for several months. At 3–4 weeks of age, they begin to graze forage, which during the next few months becomes their major nutrients source [28]. A program of management, which provides energy feeds other than milk, plus grass or hay usually, is defined as a creep feeding arrangement. Creep feeding usually results in increased calf gain during its suckling period. Creep feeding may be expected to make a difference in calf performance at almost any time of the year, but the greatest benefit may be expected when pasture or hay is of less than optimal quality and quantity [29]. Creep feed should be based on grain and protein supplement. Post-weaning calves and replacement heifers feed good quality forage free choice. Supplement with grain and protein supplement as necessary to produce desired level body weight gain. Weaned calves may be raised on roughage for a year or more before entering the feedlot, or they may enter the feedlot directly after weaning [28]. Stocker growth is nourished, normally, with a preponderance of roughages, balanced with adequate protein, minerals and vitamins [30].

Nutrient requirements of the various physiological conditions of beef and dairy cattle have been given by NRC. Nutrient requirements of pregnant replacement heifers, beef cows, growing bulls and large-breed dairy cattle are given by NRC in various tables [31, 32]. For additional information, see Nutrient Requirements of Beef Cattle [31] and Nutrient Requirements of Dairy Cattle [32].

7. Feeding and nutrition of small ruminants: Sheep and goat

Nutrition largely affects flock reproduction, milk production and growth in ruminants. Sheep and goat should be fed according to their nutritional needs [33, 34]. Many factors affect their nutrient requirements such as breed, age, body weight, physiological stage and yield level.

The digestive efficiency of sheep, goat and cattle is similar [35]. In general, goat is considered better browsers than sheep, has a higher voluntary feed intake and can digest fibre more efficiently, particularly when fed low or medium-quality diets [36–39].

The digestive processes of neonate lamb and kid having undeveloped pre-stomach (rumen, reticulum and omasum) are very similar to those of monogastric animals. They are unable to digest ordinary carbohydrates except for lactose or grain-based feeds. The first meal of newborn is colostrum providing all nutrients and antibodies. By feeding on dry feeds (good quality roughage and concentrates), rumen becomes inoculated with microorganisms. As the microbes multiply and begin to digest feed, they stimulate the growth and development of the pre-stomach [40]. Lamb/kid's rumen is usually functional at 45–60 days old ages.

After adequate colostrum feeding, lamb/kid may be raised on sheep/goat milk (natural rearing) or milk replacer (artificial rearing). For various reasons such as inadequate milk production, higher milk price, reducing feed costs, and so on, producers may prefer to use artificial rearing. In both rearing system, it is recommended that liquid food feeding continues until lamb/kid weight reaches at least 10 kg. The composition of a good replacer for lamb is as follows: 22–24% crude protein, 25–35% ether extract, less than 1% crude fibre, 5–8% ash and 22–25% lactose [41].

From ~2 weeks of age, they begin to consume solid feeds and should be creep-fed when pasture quality or quantity is limited. Typical feed ingredients of creep ration are ground or cracked corn, alfalfa hay or meal, soybean meal, oat and molasses. The creep ration should have 18–20% crude protein and not be contained urea. *Ad-libitum* or free choice feeding of creep rations can stimulate rumen development and increases the performance of lamb/kids [42].

Nutrient requirements of sheep/goat are just above maintenance during early and mid-gestation occurring placental development. During the last 50 days of gestation, last trimester, nutrient requirements of them substantially increase due to rapid fetal growth, particularly for ewes/goats carrying multiple foetuses. In addition, this is the period when rumen volume decreases and mammary system develops or regenerates. For these reasons, the nutrient density of diet is necessary to increase for assuring adequate nutrition. Especially, energy is important as it affects lamb/kid size and vigour at birth [35].

Milk production of the ewes/goats peaks at 3–4 weeks following lambing/kidding. Ewes/goats with twin and triplet lambs/kids produce more milk than those with singles. They have the greatest nutrient requirements during early lactation period since they should be fed on high-quality forages supplemented with concentrates. The concentrate ratio of 50–60% is sufficient. After the first 60 days of lactation, the amount of consumed feed per animal should be reduced to prevent excess fat accumulation and to obtain optimum body condition score (2.5 or 3) [35].

Nutrient requirements of various physiological conditions of sheep and goat have been given by NRC in various tables [33, 34]. For additional information, see Nutrient Requirements of Sheep [33] and Nutrient Requirements of Goat [34].

8. Conclusion

Digestive process of ruminants and non-ruminants varies depending on morphological and functional differences of the digestive tract. These variations clearly affect feed source used their nutrition and the amount and kind of nutrients required by them. Because of differences in their digestive physiology, the availability of individual nutrients can vary from feedstuff to feedstuff. Animals must receive sufficient amounts of all essential nutrients (water, energy, amino acids, vitamins and minerals) to remain healthy, to grow and to produce. Inadequate and unbalanced nutrition causes various feeding disorders or even deaths. For economic animal production, it is important for producers to choose feedstuffs that have nutrients high in bioavailability.

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References

[1] McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA, Wilkinson RG. Animal Nutrition. 7th ed. Benjamin Cummings. ISBN-13: 978-1408204238, ISBN-10: 1408204231; 2011

[2] EC, No 1831/2003. Regulation (EC) No 1831/2003 of The European Parliament and of The Council of 22 September 2003 on Additives for Use in Animal Nutrition(Text with EEA Relevance) (OJ L 268, 18.10.2003, Page 29)

[3] Yen J-T. Anatomy of the digestive system and nutritional physiology. In: Lewis AJ, Southern LL, editors. Chapter 3 Swine Nutrition. 2nd ed. CRC Press Taylor and Francis Group; 2001. pp. 31-63

[4] McGlone J, Pond W. Pig Production: Biological Principles and Applications. Thomson/Delmar Learning, ISBN: 0-8273-8484-X; 2003

[5] Chiba LI. Digestive physiology. Animal Nutrition Handbook. 2014;**2**:28-54

[6] Duke GE. Alimentary Canal: Secretion and digestion, special digestive functions, and absorption. In: Sturkie PD, editor. Avian Physiology. 4th ed. New York, NY: Springer-Verlag; 1986. pp. 289-302

[7] Leeson S, Summers JD. Scott's Nutrition of the Chicken. Publ. Univ. Books, Guelph, Ontario Canada; 2001

[8] Nivińska B. Digestion in ruminants. In: ChangC-F, editor. Carbohydrates-Comprehensive Studies on Glycobiology and Glycotechnology. Rijeka, Croatia: InTechOpen; 2012. pp. 245-258. ISBN: 978-953-51-0864-1

[9] Wu G. Principles of Animal Nutrition. CRC Press Taylor & Francis Group; 2018.ISBN: 9781498721608

[10] NRC. Nutrient Requirements of Swine. 11th revised edition. Washington, Washington, DC: National Academy Press; 2012

[11] Veum TL, Cheeke PR. Feeding and nutrition of swine. In: Cheeke PR, editor. Applied Animal Nutrition: Feeds and Feeding. 3rd ed. New Jersey, USA: Pearson Prentice Hall; 2005. pp. 398-419. ISBN: 0-13-113331-4

[12] Cromwell GL. Feeding Levels and Practices in Pigs; 2017. http://www.msdvetmanual.com/management-and-nutrition/nutrition-pigs/feeding-levels-and-practices-in-pigs

[13] Sethiya NK. Review on natural growth promoters available for improving gut health of poultry: An alternative to antibiotic growth promoters. Asian Journal of Poultry Science. 2016;**10**(1):1-29

[14] Açıkgöz Z, Yücel B, Altan Ö. The effects of propolis supplementation on broiler performance and feed digestibility. ArchivFürGeflügelkunde. 2005;**69**(3):117-122

[15] Fazayeli-Rad AR, Afzali N, Farhangfar H, Asghari MR. Effect of bee pollen on growth performance, intestinal morphometry and immune status of broiler chicks. European Poultry Science. 2015;**79**:1-9. DOI: 10.1399/eps.2015.86

[16] Uni Z, Ferket PR. Methods for early nutrition and their potential. World's Poultry Science Journal. 2004;**60**:101-111

[17] Noy Y, Uni Z. Early nutritional strategies. World's Poultry Science Journal. 2010;**66**:639-646

[18] Shariatmadari F. Plans of feeding broiler chicken. World's Poultry Science Journal. 2012;**68**: 21-30

[19] Pottgüter R. Feeding laying hens to 100 weeks of age. Lohmann Information. 2016; **50**(1):18-21

[20] Leeson S, Summers JD. Commercial Poultry Nutrition. 2nd ed. Guelph, Ontario, Canada: University Books; 1997

[21] Altan Ö. Egg: Formation, Quality, and Bioactive Components. Izmir, TURKEY. ISBN:978-605-844000-0-5: Ege University Press. p. 2015

[22] NRC. Nutrient Requirements of Poultry. 9th revised ed. Washington, DC: National Academy Press; 1994

[23] Aviagen Ross-308 Broiler. Nutrient Specifications. 0814-AVNR-035;2014

[24] Lohmann LSL. CLASSIC Layer: Lohmann Tierzucht-Management Guide; 2018

[25] Hilton M. Nutritional Requirements of Beef Cattle; 2017. http://www.msdvetmanual.com/management-and-nutrition/nutrition-beef-cattle/nutritional-requirements-of-beef-cattle

[26] Perry TW. Breeding Herd Nutrition and Management. In: Perry TW, Cecava MJ, editors. Beef Cattle Feeding and Nutrition. 2nd ed. A Division of Harcourt Brace & Company 525 B Street, Suite 1900, San Diego, California 92101-4495: Academic Press, Inc; 1995. pp. 169-197

[27] Naseri A. Animal Nutrition Training Manual; 2017. http://www.atnesa.org/docs/Alimuddin-Naseri-Animal-Nutrition-Manual.pdf

[28] DelCurto T, Cheeke PR. Feeding and nutrition of beef cattle. In: Cheeke PR, editor. Applied Animal Nutrition: Feeds and Feeding. 3rd ed. New Jersey, USA: Pearson Prentice Hall; 2005. pp. 398-419. ISBN: 0-13-113331-4

[29] Perry TW. Milk production and calf performance. In: Perry TW, Cecava MJ, editors. Beef Cattle Feeding and Nutrition. 2nd ed. A Division of Harcourt Brace & Company 525 B Street, Suite 1900, San Diego, California 92101-4495: Academic Press, Inc; 1995. pp. 212-226

[30] Perry TW. Feeding stocker cattle. In: Perry TW, Cecava MJ, editors. Beef Cattle Feeding and Nutrition. Second ed. 525 B Street, Suite 1900, San Diego, California 92101-4495: Academic Press, Inc. A Division of Harcourt Brace & Company; 1995. pp. 242-252

[31] NRC. Nutrient Requirements of Beef Cattle. 7th revised ed. Washington, DC: National Academy Press; 2000

[32] NRC. Nutrient Requirements of Dairy Cattle. 7th revised ed. Washington, DC: National Academy Press; 2001

[33] NRC. Nutrient Requirements of Sheep. 6th revised ed. Washington, DC: National Academy Press; 1985

[34] NRC. Nutrient Requirements of Goat: Angora, Dairy, and Meat Goats in Temperate and Tropical Countries. Washington, DC: National Academy Press; 1981

[35] Thompson JM, Cheeke PR. Feeding and nutrition of small ruminants: Sheep, goats and llamas. In: Cheeke PR, editor. Applied Animal Nutrition: Feeds and Feeding. 3rd ed. New Jersey, USA: Pearson Prentice Hall; 2005. pp. 398-419. ISBN: 0-13-113331-4

[36] García MA, Isac MD, Aguilera JF, Molina-Alcaide E. Rumen fermentation pattern in goats and sheep grazing pastures from semiarid Spanish unsupplemented or supplemented with barley grain or barley grain-urea. Livestock Production Science. 1994;**39**:81-84

[37] Molina-Alcaide E, García MA, Aguilera JF. The voluntary intake and rumen digestion by grazing goats and sheep of a low-quality pasture from a semi-arid land. Livestock Production Science. 1997;**52**:39-47

[38] Yáñez-Ruiz DR, Martín-García AI, Moumen A, Molina-Alcaide E. Ruminal fermentation and degradation patterns, protozoa population, and urinary purine derivatives excretion in goats and wethers fed diets based on two-stage olive cake: Effect of PEG supply. Journal of Animal Science. 2004;**82**:2023-2032

[39] Yáñez-Ruiz DR, Martín-García AI, Moumen A, Molina-Alcaide E. Ruminal fermentation and degradation patterns, protozoa population and urinary purine derivatives excretion in goats and wethers fed diets based on olive leaves. Journal of Animal Science. 2004;**82**:3006-3014

[40] Yami A. Nutrition and Feeding of Sheep and Goats. Sheep and Goat Production Handbook for Ethiopia; 2011

[41] Umberger SH. Profitable artificial rearing of lambs. Virginia Cooperative Extension, Publication N° 410-023; 1997

[42] Alcock D. Creep Feeding Lambs. Primefact 224; 2006

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