

The Science of Providing Milk for Man

The Science of Providing MILK for MAN

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Preface

The dairy industry exists for one purpose—to provide, at a reasonable cost, milk and milk products that satisfy man's appetite and fulfill his nutritional needs. The authors firmly believe that milk and milk products are highly nutritious, appetizing, and economical. Moreover, through production of milk and milk products, optimal use is made of many of earth's renewable natural resources.

During 15 years of teaching the scientific aspects of providing milk for man, we have seen the need for a current, comprehensive dairy science textbook become increasingly more apparent. Many students and teaching colleagues have expressed this need.

This book is designed for students desiring a fundamental understanding of dairy animals, dairy products and their manufacture, and the scope of the dairy industry. Although the book is designed primarily for use as a text for college students enrolled in dairy and food science courses, it will be useful to others who desire background, principles, concepts, and facts pertaining to dairy science, and to the dairy foods aspects of food science. It will be useful as a reference for those who teach vocational agriculture and for those organizations and groups which provide services to the dairy industry. We believe progressive dairymen will also find the book of interest and value.

Many educational institutions throughout the United States present an introductory course in dairy science. Most of these courses pertain to both the production and processing of milk. Therefore, we have introduced and developed concepts in both of these areas of study. Chapter sequence is in keeping with our teaching experience; however, materials may be assigned as teachers desire.

To guide students in learning essential principles and facts concerning subjects presented, study questions have been included with each chapter. For the convenience of those seeking additional information pertaining to certain topics, selected references are given throughout the text and footnotes. An extensive glossary of terms is provided to enable readers better to understand concepts presented and terminology used.

Since the metric system is currently used in most scientific literature and since trends in the United States are toward converting to this more universal means of weights and measures, a temperature conversion table and convenient conversion data are presented in Appendixes A and B, respectively.

We are especially grateful to Joan Stauffer for her editorial assistance and for her accurate and expeditious typing of the manuscript. Her contributions greatly facilitated our task.

Thanks are due our students and colleagues who critically reviewed the manuscript, and to officers of breed associations, dairy foods processing plants, dairy equipment manufacturers, publishers of dairy farm periodicals, and others who kindly provided photographs and other materials.

John R. Campbell
Robert T. Marshall

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Nutritional Contributions of Milk to Man

Thou shalt have milk for thy food, for the food of thy household, and for the food of thy maidens.

King Solomon

The cow is the foster mother of the human race. From the day of the ancient Hindoo to this time have the thoughts of men turned to this kindly and beneficent creature as one of the chief sustaining forces of human life.

W. D. Hoard

1.1 INTRODUCTION

Man has evolved in close contact with Nature, and the first food Nature provided for man was milk. Throughout most of the history of man, the sole source of milk was from women's mammary glands. It is no wonder, then, that for many centuries, man perceived the newborn baby's soul as being hurled from the heavens via the Milky Way, only to receive its first nourishment in the form of that celestial food we know as milk.

In early times, when Nature failed to bless the newborn child with a lactating mother, the baby either suckled another woman or died. Then, as man domesticated animals, milk from other mammals became available to provide essential nutrients. Various species of mammals have been used for dairy purposes throughout the world. However, in the United States the cow provides essentially all the **fluid milk**.¹ Except when noted otherwise, then, references to milk throughout the book will be to that of cows.

1.2 THE COMPOSITION OF MILK

Every person, young and old, should drink milk. Milk contains a large variety of nutritional constituents and, considering its cost per pound, more food for the money than any other food material available.—*Charles H. Mayo, M.D.*

Although milk is a liquid and often considered a drink, it contains an average of 13 percent solids—an amount comparable to the solids content of many other foods—and more appropriately should be regarded as a food. (The foods lettuce and tomatoes, for example, have a solids content of only 5 and 6 percent, respectively.) The solids of milk contain protein, carbohydrate, fat, minerals, and vitamins. Altogether, approximately 250 chemical components have been identified in milk (about 140 individual fatty acids have been identified). These constituents vary in amount in different forms of milk in accordance with the procedure used in their preparation. Their physical and chemical properties are discussed in Chapter 19.

An interesting phenomenon found in Nature is the relationship between the composition of milks among various mammalian species and the growth rates of the respective species. Nature is, perhaps through evolution, conservative and designed the milk of a given species specifically for growth and development of the offspring of that particular species. This extraordinary wisdom and conservation of energy by Nature are demonstrated by and can be appreciated through a study of the data presented in Table 1.1. Note the relatively low percentages of protein and ash in a

Table 1.1 Milk Composition and Growth Rates of Selected Mammals

Mammal	Milk Composition, in %					Total Solids	Time, in days, for the newborn to double its weight
	Protein	Lactose	Milk Fat	Ash			
Woman	1.6	7.0	3.7	0.2	12.5	180	
Mare	2.2	5.9	1.3	0.4	9.8	60	
Cow	3.3	5.0	4.0	0.7	13.0	47	
Goat	3.7	4.2	4.1	0.8	12.8	19	
Sow	4.9	5.3	5.3	0.9	16.4	18	
Dog	7.1	3.7	8.3	1.3	20.4	8	

Source: J. R. Campbell and J. F. Lasley, *The Science of Animals That Serve Mankind*, McGraw-Hill, New York, 1969, pp. 38, 288.

¹Words set in boldface type are defined in the Glossary at the back of this book.

woman's milk compared with milks of the cow and dog. It requires about 180 days for the newborn infant to double its birth weight, but only 47 and 8 days for the calf and puppy, respectively. Note the parallel, then, between growth rate and concentrations in milk of protein and ash, the nutrients needed to develop muscle and skeleton.

1.3 NUTRITIONAL MERITS OF MILK

The people who have achieved, who have become large, strong, vigorous people, who have reduced their infant mortality, who have the best trades in the world, who have an appreciation of art, literature, and music, who are progressive in science and in every activity of the human intellect, are the people who have used liberal amounts of milk and its products.—*E. V. McCollum*

I have never had an outstanding successful athlete who was not a hard milk drinker.—*Vince Lombardi*

Milk is especially good for them which be oppressed with melancholy, a common calamity of students.—*Thomas Cogan (1584)*

Although he must learn to ingest other foods, man, in common with other mammals, is born a milk drinker. Milk has evolved through the corridors of time specifically for the nutrition and well-being of mammalian infants—to bridge the gap between the dependent intrauterine and the independent adult life. It is interesting that the milks of all species contain the same nutrients, differing only in proportions. Finding milk good, man domesticated certain mammals which provide milk for his use throughout life.

The nutritional merits of milk are indicated by the fact that daily consumption of a quart of cows' milk furnishes an average man approximately all the fat, calcium, phosphorus, and riboflavin; one-half the protein; one-third of the vitamin A, ascorbic acid, and thiamine; one-fourth the calories; and, with the exception of iron, copper, manganese, and magnesium, all the minerals needed daily. (See Table 1.2.) Considerable amounts of nicotinic acid and choline are also provided.

1.4 MILK AS THE MOST NEARLY COMPLETE FOOD

Milk consumption is the keystone of American nutrition.—*S. Brody*

Hippocrates recorded his principles of medical science some 400 years before the birth of Christ and is generally recognized as the father of medicine. His nutritional wisdom and his observation related to the nutritional contributions of milk to man were conveyed to us in his early recorded statement that "milk is the most nearly perfect food."

Now, to better appreciate the nutritional contributions of milk to man, let us consider the merits of each major component, or grouping of nutrients, of milk, beginning with protein and following with lactose, fat, minerals, and vitamins.