THE NUTRITION OF VERY YOUNG ANIMALS

by Imogene P. Earle

Very young farm animals have rather special nutritional needs that are normally supplied by the milk of the dam. Sometimes, however, the young animal is an orphan, and frequently young animals are taken away from their dams at an early age. This discussion deals with calves, foals, kids, lambs, pigs, and puppies, telling about their nutritive needs and covering such subjects as the characteristics of colostrum milk, substitutes for mother's milk, and the weaning process. Another article in this book covers the feeding of dairy calves in greater detail.

Very young mammals have special nutritive requirements which, under natural conditions, are adequately met by the milk of the dam. This milk is a food adapted to the more or less undeveloped eating habits and digestive functions of the offspring and is designed by nature to meet the specific nutritive needs of the newborn of the species for which it is supplied. Thus for a period following birth, the young mammal remains more or less dependent on its dam for nourishment. This suckling period is one of changing requirements and of transition from the complete dependence of the fetal state to a condition of entire nutritional independence from the maternal animal.

Immediately after birth most young mammals are nourished entirely on milk. Other foods are gradually substituted for milk until they have replaced it entirely, and from then on the young animal may be fed the same varieties of feeds supplied to the adults.

Where the nutrition of the young is the sole consideration, the most satisfactory and economical procedure for feeding young mammals during the suckling period may be outlined as follows: (1) The proper feeding of the dam for the production of a sufficient supply of milk; (2) opportunity for the young to suckle their dams at will for a suitable period after birth; (3) at an advanced stage in the suckling period, the provision of suitable feeds to supplement the dam's milk.

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Under certain circumstances it may be necessary or desirable to feed some substitute for the natural milk of the dam, either from birth or beginning at some time after birth. In the case of the cow, where the economic value of the milk must be considered as well as the nutrition of the young, considerable attention has been given to studies of adequate methods of feeding the calves on a minimum amount of whole milk. Feeding of the young of all farm species becomes a problem when the dams die or refuse to suckle their young, or when their milk is insufficient in quantity or is unsuitable for some reason, such as disease. In such cases, particularly if the animals are of valuable stock, it becomes of practical importance to be able to feed the young animals by hand. The labor involved is no small item, however, and may be a limiting consideration. The careful preparation of feed, and the frequency with which the young must be fed during each 24 hours, all tend to make any system of hand feeding rather expensive aside from the actual cost of the feed consumed. The saving effected on feed consumed by dairy calves more than offsets the cost of labor.

The feeding of maternal animals for the production of milk is treated elsewhere. The present article is concerned primarily with a discussion of the general nutritive requirements of the very young; the functions and characteristics peculiar to the colostrum and milk of maternal animals of different species; and some substitutes that have been used to replace, either wholly or partially, the natural food of sucklings. The article will also include a brief treatment of feeds suitable for supplementing the dam's milk during the suckling period. The animals with which this discussion is chiefly concerned are young calves, foals, kids, lambs, pigs, and puppies.

**INFLUENCE OF IMMATURITY ON NUTRITIONAL REQUIREMENTS**

From the point of view of nutrition, the birth of a young mammal marks an abrupt and radical change from the state within the uterus—in which it is passively nourished by the blood of the mother, to an environment in which the still immature organism must take in its own food, digest it, and absorb from it the factors required for maintenance and further development. The state of development of the newborn and the degree of dependence on the maternal animal vary in different species. For example, the young guinea pig at birth is quite active; it scampers about as soon as born, and will begin to eat whatever food is available to the mother almost at once. Young puppies on the other hand are entirely helpless; their eyes are not open until 9 to 14 days after birth, and it is not until some time later that they are able to walk about.

While the newborn of some species are more mature, with respect to their ability to obtain and assimilate food, than those of others, in no mammalian species is the young animal equipped at birth to maintain itself entirely on the kind of food suitable for the adult. In the first place it is deficient in the digestive enzymes operating in the adult. Further, its metabolic rate exceeds that of the adult, and consequently its energy requirements for maintenance alone are greater in proportion to size. In addition to energy requirements, its demands for building materials—proteins and minerals—are great, since the
most rapid growth occurs in the suckling period. This means that the feed must be of a kind the young animal can easily digest, and that it must be fed frequently in order that it may have a sufficient quantity to meet its demands.

Another factor which must be considered in connection with a young animal's early nutrition is the undeveloped power for building up active resistance against bacterial infections. The mature animal actively resists many kinds of commonly occurring bacteria that invade its body by developing immunity-conferring substances that constitute a protection against diseases caused by these bacteria. The very young animal apparently has not the same ability as the mature animal for developing its own immunity to these diseases, and hence is largely dependent for protection on the antibodies that have been conveyed to it by the dam, either through the placenta before birth or through the colostrum, or first milk, shortly after birth.

In all mammals the developing embryo or fetus is nourished through the placental tissues, which constitute the attachment of the fetus to the uterus. The placenta accommodates both maternal and fetal circulations, holding them apart physically so that the maternal blood can never be directly introduced into the fetus, yet permitting the passage through the separating membranes of those substances that make up the food supply of the fetus. The structure of the membranes separating the two circulatory systems varies in different species.

It has been suggested (249) that the permeability of these membranes to immune substances varies according to the number of layers of cells composing the separating membranes. In human beings and in the rodents the placenta interposes only one layer of cells between the maternal and fetal circulations, and immune substances are transferred, in part at least, through the placenta. The human infant at birth apparently has a supply of many, if not all, antibodies present in the circulating blood of the mother and hence is resistant to those diseases to which the mother is immune. In the pig, the horse, and the ruminants a multiplicity of cell layers intervenes between the maternal and fetal bloods, and in these species there is apparently no transfer of immune bodies through the placenta. The newborn of these species are dependent on the absorption of such substances from the colostrum of the dam. In the carnivores, exemplified by the dog, the separating membranes are made up of only two or three cell layers, and the possibility of placental transfer of immunity appears greater than in other species of domestic animals. Hence immunity may well be less of a nutritional problem in the puppy than it is in the colt and calf.

**COLOSTRUM**

Observations over the course of many years have shown that normally the products of mammary secretion of the maternal animal are satisfactory foods for her young. The requirements of the newborn differ from those of the older suckling in that they are those of a less mature animal. They are, however, adequately met by the colostrum, the first product of mammary activity after birth.

2 Italic numbers in parentheses refer to Literature Cited, p. 1075.
The colostrum differs substantially from the later milk. It is a much more concentrated fluid—that is, it has a higher percentage of solids. The constituents of the later milk are present but in different proportions. In addition, other factors are present which give colostrum certain biological properties that the later milk does not have. The composition of the colostrum varies within wide limits and changes rapidly following the birth of the young. There is considerable variation in the length of time during which the colostral characteristics of the milk persist, even in different individuals of the same species. Usually, however, these characteristics are not observed in the milk after the fourth or fifth day following birth.

The most significant difference in chemical composition lies in the high concentration of protein characteristic of colostrum from all species. This protein belongs largely to the group called globulins, and it has been found to be identical (241, 1206) with the globulins in the blood serum of the same animal. The concentration of globulins has been reported to run as high as 17 percent in mare's colostrum and as high as 15 percent in ewe's and sow's colostrum (289). The percentage of globulin rapidly decreases in a few hours, as the data presented in table 1 show for the mare, goat, and ewe (289).

<table>
<thead>
<tr>
<th>Species of animal</th>
<th>Time after parturition</th>
<th>Species of animal</th>
<th>Time after parturition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein present in colostrum</td>
<td>Globulins</td>
<td>Albumin</td>
<td>Casein</td>
</tr>
<tr>
<td>Mare</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td>Percent</td>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
<td>1</td>
<td>11.45</td>
<td>1.76</td>
<td>6.04</td>
</tr>
<tr>
<td>12</td>
<td>2.36</td>
<td>1.22</td>
<td>2.40</td>
</tr>
<tr>
<td>24</td>
<td>4.42</td>
<td>.66</td>
<td>1.84</td>
</tr>
<tr>
<td>Goat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td>Percent</td>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
<td>1</td>
<td>8.18</td>
<td>.69</td>
<td>6.32</td>
</tr>
<tr>
<td>16</td>
<td>1.83</td>
<td>.59</td>
<td>3.43</td>
</tr>
<tr>
<td>24</td>
<td>.69</td>
<td>.40</td>
<td>3.19</td>
</tr>
</tbody>
</table>

It has also been shown that the colostrum of the mare, cow, goat, and ewe may contain antibodies—bodies that protect the animal against foreign substances, such as bacteria and toxins—in higher concentration than does the blood and that these are associated with serum globulins of the same animals (60, 356, 691, 758). The concentration of antibodies apparently diminishes as globulin concentration diminishes following parturition, although it is possible to have colostrum of relatively low globulin and high antibody concentration. It has been assumed that the colostrum globulins are probably serum globulins that have been secreted unchanged together with the associated antibodies from the blood of the animal.

Practical observations have shown that newborn mammals have a better chance of survival when they receive the first milk of their dams soon after birth. Hence several functions have been attributed to this first milk or colostrum. Many livestock owners still think the chief function of the first milk is that of a laxative essential for the removal of the meconium, the first matter discharged from the
bowels of the newborn. Bauer (67) and Birk (105) have expressed the view that colostrum, with its high concentration of blood proteins, is especially designed as a suitable and necessary food for the young animal in the first and most difficult stage of adjustment after leaving the uterus, where he has been nourished wholly by the maternal blood. The high concentration of nutrients in an easily digested and assimilated form is doubtless one of the advantages of colostrum to the young.

The possible function of colostrum in supplying the newborn animal with vitamins should not be overlooked. Dann (260) found that cow's colostrum has a concentration of vitamin A which may be 70 times as great as that in later milk. This is especially significant in view of the fact that the body of the newborn calf has a very low supply of vitamin A (444). Cow's colostrum may contain also 3 times as great a concentration of riboflavin (vitamin G) as the later milk (647). This concentration of vitamins in the colostrum may not occur in all species.

The most important function of colostrum, however, is undoubtedly its role in the passive immunization of the young against disease. The young calf, foal, kid, lamb, and pig (356, 691, 758, 842) lack at birth the antibodies present in the blood of the dam and the protein fractions (globulins) with which these antibodies are closely associated in the blood serums (289). Shortly after the ingestion of colostrum, both antibodies and globulins appear in the blood serum of the young suckling. These substances absorbed from the colostrum usually endow the newborn with sufficient resistance to protect it from infection by many of the kinds of bacteria commonly present in the usual farm environment until it is able to elaborate an active immunity. Without the passive immunity conferred by the colostrum, a large percentage of the young succumb to infection by organisms that do not affect older animals.

**SERUM AS A SUBSTITUTE FOR COLOSTRUM**

The remarkable ability of the gastrointestinal tract of the newborn to absorb immune bodies and globulins from the colostrum diminishes rapidly after birth. After the second day following birth, absorption can no longer be readily demonstrated. This permeability is somewhat selective, since it permits the passage of large amounts of colostrum globulins, while apparently no demonstrable amounts of casein and lactalbumin are absorbed.

That antibodies can also be absorbed from serum either of the same species or of another species when these products are fed by mouth or are injected under the skin has been demonstrated in foals, lambs, puppies, and calves (758). Since serum from the dam contains the same immune bodies found in the colostrum and is an easily absorbed substance, serum from the same species is the most obvious substitute for colostrum in the transfer of passive immunity. In fact, it has been fed as a substitute for colostrum to calves (1085) and to foals and lambs (406).

Smith and Little found 200 to 350 cubic centimeters of cow serum fed in milk to young calves to be partially successful as a substitute for colostrum. Better results were obtained when 60 cubic centi-
meters of serum was injected and 120 cubic centimeters fed. In some experiments reported by the Bureau of Animal Industry 1 liter or more of horse serum substituted for a like volume of water in a dried-milk mixture was used with entire success to replace colostrum in rearing healthy foals (406). Other colts in the same experiment, fed the milk mixture without the serum, all died. This represents an extreme rather than an average death rate, since it is not impossible that some colts may survive without the benefits of colostrum or serum. Sheep serum to which was added 15 percent of dried whole milk was used as a substitute for ewe's colostrum, but with somewhat less striking results.

COMPOSITION AND NUTRITIVE VALUE OF MILKS

The milks of all species are similar in that they are all mixtures of similar chemical substances, including fat, lactose (milk sugar), proteins, vitamins, inorganic salts, and water. Yet there are marked species differences in all milks, the most apparent of which are in the relative proportions of the various constituents. Abderhalden (4) directed attention to a relationship between the concentration of protein and minerals in the milks of different species and the length of time required for the young of the species to double their birth weight. The data he compiled to illustrate this relationship indicate that the more rapid the rate of growth and development of the young, the greater is the concentration of protein and minerals needed in the milk.

The percentage composition of the milks of the six species with which this discussion is concerned are given in table 2. The quantitative differences in the chemical composition of the different milks are obviously of considerable importance in meeting the nutritive requirements of the young. If one can assume that normal milk of the same species is the best food for the nutrition of the young, then the carbohydrate-fat-protein ratio in each milk is probably one particularly favorable to the digestion and metabolism of the food factors required by the suckling of that species.

TABLE 2.—Average composition of different milks

<table>
<thead>
<tr>
<th>Species</th>
<th>Water</th>
<th>Protein</th>
<th>Fat</th>
<th>Lactose</th>
<th>Ash</th>
<th>Species</th>
<th>Water</th>
<th>Protein</th>
<th>Fat</th>
<th>Lactose</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse 1</td>
<td>80.04</td>
<td>2.09</td>
<td>1.59</td>
<td>6.14</td>
<td>0.51</td>
<td>Sheep 4</td>
<td>82.50</td>
<td>5.44</td>
<td>6.24</td>
<td>4.20</td>
<td>0.49</td>
</tr>
<tr>
<td>Cow 2</td>
<td>87.90</td>
<td>3.13</td>
<td>3.05</td>
<td>4.50</td>
<td>0.72</td>
<td>Pig 5</td>
<td>82.02</td>
<td>6.22</td>
<td>6.77</td>
<td>4.02</td>
<td>0.97</td>
</tr>
<tr>
<td>Goat 3</td>
<td>87.14</td>
<td>3.71</td>
<td>4.09</td>
<td>4.20</td>
<td>0.78</td>
<td>Dog 7</td>
<td>80.1</td>
<td>7.3</td>
<td>8.5</td>
<td>2.8</td>
<td>1.3</td>
</tr>
</tbody>
</table>

1 Linton (686).  
2 White (887, p. 56).  
3 Früh (841).  
4 Hughes and Hart (557).  
5 Difference between total solids and proteins + fat + ash.  
6 Linton (888).  
7 Difference between total solids and fat + lactose + ash.

Campbell, publishing in collaboration with Supplee and Ware (188), has stated that the carbohydrate-fat balance tolerated by young puppies has a very narrow range, particularly in artificially fed puppies. There is evidence that the limits of the carbohydrate-fat ratio tolerated by the young of other species is much wider. Linton (686), analyzing milk from 142 mares, observed that those foals receiving milk abnormally low in lactose, a carbohydrate, appeared
malnourished, whereas milk somewhat high in lactose was well tolerated. Variations in fat, on the other hand, unless the fat content of the milk was quite high, seemed to be without influence on the condition of the foal. Ritzman (970) made some observations on the relation between the fat content of ewe's milk and the weight increase in lambs on the different milks. He found a considerable fluctuation in rate of weight increase, but it bore no definite relationship to the percentage of fat in the milk. He concluded from his practical observations that a quantitative variability in milk fat is not significant in the nutrition of lambs so long as the demands for protein, minerals, and vitamins are met. The excellent results reported by Converse and Meigs and by Archer, Archer, Bond, and Dunlop (27) from the feeding of calves on skim milk plus cod-liver oil show that the carbohydrate-fat ratio well tolerated by the calf has very wide limits.

While it is evident that the amount of fat in the ration of the suckling foal, calf, and lamb may be considerably reduced below the average of fat in the normal milk of the respective species without unfavorable effects on the sucklings, it seems that some milk fat is necessary in the ration of the growing animal to supply the essential fat acids or fat-acid compounds necessary for growth and to serve as a medium for fat-soluble vitamins.

Lactose serves as a source of energy in the ration of the young animal. It also plays a part in the utilization of calcium and phosphorus. French and Cowgill (393) have shown that in the immature animal lactose has a definitely favorable influence on the utilization of calcium and phosphorus. There is some indication that the ratio of protein to lactose is an important factor in this role of lactose, since a favorable effect on calcium metabolism is obtained from lactose in parathyroid tetany (574), a disease condition marked by a low level of calcium in the blood, only if the ratio of protein to lactose does not go above 4 parts of protein to 1 part of lactose, or below 2 parts of protein to 25 parts of lactose.

There are other differences in milk the importance and significance of which are not so obvious as are differences in the percentages of constituents. Differences in such factors as the physical state of the fat, the size and toughness of the curd formed, and the capacity of the milk to resist change in acidity with the addition of acid or alkali may be important in the digestion of the milk. Again, differences in the composition of the various constituents themselves may be of as great significance as differences in their concentration.

Milk fat has characteristic physical properties and fat-acid composition for each species. It is to be expected that it also differs in biological properties.

Milk proteins likewise vary with the species in chemical composition and in immunological properties. Usually an immunological or defensive reaction occurs when a protein from one species is introduced into the blood stream of an animal of an unrelated species. When such a reaction is produced the protein causing it is designated as antigenic. Milk proteins are antigenic, some producing more marked antigenic reactions than others. The term "milk proteins"
includes at least three chemically distinct proteins—casein, lactalbumin, and lactoglobulin. These three proteins vary by species in their ratios to each other. Casein, which is found only in milk, forms the bulk of the protein in that of most domestic species. Though the caseins of all species are rather closely related immunologically and are similar in chemical composition, species differences, though not great, do exist. Lactalbumin also is a protein found only in milk, although it is somewhat similar to the serum albumin of the same species. The lactalbumins of different species are distinct and different. Lactoglobulin has been shown to be identical with serum globulin of the same species and, like the serum globulin, to differ with species.

These three milk proteins differ from each other in their value as body-building material. Osborne and Mendel (882, 883) have shown that the fraction of milk proteins containing lactoglobulin and lactalbumin is utilized much more efficiently in the growth of young animals than the casein fraction. That milk proteins as a whole are more efficient than vegetable proteins has been indicated by data from many experimenters.

In the feeding of milk of one species to the young of another the potential effects of the antigenic differences in the milk proteins are often overlooked. It has long been recognized that in general the young of one species thrive better on milk of their own kind than on that of another species. Furthermore, the sooner after birth the milk of another species is substituted for milk of the same species, the more unfavorable is the outlook for the young animal. The results of some studies published by Bilek (100) are cited as indicating that some of the unfavorable effects so often obtained from feeding milk of another species may well be attributed to qualitative rather than quantitative differences. In these experiments, cow’s milk and goat’s milk were fed to the young of several species. The different species did not react alike. Kids used both milks equally well, while calves reacted to goat’s milk with severe gastrointestinal disturbances which lasted as long as goat’s milk feeding continued. Pigs showed no disturbance on cow’s milk but reacted to goat’s milk in a fashion similar to that observed in the calves. Foals showed a stubborn diarrhea when fed undiluted cow’s milk but not the slightest disturbance on goat’s milk. Since the two milks are very similar in percentage composition, the results indicate the presence in the milk of substances incompatible or toxic to the animals that reacted unfavorably. It is suggested that the incompatible factors are proteins.

It is known that the presence of a foreign protein undigested in the circulating blood is more or less toxic to an animal and may produce a sensitization to further additions of the foreign protein. It has been established that the newborn animal normally absorbs considerable protein undigested through the gastrointestinal wall. Although this apparent permeability decreases rapidly after birth, it probably does not cease abruptly, since, as Ratner (948) has shown, it still occurs to some slight extent in about 50 percent of adults. The possibility of the absorption in the very young suckling of appreciable amounts of undigested and sensitizing foreign protein might be a major factor in the incompatibility of the milk of one species for the young of another.
PRACTICAL POINTS ON THE FEEDING OF SUCKLING ANIMALS

Whether a newborn animal is to be suckled by its dam or by a foster mother or is to be fed by hand, it should if possible receive colostrum of its own species. When this is not available serum of its own species is suggested as the substitute most likely to be successful in protecting the animal against disease. Since normal serum for feeding is not at present readily available as a commercial product, the farmer or stockman will probably require the services of a veterinarian in the preparation of blood serum from adult animals for use as a colostrum substitute. This serum may be fed with milk, it may be injected, or it may be administered in both ways. Only sterile serum should be injected, of course. It is important that the protective food, whether colostrum or serum, be fed as soon as possible after birth, since the protection it confers is probably needed within the first few hours.

FREQUENCY OF FEEDING

Where a system of hand feeding is to be employed, the frequency of feeding is an important factor in its success. The young pig left with the sow has been observed to suckle 24 times within 24 hours, the young foal 20 times in the same interval. Calves, kids, lambs, and puppies probably suckle with a similar frequency. Thus the nutritive requirements of the young animal are met naturally by small quantities frequently supplied. Such frequency is obviously impractical in hand feeding. It has been found that calves, after the period of colostrum feeding, do quite well on two or three feedings a day. Newborn foals, kids, lambs, and pigs have done very well when started on five feedings a day. This schedule was arbitrarily adopted with good results in some feeding experiments carried out at the Animal Husbandry Experiment Station at Beltsville, Md. Equally good results may perhaps be obtained with less frequent feedings. The five daily feedings may certainly be reduced to four within 4 or 5 days, and to three within 2 weeks. Frequent feeding is much more important during the first few days after birth, while the animal is making its adjustment to a new environment, than at a later period.

FEEDING CALVES

The methods in use in the feeding of calves may be enumerated as follows: (1) Suckling by dam; (2) feeding whole milk; (3) feeding skim milk or separated milk; (4) feeding reconstructed dried skim milk, that is, with water added; (5) feeding calf meals or gruels with a minimum amount of liquid milk (fig. 1). Unless the cow dies or is diseased every calf should be left with its dam from 1 to 4 days to receive colostrum. With calves from dairy cows whose milk is marketable, unless the calf is a very valuable animal from the breeding standpoint, it is practical to substitute as soon as possible a less expensive food for either a part or all of the whole milk. In such cases the general practice seems to be to feed whole milk for the first 2 weeks. Beginning about the third week whole milk may be gradually replaced with the milk substitute, which may be fresh skim milk, reconstructed dried skim milk, or some form of calf starter, either a gruel or a dry meal. For general directions for feeding management of dairy calves the
reader is referred to Department of Agriculture Farmers' Bulletin 1723 (1037) and to the article beginning on page 597 of this yearbook.

Contrary to the general belief that calves should receive whole milk for the first 2 weeks at least, Converse and Meigs* found that dairy calves fed skim milk supplemented with cod-liver oil beginning the fourth day after birth were indistinguishable in general appearance after the first month from calves that had received equal amounts of whole milk for the first 20 days and skim milk thereafter. Archer, Archer, Bond, and Dunlop (27) also have reported good results from feeding, beginning the fourth day after birth, of 1 gallon of separated milk plus 1 tablespoonful of cod-liver oil daily. This amount of milk was increased to 1½ to 1¾ gallons by the third week. Meadow hay and a meal mixture of 4 parts of flaked maize and 1 part of linseed cake were made available after the first week.

Dried skim milk can be reconstructed and fed; in this form it is apparently as good as fresh skim milk in calf feeding. It has the further advantage that at an early age it can be fed dry in a meal. Knott, Hodgson, and Ellington (640) have reported that a group of experimental calves weaned at 5 to 6 weeks from reconstructed skim milk to a dried skim-milk meal were healthy and vigorous, and at the age of 6 months were indistinguishable from heifers raised on separated skim milk.

Calves begin to supplement a milk diet by nibbling at other feeds when 2 or 3 weeks old. For a description of calf starters or calf meals the reader is referred to the New York (Cornell) Agricultural Experiment Station Bulletin 622 (1012).

It is of interest that attempts to raise calves on diets of milk alone

* See footnote 3, p. 607, for reference.
have consistently failed. In some experiments reported by Herman (510) calves fed exclusively on whole milk appeared practically normal for about 6 months, but when the exclusive milk diet was continued beyond this period, became increasingly anemic and died within a few months thereafter. With the addition of iron, copper, manganese, and cod-liver oil to the ration the period of growth was prolonged and the calves lived about a month longer than those receiving milk alone.

FEEDING FOALS

Since in this country mare's milk commonly has no value as a marketable product, it is the cheapest feed for the young foal as well as the best that can be provided (fig. 2). The suckling period of the foal varies widely with custom in different localities, with the availability of other feeds for the foal, and with the use which it is desired to make of the mare. According to Ehrenburg (312), in certain sections of Germany foals are always separated from the dam at 3 months, while in Spain it is the custom to allow them to suck for 9 or 10 months. In old Rome the foal was often permitted to suckle for 2 years. The first 6 months of the foal's life constitute the period of most rapid growth and development, and the nutrients most suitable for this growth should be supplied to him during this time. Especially where there is a shortage of good feed, the foal should be permitted a suckling period of fully 6 months or longer, since the mare is better able to utilize poor food. Where the mare is required for heavy work or is being used to produce another foal, the suckling period may possibly be reduced

Figure 2.—The foal gets the best and cheapest food from its mother for the first 6 months of its life.
to 3 or 4 months without retarding the development of the foal if an ample supply of other suitable feeds is available. In such cases, fresh cow’s milk, whole, or preferably skimmed, has been fed after weaning with good results. Dried skim milk mixed with the grain can also be used to advantage.

Hand-fed foals are sometimes fed fresh cow’s milk modified as follows: One-half to two-thirds cow’s milk, the other half or third water, with 1 tablespoonful of sugar to every pint of mixture. Cow’s milk thus modified roughly approximates mare’s milk in the concentration of fat and sugar, although protein and minerals are low. Whole cow’s milk is usually unsuited to very young foals, perhaps partly because of its fat content. The following mixture of dried cow’s milk has been used with excellent results: Dried whole milk, 8.69 percent; dried skim milk, 5.49; sugar, 3.9; lime water, 6; and water for mixing, 76.2 percent. In this mixture the concentration of total solids exceeds that in mare’s milk, but the proportions of carbohydrate, fat, and protein are approximately the same.

The quantity of milk supplied by a mare to her foal 4 to 6 weeks after birth has been estimated at figures varying between 4 and 35 quarts a day. According to Blechschmidt (187) a draft mare should give 18 or more quarts and a mare of one of the lighter breeds 10 to 12 quarts daily. A foal will require 4½ to 6 quarts of mare’s milk for each 100 pounds of its own weight until such time as it is eating an appreciable quantity of supplementary feed. Three to four quarts of the dried-milk mixture described in the previous paragraph will supply approximately the same amount of energy as 4½ to 6 quarts of mare’s milk.

It should be mentioned that, while little is known of their vitamin requirements, unless foals have access to green pasture or to good-quality alfalfa hay, it seems advisable to include some cod-liver oil in their ration.

The foal begins nibbling grain and hay about 3 weeks after birth. Crushed or ground oats or bran are good feeds for him to start on. A mixture of 2 parts of cracked corn, 4 parts of crushed oats, 2 parts of bran, and 1 part of linseed meal is also excellent. The foal should be eating approximately 0.5 pound of grain per 100 pounds of body weight daily at 3 months and twice this much at weaning time. Good legume hay should be made available as soon as the foal will eat it.

FEEDING KIDS

Goat kids, after the colostrum feeding period, apparently do equally as well on whole cow’s milk as on whole goat’s milk. Where comparative feeding tests have been made with the two kinds of milk, the differences in results have been attributed to differences in the energy values of the milks. That is, the animals on the richer milk made slightly greater gains.

In a herd of dairy goats, the kids are customarily removed from the does after the colostrum feeding period and thenceforth are hand-fed from bottles (fig. 3), or preferably from pails. The milk fed may be either goat’s or cow’s. Kids grow well when fed 24 ounces of milk daily, given in four feedings, during the first week. This amount is increased gradually until the kid is receiving approximately 64
ounces at 10 weeks of age. At 4 weeks alfalfa hay and a grain mixture of 4 parts of ground corn, 2 parts of oats, 1 part of bran, and \( \frac{1}{2} \) part of linseed meal are made available. As the kids consume more grain and hay the amount of milk may be decreased.

Kids are sometimes milk-fed for 5 months, but this seems unnecessarily long. A milk-feeding period of 3 months, as is customarily followed in feeding lambs, is probably quite sufficient. There seems to be no reason why the amount of whole milk consumed by kids cannot be reduced as in the case of calves by substituting fresh skim milk or dried skim milk for whole milk at an advanced stage in the milk-feeding period.

**FEEDING LAMBS**

Lambs are usually allowed to run with their dams until they are 3 to 5 months old (fig. 4). They begin to nibble at feed from 10 to 16 days after birth. Unless the lambs are dropped after the pastures are ready, it is good practice to supply hay and grain in a small enclosure accessible to the lambs but inaccessible to the ewes. Green alfalfa hay is excellent roughage. A grain mixture which has been recommended by the Ohio Agricultural Experiment Station (464) for lambs that are to be marketed consists of 5 parts of corn, 2 parts of oats, 2 parts of bran, and 1 part of linseed meal.

Orphan lambs, once the needs occurring during the colostrum period are satisfied, can be raised without difficulty on whole cow's milk, whole goat's milk, or a 20-percent mixture of dried whole cow's milk in water. Practical directions for feeding the orphan lamb are given in some detail in California Agricultural Extension Service Circular 14194.
In some feeding experiments carried out at the Animal Husbandry Experiment Station at Beltsville (406), in which dried-milk mixtures were used to replace ewe’s milk, a 20-percent dried whole-milk mixture, which has the same energy value as ewe’s milk, was found to give excellent results as a substitute for ewe’s milk, but dried skim milk, even when supplemented with cod-liver oil, was found quite unsatisfactory.

Lambs should be fed milk for at least 3 months. Frequent feeding of small amounts during the first 3 or 4 days is essential. Small lambs, weighing from 5 to 7 pounds, should receive about 1 pint or a little more a day. Larger lambs, 8 to 12 pounds in weight, require 1½ to 2 pints a day. The total quantity of milk should of course be increased somewhat as the lambs increase in size. It has been shown (406) that lambs can make excellent growth on the following weekly allowance of dried whole milk, which is fed as a 20-percent mixture with water: At 1 week, 3.6 pounds of dried milk per 100 pounds of live weight; at 2 weeks, 2.6 pounds; at 3 weeks, 2.5; at 6 weeks, 2.1; at 8 weeks, 1.3; and at 10 weeks, 0.9 pound.

Feeding Pigs

For the first 3 weeks of life pigs live exclusively, except for the small amount of mineral matter picked up from the soil, on sow’s milk (fig. 5). Usually they begin eating a little grain from the sow’s trough at 3 weeks, unless a special creep is provided for them, but their

Figure 4.—Lambs 10 to 16 days old nibble at feed, but they need milk from the ewe for 3 to 5 months. The lambs shown are twins.
most important feed is still sow's milk until they are weaned at 8 or 12 weeks. The average birth weight of a pig is doubled within 7 to 10 days. This is possible only because sow's milk is a more concentrated food than cow's milk and is supplied to the little pig in relatively liberal amounts. Thompson (1134) has reported, as the result of a study of the effect of milk consumption on the growth of pigs, that the average daily milk consumption of the pigs he observed varied from 0.226 to 0.505 pound per pig. Pigs receiving the greatest amount of milk made the greatest gain even after weaning. Schneider (1016) has estimated that 1.534 pounds of sow's milk is required for each pound of live-weight gain the pig makes during the first 8 weeks of the suckling period. The figure for average daily milk yield of sows

Figure 5.—Pigs double their weight within 7 to 10 days on the sow's milk. The pigs that get the most milk make the greatest gains, and continue to do so even after weaning at 8 or 12 weeks.

varies widely with such factors as breed, size of litter, and nutrition. Published estimates have ranged from 4.5 to 18 pounds of milk a day.

The daily milk yield of the sow reaches its maximum during the third or fourth week of lactation. From this time on she can no longer entirely satisfy the nutritive requirements of the pigs and it becomes necessary to supplement her milk with other feed. This supplemental feed may be supplied as a mixture consisting of 80 percent ground grain and 20 percent protein supplement; or if the self-feeding system is employed, shelled corn may be provided in one compartment of a feeder, a protein supplement in another compartment, and a mineral mixture in a third. The protein supplement may be fish meal, tankage, linseed
meal, shorts, or middlings, which should be combined with alfalfa meal in a ratio of 3 parts of supplement to 1 part of alfalfa meal. A combination of animal and plant proteins may also be used as in the so-called trinity mixture, made up of 2 parts of tankage, 1 part of linseed meal, and 1 part of alfalfa meal. The inclusion of a good grade of alfalfa meal in the ration is especially important where pasture is not the best.

The following mineral mixture has been found satisfactory:

<table>
<thead>
<tr>
<th>Parts</th>
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<tbody>
<tr>
<td>Bonemeal</td>
<td>38</td>
<td>Sodium chloride</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>39</td>
<td>Ferrous sulfate</td>
</tr>
</tbody>
</table>

The mineral mixture may either be provided in a separate compartment of the self-feeder or it may be combined with the protein-supplement mixture in the proportion of 5 parts of mineral mixture to 100 parts of protein mixture.

Unless there is some special reason for doing so, pigs should not be weaned earlier than 8 weeks after birth. They are sometimes left with the sow as long as 12 weeks. A suckling period of 60 days is a good practice.

Studies on the raising of orphan pigs on whole cow’s milk and on modified cow’s milk have been carried out on pigs 12 days or more old. The investigations of Washburn and Jones (1183) indicated that cow’s milk with a relatively low fat content was satisfactory for young pigs 4 to 5 weeks old. Evvard, Glatfelter, and Wallace (353) fed several small groups of young pigs from 12 to 72 days of age on cow’s milk and on cow’s milk plus various protein supplements. The number of pigs with which they worked was small and their results were complicated by diseases probably due to vitamin deficiencies, but the results indicated that cow’s milk supplemented by 1 to 3 percent of casein can be used in place of sow’s milk after the pigs are 2 weeks old. Pigs so fed should, however, have access to green pastures as well as to grain and a mineral mixture as soon as they will eat.

The occurrence of nutritional or milk anemia among suckling pigs is an important factor in the mortality of pigs before weaning time. Most young animals are supplied at birth with sufficient stores of iron and copper to supplement the deficiencies of these elements in milk until such time as they begin eating solid food. The young pig seems to be exceptional in that he usually develops anemia within 2 weeks after farrowing when restricted to a diet of milk alone and denied access to dirt or sod. The disease can be entirely prevented by the inclusion of a very small quantity of soluble iron and copper salts in the milk diet.

The following are some practical methods that are in use for the prevention and cure of milk anemia in young pigs: (1) Placing soil or sod in pens; (2) painting a solution of iron and copper on the sow’s udder daily; (3) a weekly dose of 180 milligrams of iron and 25 milligrams of copper; (4) the incorporation of a mineral mixture in a pig creep to be used from the time the pigs are 8 days old.

**FEEDING PUPPIES**

Except in breeds such as the Alsatian, in which lactation is said to cease about 4 weeks after parturition, the pups of normal healthy
bitches are usually suckled for 6 weeks, sometimes for 8. In order that the transition to other foods may be gradual, supplementary feeding should be started while the puppies are still receiving milk from their dams. When puppies are to be weaned entirely at 6 weeks, it is well to begin feeding some solid food at 3 to 4 weeks after birth. It is recommended that at this time the pups be offered daily small amounts of chopped or ground lean meat and some dry bread, dry cereal, or puppy biscuit which has been moistened with milk or broth (fig. 6).

Spaulding (1092) recommends feeding one-half teaspoonful of raw scraped beef once a day for 2 or 3 days beginning at 3 or 4 weeks of age. This amount is then fed twice a day and the number of feedings increased at 3-day intervals to three and then to four times a day. When meat is fed four times a day an equal quantity of dry cereal or puppy meal should be added to it. A drink of cow’s milk or a milk substitute may be given twice a day throughout the remainder of the suckling period. When the puppy has been taught to eat such foods before weaning, unfavorable effects on rate of growth after separation from the dam will probably not be noticeable.

The artificial existence imposed on pets may result in a lack of exercise and probable deficiencies in nutrition, in some instances with impairment of reproductive functions to the extent that the bitch produces either an insufficient supply of milk or even unsuitable milk. In such cases as well as in those in which puppies are orphaned at birth, it is necessary to feed some substitute for the dam’s milk. The usual experience has indicated that unless the animals receive colostrum from the dam, the success of any hand-feeding procedure is doubtful. Whether this is due to the incompatibility of the substituted milk that has been used or to a need for the immunizing bodies present in the colostrum is undetermined.

Figure 6.—Puppies should be started on solid feed before they are weaned to prevent unfavorable effects on rate of growth after weaning.
Fresh cow's milk is not satisfactory for feeding very young puppies, partly at least because the concentration of protein, fat, and minerals in cow's milk is so much lower and the sugar so much higher than it is in bitch's milk. Canned condensed milk has sometimes been used with success after the puppies are 3 to 4 days old. Whole dried milk may also be used by combining 20 parts by weight of milk with 80 parts of water. Another mixture sometimes recommended consists of whole cow's milk, either fresh or reconstructed from dried milk, to which has been added half its volume of raw egg yolk. Still another mixture, suggested by Spaulding (1092), is made by combining 2½ teaspoonfuls of cream and 2½ teaspoonfuls of casein with 4 ounces of milk. The same author recommends that puppies receiving a substitute milk be fed every 2 hours during the day and every 3 hours during the night for the first week. These intervals may be increased to 3 and 4 hours during the second week.

With artificially fed puppies, the supplementary feeding may be started in the third week.