FLUID MILK SUBSTITUTES - CURRENT STATUS AND EXPECTED TRENDS

by

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Introduction

In any discussion on the challenge of synthetic and substitute foods, it is only natural that the question of fluid milk substitutes receive wide discussion. Because of the importance of milk in the diets of many people, particularly in the developed areas of the world, and the general wide acceptance that milk holds in the consumers' minds, it has been one of the products that has been subjected to wide speculation with respect to the impact of synthetic or imitation forms. For example, in the United States fluid milk consumption is over 300 pounds per capita. Any food product sold in this volume presents an attractive market that many firms would like to enter and obviously some firms believe the synthetic or imitation forms might be a method to break into this market. In essence, even a small percentage of a large market could generate a large scale business for in the U.S. 10% of the fluid milk market would represent about 6 billion pounds of product.

Unfortunately even a brief analysis of the situation with respect to fluid milk substitutes is greatly complicated by the wide variations in fluid milk consumption patterns in different areas of the world, and also by the factors which influence milk consumption in each country. Generally speaking, in the developed areas of the world when we talk about a fluid milk substitute, we are talking about a substitute for an existing product which is consumed in fairly large quantities. But in the developing countries of the world we are talking about a substitute for something that really isn't available to the bulk of the population. In these countries fresh fluid milk is generally priced well beyond the means of most of the population. Therefore, the concept of a synthetic or substitute in the developing areas of the world is generally viewed as one which will bring the advantages of milk consumption to the disadvantaged segments of the population. In this light we are really discussing a protein nutrition intervention program, whereas in the developed countries we are discussing a commercial profit and loss situation. Another factor which greatly complicates an analysis of this situation is the wide range in regulatory activities associated with milk in many countries of the world. In the United States and in many other countries milk is one of the most highly regulated food products. This regulation ranges from production

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subsidies, price supports, marketing orders, retail price maintenance, and quality control, to many other activities. In the United States laws were passed in the past to protect fluid milk from adulteration and other suspected deleterious marketing practices, and these laws, still on the books, have hindered the introduction of a substitute or snythetic milk product.

It is best at this stage to state the definitions that the author is using. Synthetic or imitation milk, in this paper, means a product produced to closely resemble fluid milk in terms of product form and usage patterns, and made from non-dairy protein and fat ingredients. In this case, in the U.S. we include sodium caseinate as a non-dairy protein ingredient because this is the way it is currently defined. In addition, in the United States a great deal of discussion has centered around the question of filled milks which are quite familiar in many other areas of the world. A filled milk is defined here as a product which uses a milk based protein ingredient, generally nonfat dry milk or skimmed milk, with a non-animal fat. In other words, a vegetable fat is substituted for the butterfat to produce a filled milk product.

Synthetic or Imitation Milk - The Current U.S. Situation

In the United States today one can safely say that there are no synthetic milk products currently being marketed in other than very insignificant quantities for special dietary purposes. Here and there a product may be in test marketing, or an unacceptable product may have been slow to leave the market, but it is generally recognized that there is not currently available in the United States any imitation milk product which has won any type of market acceptance. In the past several years several products have been tested in the United States marketplace and all these attempts have failed. Two major reasons can be cited for the failure of imitation milks in the United States. First is the question of nutritional quality. The one formula which was most widely tested used sodium caseinate as the protein form, and the resulting protein content of the product was less than 1%. In addition, the flavor or taste was unacceptable to a majority of American consumers. The combination of very poor nutritional quality and poor flavor or taste acceptance doomed this product to failure. Attempts were made to market this product in a number of markets in the United States, but they have all failed.

Currently most of the discussion with respect to imitation milk in the United States is centered around a U.S. government proposed standard of identity for imitation milk. In the United States standard of identities are used by the Food and Drug Administration to control the formula for relatively standardized food items. The proposed standard of identity for imitation milk is a new venture in that it proposes very specific standards for nutritional quality. As far as I know this is the first attempt by our government to propose a standard of nutritional quality for a product and even more important for a product which in essence is not even being marketed. This attempt by the Food and Drug Administration to adopt this standard reflects the deep seated concern in the United States that an imitation milk of poor nutritional quality could have a substantial impact on the nutritional status of many Americans. The standard of quality that has been proposed (an abbreviated version is included as an Appendix) is intended to insure that the nutritional quality of an imitation milk is directly related to the nutritional quality of whole milk. A total of 15 specific nutrients with minimum quantities are listed in the proposed standard ranging from calcium and phosphorus, to vitamins A, D, thiamine,

riboflavin, and even folic acid, B_6 and B_{12}. Generally speaking these are set at the levels found in whole milk or the levels found in a normally fortified whole milk product. This proposed standard of identity has been the subject of quite a bit of controversy as you might expect. Generally groups representing milk producers have taken a strong position against the issuance of this standard. Their opposition is based on two facts. One, they feel that usage of the phrase "imitation milk" should not be allowed in any manner. They feel that a product labeled as imitation milk, regardless of its nutritional quality, will imply to the consumers that this is a suitable substitute for regular milk. They must feel it will be much harder to sell a synthetic milk if the phrase imitation milk or synthetic milk cannot be used. In other words, they feel that the phrase "imitation milk" will be quite helpful in the marketing of a synthetic product. Also, the groups representing the dairy producers are adamant in their opposition to the standard of identity because they feel that a product cannot be made that would be the true nutritional equivalent of whole milk. On the basis that there are nutrients in whole milk in small quantities that are not required in the standard of identity, such as copper, bromine, fluorine and other trace minerals, they are correct in this position. They feel that milk may even contain unidentified growth factors and that therefore whole milk itself cannot be duplicated. Nutritionists maintain on the other hand that based on growth tests with both animals and human subjects this position is not valid. The Food and Drug Administration favors the adoption of this standard of nutritional quality on the grounds that milk is so important in its contribution to the nutrition of many vulnerable groups, particularly children, that they wish to prevent the marketing of nutritionally inferior imitation milk. Our limited experience with these products in the United States indicated that in most cases the marketers did not make any effort to point out the poor nutritional quality of their products and therefore many feel regulation is necessary. Many nutritionists and food scientists fall in between these two positions. They feel that we should not discourage new technology and that if a nutritionally adequate imitation milk can be produced, hopefully at a substantially lower cost, we should allow this to take place. They also feel though that proper safeguards should be taken.

Most of the controversy among the professional nutritionists and food scientists with respect to this standard of identity has centered around the provision for protein quality and quantity. The regulation states as follows:

> "On the basis of an 8 fluid ounce serving imitation milks shall contain nutrients as follows;
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> (1) Protein; the total protein of imitation milks (including supplemental amino acids when present) has a biological quality not less than 70% of that of casein. The amount and biological quality of protein present are such that the quality of protein expressed as a fraction of that of casein multiplied by the amount of protein in grams shall not be less than 8."

If this phrase confuses you, do not be distressed for it has confused many people. Obviously what the designers of this have attempted to do is to allow for additional quantities of protein to make up to a certain extent for a low biological quality. For example, if casein was used as the protein ingredient and 8 grams were present in 8 fluid ounces, it would have a biological quality relative to casein of 100, so 1 times 8 would equal the number 8 in the regulation. If a protein ingredient was used which met the minimum level of 70%

of the biological quality of casein, then it would be necessary to have approximately 11.5 grams of the protein in the 8 fluid ounce serving. In this case the quality of protein expressed as a fraction of casein would be .7 and when multiplied by the amount of protein in grams, 11.5 would equal 8.05 which would match the proposed standard. Protein ingredients with a higher biological value relative to casein would, of course, reduce the amount of protein needed. Some of the objections to this proposal are centered around the fact that casein does not have as high a biological quality as whole milk protein. For example, using a standard PER test one might expect a rating of 3.00 for whole milk protein and 2.80 for casein. So in essence, the argument goes, casein is lower quality to begin with, therefore the standard is deficient at its start. Some experts are also reluctant to adopt the concept of additional protein to make up for low biological quality.

Regardless of whether this standard of identity is adopted or not, it soundly expresses the views of the Food and Drug Administration and many others that if an imitation or synthetic milk is to be marketed in the United States, the nutritional quality is going to have to be either very close to or superior to the nutritional quality of whole milk. The date for the filing of views, comments and objections to this proposed standard of identity has just passed, and based on previous experience it will probably be several months as a minimum before the Food and Drug Administration announces the decision with respect to this very important matter.

Filled Milks - The Current U.S. Situation

Although as mentioned previously filled milks have been marketed for many years in other areas of the world, the attempt to market a product of this nature in the United States has really been centered in the last several years. In general, the potential for a filled milk product in the United States is based upon price support activities which have priced butterfat at an artificially high level which encourages the substitution of lower cost vegetable fats. The products which have been marketed in the United States have been either reconstituted from nonfat dry milk or made directly from fluid skimmed milk available in the local market. To this skim milk base a vegetable oil, and in the past it has generally been coconut oil, has been added. The mere substitution of a vegetable oil for butterfat allows a substantial cost reduction.

The last data available indicated that in the 65 federal order markets which account for about 75% of the fluid milk market in the United States, that there were 18 markets where a filled milk product was being offered. The peak with respect to sales of filled milk products in the United States was reached in March 1969 when in these federal order markets it was reported that 5.8 million pounds of filled milk products were being sold. This may sound like a large quantity but in these same 65 federal order markets 3.3 billion pounds of Class I, milk for fluid purposes, was sold in the same period. This means that with respect to these markets, filled milk had obtained less than two-tenths of 1% of the total market. A large proportion of this filled milk has been sold in two markets. In the Arizona and Oklahoma markets these products have gained wider acceptance than in any other market. In the Central Arizona market the sales of filled milk products reached their peak in late 1968 at about 11% of the Class I sales. Since early 1969 the sales of the product in Central Arizona have dropped steadily. The reason for this is apparently a

vigorous advertising program sponsored by the American Dairy Association and the local milk producers in that market which stressed the true nutritional qualities of real milk and also cleared up some misunderstanding in consumers' minds with respect to the filled milk product. Our own research in the Arizona market in late 1968 indicated a substantial amount of confusion in the consumers' minds relative to the filled milk product.3/ Over two-thirds of the consumers indicated that they felt the filled milk product had fewer calories than whole milk. This was not the case since the fat level was approximately the same. Also we found that over half of the consumers of filled milk in the Arizona market felt this product would produce less cholesterol. This also was not true since all of these products were using coconut oil. This indicates something about the American market for fluid milk in that we are very conscious of calories and of the cholesterol question. When the advertising program stressed that these facts were not true the sales for filled milk have dropped rapidly. It should also be realized that filled milk is subject to a substantial amount of regulation in the United States. There is a federal Filled Milk Act which prohibits the movement in interstate commerce of a filled milk product. In spite of this a number of states, approximately 20, do allow the marketing of filled milk. The federal prohibition means that it has not been possible for anybody to market a product on a nationwide or even on a regional basis since a filled milk product would have to be produced in the state where it is sold.

A recent regulatory ruling will probably also have a substantial impact on the marketing of a filled milk product in the United States. It was recently ruled that a manufacturer of filled milk, in a federal order market, using either nonfat dry milk or fluid skim would have to price these products at the Class I level. This means the ingredients would be priced equivalent to fluid skimmed milk being sold in fluid form. In the Northeast for example a manufacturer who buys nonfat dry milk for a midwestern plant and reconstitutes it would have to pay to the market order an additional amount to bring the price of the mixture up to the equivalent of the price being paid for fluid skimmed milk for human consumption in that market. This will remove much of the price advantage that filled milks have held prior to this time. This new pricing regulation would indicate that filled milk products can be sold for about 3 to 4¢ a quart less than whole milk in these federal order markets. This amounts to a price advantage of about 10%. In those markets not covered by federal marketing orders, the situation is confusing because of various state orders such as in California.

The use of coconut oil was detrimental to the long run attempts to market a filled milk product in the United States. Nutritionists and others who have been pushing for a reduction in the amount of saturated fat in our diet looked upon coconut oil as a fraud. Although highly saturated it was implied that it had the advantages of other vegetable oils, i.e., a low degree of saturation. In most markets producers of filled milk are now gradually shifting to special mixtures of polyunsaturated oils to get away from the stigma attached to coconut oil. Unfortunately these new mixtures often do not have the flavor and stability characteristics of the coconut oil. We have been very interested in the marketing of filled milk in the United States because we feel it may be a good indicator of the possible future acceptance of a true imitation milk.

3/ Call, D. L. and Wilkerson, L. J., "Consumer Acceptance of Fluid Milk Substitutes in Three U.S. Markets," (monograph) Milk Industry Foundation, Washington, D. C., 1969.

In some states, California for example, filled milk products have to be labeled as an imitation milk, and we found most consumers really didn't know what it was made of and didn't really seem to care.

Factors Influencing the Future Development of Imitation Milk in the United States

At this stage it appears there are a number of factors which will clearly influence the possible marketing and acceptance of an imitation milk product in the United States. Heading the list has to be the development of new technology with respect to protein ingredients. For an imitation milk to be acceptable to the United States regulatory agencies it is clearly going to have to have a protein of a relatively high nutritional quality. Such a protein ingredient is not currently available in the United States. This protein ingredient will have to have a quality approximating casein but even more importantly will have to have functional characteristics such as solubility or dispersability which will allow its use in a beverage type product. A bland or neutral flavor is going to be a necessity, and either an imitation milk flavor will have to be duplicated or small amounts of nonfat dry milk or other dairy based ingredients will have to be used in combination with this new ingredient. In addition to this list of characteristics, it would appear that the product will have to cost substantially less than nonfat dry milk. It would appear to me that there are two possibilities with respect to the production of this type of ingredient. One would be a continuation of the research on vegetable protein isolates that would produce a product with the desired functional characteristics and then when supplemented with selective amino acids would have sufficient nutritional quality. Currently most of the research is centered on soy protein derivatives, but flavor is a major obstacle. The other route seems to me to be the possible development of a fish protein concentrate which would certainly have the high nutritional quality. Substantial further research is necessary to develop a FPC with the desired functional characteristics. The alcohol extraction processes which have been researched in the United States by the Bureau of Commercial Fisheries produce a product with the desired nutritional quality but it is completely lacking with respect to functional characteristics. Research is going on on other types of extraction techniques, including biological, which hold some promise of ultimately producing a high quality protein ingredient with the desired functional characteristics from fish. For a protein ingredient such as the one described to successfully compete in the American market is going to have to be priced substantially below nonfat dry milk on a protein basis. The reason for this is that an imitation or synthetic milk in the United States is going to have to have a substantial cost advantage to begin with, and it is going to need a wide margin so that extensive promotion activities can be implemented. The total cost of the product to the consumer, including the cost of advertising and promotion, might need to be at least 10 to 15% below the cost of whole milk before widespread consumer acceptance can be anticipated if price alone is the main appeal. The other alternative is to develop a product which has a number of desirable characteristics that whole milk does not have. For example, the polyunsaturated fat may be one of these characteristics as could longer shelf life. With this approach a price discount might not be necessary. Currently in the U.S. in some markets low fat milks are being sold at a higher price than whole milk because the consumer prefers this type of product. The point to be made is that price discounts are not essential.

Another major area that will influence the possible acceptance of imitation milks is what I would refer to as technology with respect to the marketing of these products. In the United States, in the past, imitation and filled milk products have gone through the traditional marketing channels, that is in fluid form through either the retail store, about three-quarters of the sales, or through home delivery, about one-quarter. Unfortunately these traditional marketing channels in the United States are high cost channels and place a new product at a disadvantage. Technology which would allow the production of a product that would bypass these traditional channels and in essence would be cost reducing could be very advantageous. For example, a product was test marketed briefly in the United States which was a frozen concentrated filled milk product, concentrated on a 3 to 1 basis. Unfortunately the flavor of the product was poor and so we didn't really get a good test on this concept. But this type of a product would have bypassed the traditional marketing channels for fluid milk and entered the channels for frozen foods in the retail sector. Possibly a dehydrated or a freeze dried product with instant rehydration has potential, for it would also bypass these traditional marketing channels. In the American market a great deal of stress is put upon convenience and currently fluid milk is not a convenient product with respect to the consumer. Home delivery is too expensive for the bulk of the population and carting home gallons and gallons of fluid milk from the supermarket is not viewed as a convenient process by most American consumers. In many cases an imitation product has more flexibility with respect to product form and marketing channels than real milk products which are hampered by many regulations.

The third general area which can have a major impact on the acceptance of these products in the United States revolves around the strategy of the traditional dairy industry groups. One can simplify this and say that a decision will have to be made by the traditional marketers of fluid milk as to whether to fight the movement toward an imitation or synthetic product or to join it. Generally speaking you can assume that the dairy cooperatives which control a large amount of the milk production but a relatively small amount of the milk retailing in the United States, will fight strenuously against any move toward an imitation milk. In most cases it appears the traditional dairy companies have not attempted to exploit the possibilities of an imitation milk product, but one is never sure what is going on in their laboratories, and it can be assumed that many of these large companies have done a great deal of research on these product forms for defensive purposes as a minimum. The large dairy companies have experimented with the marketing of filled milk products in the United States but none of them could be characterized as having taken a strong position on these products in the past. If a new bundle of technology is put together which would present a suitable product at a suitable cost that would bypass the traditional channels, then it could be assumed that a non-dairy oriented food company might enter the picture. This is the fear of many in the American dairy industry. For example, a frozen concentrated imitation milk could be marketed easily by large food companies which have traditionally not been involved in the dairy industry but have been involved in the marketing of frozen foods. Another question that bears attention is the strategy of the dairy industry itself. In the past, attempts to combat filled or imitation milk products in the United States have centered primarily in the legislatures both at the State and Federal level. The fight has centered on the law making bodies rather than in the marketplace. This attitude now seems to be changing. The dairy industry in the United States, particularly at the producer level, is putting a great deal more emphasis on new product development. The message

from the consumer that butter and whole milk were not her idea of perfect products is finally getting through. The important trend in the U.S. milk industry is the relatively rapid shift to low fat fluid milk products. In recent years the market for low fat fluid products has been growing at a compounded rate of 10 to 12% per year. This is in face of a gradual decline in the overall consumption of fluid milk products. This shift will be accentuated in the coming years by the widespread introduction of products with 1% or less fat fortified with additional milk solids and the further acceptance of products at the 2% fat level. Clearly in the United States more and more consumers prefer a low fat product to the traditional 3.5 to 3.7% butterfat product. This preference is based upon the desire to restrict calories in the diet, and also because of the growing fear of cholesterol and saturated fats in the diet.

With respect to the other areas of the world, the thing of prime interest to watch in the United States is what happens in the development of a protein ingredient suitable for a nutritionally acceptable imitation milk product. If such an ingredient is developed, obviously it would soon be available in other parts of the world. If it could be produced with indigenous materials in many countries it could have a wide impact on the acceptance of a fluid milk substitute in both the developed and the developing areas of the world.

APPENDIX

The Proposed Standard of Nutritional Quality for Imitation Milk

(This is an excerpt from the FDA proposed standard of identity for imitation milk as printed in the Federal Register of October 9, 1969; 34 F.R. 15657)

18.551 Imitation milks; quality; label statement of substandard quality.

The standard of quality for imitation milks is as follows:

(a) On the basis of an 8-fluid ounce serving, imitation milks shall contain nutrients as follows:

(1) Protein: The total protein of imitation milks (including supplemental amino acids when present) has a biological quality not less than 70 percent of that of casein. The amount and biological quality of protein present are such that the quality of protein expressed as a fraction of that of casein multiplied by the amount of protein in grams shall be not less than 8.0. The amount and biological quality of protein shall be determined by the methods specified in paragraph (c) of this section.

(2) Linoleic acid: When fat is present, not less than 5 percent by weight of the total fat shall be linoleic acid in the form of a glyceride.

(3) Calcium and phosphorus: Not less than 280 milligrams and 220 milligrams, respectively, with the ratio of approximately 5 parts calcium to 4 parts phosphorus being maintained.

(4) Sodium: Not less than 70 milligrams or more than 180 milligrams.

(5) Potassium: Not less than 200 milligrams or more than 340 milligrams.

(6) Magnesium: Not less than 30 milligrams.

(7) Vitamins A and D: 500 and 100 U.S.P. units, respectively. This requirement will be deemed to have been met if reasonable overages of the vitamins, within limits of good manufacturing practice, are present to insure that the required levels of the vitamins are maintained throughout the expected shelf life of the food under customary conditions of distribution.

(8) Thiamine: Not less than 0.1 milligram.

(9) Riboflavin: Not less than 0.4 milligram.

(10) Niacin equivalent: Not less than 1.8 milligrams (60 milligrams of tryptophan equals 1 milligram of niacin).

(11) Pantothenic acid: Not less than 0.8 milligram.

(12) Folic acid: Not less than 10 micrograms or more than 25 micrograms.

(13) Vitamin B_6: Not less than 0.1 milligram.

(14) Vitamin B_{12}: Not less than 1 microgram.

(15) Carbohydrate: Not less than 12 grams.

(b) On the basis of an 8-fluid ounce serving, imitation milks may contain optional nutrients as follows:

(1) Iron: If iron is added, the finished food should contain not less than 2 milligrams of iron.

(2) Ascorbic acid: If ascorbic acid is added, the finished food should contain not less than 10 milligrams of ascorbic acid.

(3) Vitamin E: If vitamin E is added, the finished food should contain not less than 1.2 International Units of vitamin E.

(c) (1) The method for determining biological quality of protein referred to in paragraph (a) (1) of this section is prescribed on pages 785-786 (39.133-39.137), under "Biological Evaluation of Protein Quality-Official, Final Action" of "Official Methods of Analysis of the Association of Official Agricultural Chemists," 10th Edition, 1965.

(2) The method for determining the amount of protein referred to in paragraph (a) (1) of this section is to multiply by 6.25 the total nitrogen content in grams, as determined by the method prescribed on page 16 (2.044) under "Improved Kjeldahl Method for Nitrate-Free Samples-Official, Final Action" of "Official Methods of Analysis of the Association of Official Agricultural Chemists," 10th Edition, 1965.