Recent Trends in Weaning in the United States

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The many remarkable changes in attitude of mothers in the United States regarding the feeding of their infants have, during the past 50 years, provided fascinating examples of how rapidly folklore can be modified or abandoned in an affluent society. The decreasing interest in breast-feeding that occurred in the United States over a 30-year interval ending in the early 1970s was undoubtedly encouraged by a complex and ill-defined combination of economic and social factors. The enigmatic resurgence among mothers of interest in breast-feeding has occurred in less than half the time it took to abandon the practice. It resulted from a maternal reevaluation of the nurturing process and was achieved without significant guidance from the medical profession. Perhaps coincidentally, but more probably due to common roots, as attitudes toward breast-feeding were changing, so were practices involving use of weaning foods.

BEIKOST—WHEN TO FEED?

The term beikost is defined as any food other than milk or formula fed to infants. In the discussion that follows beikost and weaning foods are used synonymously, and, unless stated otherwise, the terms refer to commercially prepared products.

Loss of interest in breast-feeding seems to have been accompanied by an increasing preoccupation with early introduction of beikost. Prior to the 1920s, when most infants in the United States were breast-fed, beikost was seldom offered before 1 year of age (1). Over the next four decades there was a gradual reduction in the age at which introduction of beikost was recommended—4 to 6 months in the 1930s (2) and 2½ to 3 months in the 1950s (1). Advice by Sackett (3) during the 1960s that cereal “thick as putty” be fed at 2 to 3 days of age represented the extreme in early introduction of beikost. The most recent position of the American Academy of Pediatrics (4) is that no nutritional advantage results from the introduction of beikost prior to 4 to 6 months of age. Fomon et al. (5) are of the opinion that weaning foods should not be introduced until 5 to 6 months of age.

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During the early 1970s it was common for infants, particularly those among low-income groups, to be fed beikost in the first month of life (6,7). A series of infant nutrition studies conducted between 1974 and 1983 by one manufacturer of beikost documents a gradual and continuing decrease in the percentage of total calorie intake from beikost of 2- to 3-month-old infants (8).

Extremely early introduction of weaning foods in the United States has been a poorly understood cultural phenomenon. It may partly have been encouraged by manufacturers of beikost in the promotion of their products, but it seems also to have been perceived by mothers as helpful in getting their infants to sleep through the night as well as demonstrating, in a competitive manner, their infant’s precocity. Although harmful effects of introducing weaning foods during the first month of life have not been proven, it must be considered a form of force-feeding since at this age it is necessary to support the infant’s head while repeatedly spooning food into the mouth in an attempt to counteract the extrusion reflex that is active during the first several months of life.

Two aspects concerning early introduction of beikost merit consideration. First, as pointed out in 1980 by the Committee on Nutrition of the American Academy of Pediatrics (4), during the first 4 to 6 months of life the infant’s intestinal tract may not have yet developed the defense mechanism for coping with foreign proteins. Because it is not known whether in certain infants feeding of foods other than human milk during this period might result in subsequent adverse reaction to those foods, it would appear prudent to consider the suggestion by Walker (9) that human milk should provide the sole source of nourishment during these first critical months of life.

The second consideration is that the developmental immaturity of the infant during the nursing period precludes accurate assessment of when overfeeding might occur as a result of feeding beikost. It has been suggested that overfeeding during infancy might have permanent sequelae, such as obesity in childhood and adulthood (10). Although this is far from proven, in the absence of demonstrated benefit associated with early introduction of beikost, avoidance of even the possibility of later obesity due to overfeeding would seem to be a wise course of action.

Recent guidelines for the appropriate age at which to begin feeding of weaning foods take into account the infant’s developmental readiness. An infant who is able to sit with support and has neuromuscular control of head and neck is clearly able to communicate hunger or satiety more freely than a younger infant who must be held. It is this stage of development that is thought to be important in determining the appropriate age to introduce beikost into the infant diet (4,5,11).

The physiologic maturity criteria for introduction of beikost apply to the breast-fed infant receiving an ample milk intake and to the bottle-fed infant. These criteria, however, may be of secondary importance in the management of a younger breast-fed infant who, because of inadequate milk intake, may require supplemental feedings. In this situation beikost may be preferred over formula, despite lack of developmental readiness for weaning foods.
CHANGES IN COMPOSITION OF BEIKOST

From the time commercial prepared weaning foods became available in the late 1930s until the mid-1960s, relatively little attention was paid by pediatricians or purchasers of these foods to the ingredients used in formulation. The number of products available for purchase gradually increased, until in 1970, over 400 strained and junior foods were being offered by the three major American manufacturers. During the mid-1960s the formulation of certain varieties of beikost was being questioned by a few individuals interested in pediatric nutrition. Consumer advocates became more active in attempting to translate speculation among scientists or the published results of laboratory studies into public argument about quality and safety of the food supply. Specific concerns about formulation of beikost centered around the safety of salt, sugar, modified food starch, monosodium glutamate (MSG), and nitrate/nitrite as ingredients and the bioavailability of iron added to cereals. In 1970 the Food and Drug Administration asked the National Academy of Science (NAS) to evaluate the safety and suitability of MSG and other substances in baby foods. The resulting recommendations of the NAS for salt, MSG, and modified food starches will be discussed.

Salt

Dahl et al. (12) were among the first to call attention to the amount of sodium being added to beikost by manufacturers in the United States. These authors had shown that hypertension produced by feeding beikost in a salt-sensitive strain of young rats was self-sustaining after withdrawal of salt from the diet. In view of no demonstrated benefit associated with consumption of an infant diet high in sodium content and the possibility of a relationship between high salt intake and development of hypertension in susceptible infants, others (13–15) also questioned the wisdom of adding excessive amounts of salt to beikost. The recommendation was made by the NAS that manufacturers should add no more than 0.25% salt to any beikost product (16). Industry compliance with this recommendation was immediate and, as shown in Table 1, resulted in an approximate 50% reduction in salt content. One manufacturer of beikost decided in 1976 to remove all added salt from its products, and the other two manufacturers soon followed suit. The nutritional rationale for removal of all added salt from beikost is not clear. As indicated in Table 1, beikost without added salt contains approximately 90% less sodium than products produced in the mid-1960s. The NAS was of the opinion that the addition of some salt to certain categories of beikost was reasonable. Certainly, as infants are introduced to table foods, they will experience a significant increase in salt intake. It would seem that if a reasonable intake of sodium by infants was an objective in formulation of commercially prepared weaning foods these products would never have contained either the excessive amounts of sodium added in the
1950s and 1960s or the minimal amounts resulting from complete removal of all added salt in the mid-1970s.

MSG

In 1969 Olney (17) published a report that subcutaneous injections of MSG induced acute neuronal necrosis in the brains of newborn mice. MSG has been used for years as a flavor enhancer in beikost produced in the United States. Controversy regarding the safety of MSG in beikost followed publication of Olney’s article. By the end of 1969 American baby food manufacturers were no longer adding MSG to their products, a decision reinforced by the recommendation of the NAS that, even though the risk associated with using MSG in beikost was extremely small, MSG conferred no benefit to the infant and therefore should not be added to foods specifically designated for infants (18).

Modified Food Starch

Modified food starches (MFS) have found wide usage in the formulation of beikost because they provide a means of controlling viscosity and preventing retrogradation and impart what is considered to be a desirable “mouth feel” to these products. Because animal feeding studies revealed that in some instances rats fed MFS gained poorly and had enlarged ceca, and because digestability of MFS had not been studied in infants, concern was expressed about their use in beikost. The NAS concluded that there appeared to be no toxicologic basis for excluding MFS, as then used, from the diets of infants (19).

Because epichlorhydrin, the crosslinking agent used in the production of acetylated distarch glycerol, was found to be a potent carcinogen, the addition of this

<table>
<thead>
<tr>
<th>Variety</th>
<th>1966</th>
<th>1972*</th>
<th>1984</th>
<th>Changea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32 (2-46)</td>
<td>11 (1-30)</td>
<td>3 (2-6)</td>
<td>-90%</td>
</tr>
<tr>
<td>Vegetables</td>
<td>225 (179-321)</td>
<td>120 (101-170)</td>
<td>25 (1-89)</td>
<td>-89%</td>
</tr>
<tr>
<td>Vegetable-meat</td>
<td>279 (185-344)</td>
<td>139 (101-233)</td>
<td>22 (11-84)</td>
<td>-92%</td>
</tr>
<tr>
<td>combinations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ranges are given in parentheses.

aAdded salt limited to less than 0.25% by recommendation of National Academy of Sciences (16).

particular type of MFS to beikost was discontinued by manufacturers in the mid-1970s. By the late 1970s one manufacturer limited use of MFS to certain tapioca-containing fruits and to desserts containing added cornstarch. Use of MFS in products of the other two manufacturers has not been curtailed.

Nitrates and Nitrites

In 1967 Commoner, in a speech before the American Association for the Advancement of Science, expressed concern about the accumulation of nitrate by certain vegetables fertilized with nonorganic forms of nitrogen. He specifically questioned the safety of feeding nitrate-containing foods to infants. Although beets and spinach usually accumulate more nitrate than carrots (20), Keating et al. (21) reported a case of methemoglobinemia in an infant fed home-prepared carrot juice. Because young infants with diarrhea often harbor populations of coliform bacteria in the upper small intestine capable of reducing nitrate to nitrite (22), this is a good rationale for the exclusion of foods containing significant amounts of nitrate from the diets of young infants. Since the mid-1970s the labels on jars of strained beets and spinach have contained a statement advising use only after 12 weeks of age; however, it would seem more prudent to defer their use until the infant is more than 6 months old.

Sugar

Although there is some evidence that infants will consume more of a sweet than of a less-sweet formula (23,24), the conditioning of a subsequent preference by early feeding of sweet foods has not been proven. By the mid-1970s, partly in response to criticism regarding the amount of sugar added to beikost and partly to lower cost of production, manufacturers began to reduce the amount of sugar added to juices, fruits, and desserts. The same manufacturer who, in 1976, stopped adding salt to its products, at the same time discontinued the addition of sugar to juices and fruits. The other two major manufacturers soon made similar changes. Use of corn sweeteners has gradually replaced the use of sucrose in those products to which sucrose is still being added.

The effect of eliminating or reducing sugar on the caloric density of strained fruits, desserts, and juices is shown in Table 2. An infant fed a jar of strained fruit (128 g) as formulated in 1984 would receive an average of 41 fewer calories than if the jar (134 g) were formulated as in 1972. It is not clear if the young infant is able to adjust energy intake to compensate for this difference in caloric density.

Iron

For many years in the United States, supplemental iron has been added to infant dry cereals and to jarred cereals with fruit. Sodium iron pyrophosphate, the iron compound at one time used almost exclusively for this purpose, is a nonreactive
TABLE 2. Effect of change in sugar content (kcal/100 g) on caloric density of beikost in the United States

<table>
<thead>
<tr>
<th>Variety</th>
<th>1972</th>
<th>1984</th>
<th>Change*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desserts</td>
<td>90</td>
<td>75</td>
<td>-17%</td>
</tr>
<tr>
<td>Fruits</td>
<td>82</td>
<td>54</td>
<td>-34%</td>
</tr>
<tr>
<td>Juices</td>
<td>59</td>
<td>48</td>
<td>-19%</td>
</tr>
</tbody>
</table>


form of iron preferred by food technologists because its incorporation into food presents few technical problems. Because animal feeding studies demonstrated sodium iron pyrophosphate to be of very low bioavailability, by the mid-1970s manufacturers began to use electrolytic iron powder as the iron supplement in dry cereals and ferrous sulfate as the form of iron added to jarred cereals with fruit. Although one might anticipate an improvement in iron nutritional status of infants in response to the improved bioavailability of iron in these cereal products, the effect of the change in source of iron on iron nutritional status of infants consuming these products has not been carefully evaluated.

One manufacturer has recently added ferrous sulfate to fruit juices intended for consumption by older infants. The ascorbic acid content and low pH of fruit juice should enhance the bioavailability of iron.

CHANGING ATTITUDES TOWARD USE OF BEIKOST

During the time that formula-feeding of American infants was high in popularity, an unquestioned belief seemed to be prevalent that early introduction of beikost was necessary for the nutritional and psychological well-being of infants. As interest in breast-feeding began to recur in the early 1970s—the same period during which many changes in formulation of beikost were occurring—women gradually became more interested in home preparation of beikost. In 1984, the average infant in the United States consumed approximately 40% less commercially prepared beikost than an infant born in 1970. This decrease in consumption of beikost has resulted from the combined influences of later introduction of beikost, avoidance of any commercially prepared weaning foods by some mothers, and earlier introduction of table foods.

Comparison of sales of the various product categories of beikost in the United States between 1971 and 1984 reveals decreased usage of fruits, soups, dinners, and high-meat dinners and a significant increase in percentage of sales of both types of cereals, juices, vegetables, and meats (Table 3).

Cereals may currently account for a greater percentage of sales because pediatricians have stated that they provide a needed source of iron in the infant diet. The
TABLE 3. Sales of strained and junior beikost by product category in the United States

<table>
<thead>
<tr>
<th>Variety</th>
<th>Percentage of sales</th>
<th>Percent Change^c</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1971^a</td>
<td>1984^b</td>
</tr>
<tr>
<td>Cereals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry</td>
<td>2.9</td>
<td>5.4</td>
</tr>
<tr>
<td>Wet pack</td>
<td>3.1</td>
<td>4.7</td>
</tr>
<tr>
<td>Juices</td>
<td>9.7</td>
<td>16.7</td>
</tr>
<tr>
<td>Fruits</td>
<td>18.9</td>
<td>15.6</td>
</tr>
<tr>
<td>Vegetables</td>
<td>8.3</td>
<td>13.6</td>
</tr>
<tr>
<td>Meats</td>
<td>9.7</td>
<td>13.2</td>
</tr>
<tr>
<td>High-meat dinners</td>
<td>4.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Soups, dinners</td>
<td>23.3</td>
<td>16.0</td>
</tr>
<tr>
<td>Desserts</td>
<td>17.1</td>
<td>10.1</td>
</tr>
<tr>
<td>Other</td>
<td>2.6</td>
<td>3.1</td>
</tr>
</tbody>
</table>

^aAdapted from ref. 25.
^bAdapted from ref. 26.

infant nutrition study (8) documents a substantial increase between 1979 and 1983 in the amount of iron consumed by infants, due in part to increased consumption of iron-fortified cereals. The increased percentage of sales accounted for by juices is undoubtedly related to convenience resulting from introduction in 1977 of a screw-capped jar capable of accepting a nipple assembly. Aggressive pricing and the packaging of juices in six-packs have also stimulated sales. The American Academy of Pediatrics and the American Academy of Pedodontics have issued a joint recommendation (27) that the feeding of juice from a bottle should be discouraged, thus avoiding the potential for habitual and prolonged bottle-feeding of cariogenic fluids to infants over 12 months of age. A severe form of dental decay known as "nursing bottle caries" is thought to be caused by this practice.

The reasons for changes in sales of other varieties of beikost are less well defined. Removal of added sugar and salt may have reduced the palatability of certain products, whereas the feeding of vegetables together with meat might be perceived as a more palatable and nutritious combination than that provided by ready-prepared soups and dinners and high-meat dinners. Reduced purchases of desserts may be related to concern about sugar intake.

NUTRITIONAL RATIONALE FOR CHOICES OF WEANING FOODS

During the first months of life, when human milk or formula provides total nourishment, most nutrients are provided in adequate amounts whenever the intake of calories is adequate. Supplemental vitamin D and iron may be appropriate for the totally breast-fed infant (5). If one accepts the distribution of calories in human
milk as optimal for meeting the nutritional requirements of infants, the offering of feedings that result in prolonged intake of a total diet markedly at variance with the optimum must be open to question.

For example, during the 1970s, it was common practice for infants in the United States to be fed skim or lowfat (2% fat) milk after the feeding of formula was discontinued at 3 to 4 months of age. As shown in Table 4, percentages of calories provided by protein are 4 to 7 times greater, and percentages of calories provided by fat 45 to 95% less, in these forms of cow’s milk than found in human milk. Fomon et al. (5) have pointed out several undesirable aspects of feeding reduced-fat milk to infants during the first year of life under circumstances likely to be encountered in the United States.

The wide range in nutrient composition of the various product categories of beikost shown in Table 4 provides many choices for complementing the nutrient composition of the milk or formula fed concurrently. For example, beikost given to a breast-fed infant should be of a higher protein content than that fed to an infant consuming whole cow’s milk. It can be seen from Table 4 that there are few choices of beikost capable of compensating for the imbalance of protein and fat in skim milk.

The wide range in caloric density among the various product categories of commercially prepared beikost provides an opportunity for selection of beikost that, when substituted isogravically for milk or formula, may either increase or decrease total intake of calories.

### TABLE 4. Average caloric distribution of foods fed to infants in the United States

<table>
<thead>
<tr>
<th>Food</th>
<th>kcal/100 g</th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human milk</td>
<td>75</td>
<td>6</td>
<td>56</td>
<td>38</td>
</tr>
<tr>
<td>Prepared infant formulas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk-based</td>
<td>67</td>
<td>9</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>Soy-based</td>
<td>67</td>
<td>13</td>
<td>47</td>
<td>40</td>
</tr>
<tr>
<td>Cow’s milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole</td>
<td>65</td>
<td>22</td>
<td>48</td>
<td>30</td>
</tr>
<tr>
<td>2 percent</td>
<td>59</td>
<td>28</td>
<td>31</td>
<td>41</td>
</tr>
<tr>
<td>Skim</td>
<td>36</td>
<td>40</td>
<td>3</td>
<td>57</td>
</tr>
<tr>
<td>Beikost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egg yolks</td>
<td>199</td>
<td>21</td>
<td>78</td>
<td>1</td>
</tr>
<tr>
<td>Meats</td>
<td>110</td>
<td>52</td>
<td>46</td>
<td>2</td>
</tr>
<tr>
<td>High meat dinners</td>
<td>88</td>
<td>29</td>
<td>37</td>
<td>34</td>
</tr>
<tr>
<td>Desserts, puddings</td>
<td>75</td>
<td>4</td>
<td>7</td>
<td>89</td>
</tr>
<tr>
<td>Fruits</td>
<td>54</td>
<td>4</td>
<td>3</td>
<td>93</td>
</tr>
<tr>
<td>Fruit juices</td>
<td>48</td>
<td>3</td>
<td>4</td>
<td>93</td>
</tr>
<tr>
<td>Creamed vegetables</td>
<td>56</td>
<td>17</td>
<td>13</td>
<td>70</td>
</tr>
<tr>
<td>Soups, dinners</td>
<td>59</td>
<td>17</td>
<td>27</td>
<td>56</td>
</tr>
<tr>
<td>Plain vegetables</td>
<td>37</td>
<td>16</td>
<td>8</td>
<td>76</td>
</tr>
</tbody>
</table>
Thus, it can be seen that the relative contribution of beikost to total dietary caloric distribution and content depends on the type of feeding it is complementing. The appropriateness of a particular choice of weaning food can only be evaluated in the context of the total dietary intake.

USE OF WEANING FOODS IN DEVELOPING COUNTRIES: APPROPRIATENESS OF AMERICAN TECHNOLOGY

Weaning foods marketed in the United States have been formulated to meet consumer demand in an affluent society. Because these products are generally of low caloric density and are low in protein and fat content, they are not necessarily appropriate for feeding infants in most developing countries. In the United States, strained foods rarely provide more than half of total caloric intake, and usually are fed for a relatively short time interval during the first year of life to a population of infants consuming adequate protein. Thus, errors in choice of beikost to balance the nutritional composition of the total diet are of relatively little consequence. On the other hand, to an infant of marginal nutritional status, errors in choice may be of considerable consequence.

Waterlow et al. (28) are of the opinion that normal weight gain of an exclusively breast-fed infant can be maintained for 4 to 6 months only under the most favorable conditions. Under conditions of unfavorable maternal nutritional status, weight gain of the breast-fed infant may begin to fall off as early as 2 to 3 months of age because milk output does not keep pace with the infant’s increasing needs. The introduction of weaning foods at an earlier age than recommended in the United States may therefore often be indicated.

Because of poor sanitation in many underdeveloped societies, beikost is often the source of pathogens that cause weanling diarrhea. The challenge in developing countries is to minimize the risk of weanling diarrhea associated with introduction of weaning foods. Further, weaning foods for the most part should be protein- and energy-rich and should be fed in an amount and in a manner that is not detrimental to milk output and to maintenance of lactation (29).

FUTURE USE OF WEANING FOODS

United States

It is unlikely that changes in attitudes toward infant feeding in the United States during the next 20 years will occur as rapidly as those observed during the past 20 years. The positive attitude toward breast-feeding will undoubtedly continue. Use of weaning foods may reflect newer knowledge regarding the long-term sequelae associated with age of introduction and choices and amounts fed. More attention will be paid to selection of weaning foods that complement the composition of milk to achieve a desirable total diet.
The single most influential factor affecting all food use during the next several decades will be cost of energy. Cost of foods will more accurately reflect energy costs of production, processing, and distribution. Profitability associated with proliferation of closely related products will probably diminish and result in a reduction in the number of choices. Availability of certain foods may become more seasonal and regional, as transportation and storage costs increase.

As the concept of individual responsibility for health becomes more firmly established, the consequences of overnutrition will receive greater attention. The exercising of parental control in encouraging moderation in eating habits of children should be more widely practiced. Advertising and promotion of foods of doubtful nutritional value intended for use by children will hopefully be curtailed or altogether eliminated.

Developing Countries

The next 20 years may see more suspicion regarding the appropriateness of importing or emulating certain frivolous food technologies that have been introduced, then abandoned, by more affluent countries. The lag in adoption of the feeding practices popular in affluent societies by women in developing countries could be fortunate because it may provide an opportunity to avoid repeating errors and to reject those practices lacking a firm nutritional rationale. Because of the prevalence of iron deficiency, iron-fortified cereals are perhaps the one weaning food whose transfer from industrialized to developing countries should be encouraged without reservation. The extent to which manufacturers of beikost could be persuaded to fortify products with nutrients known to be of particular concern in a given country deserves exploration and study.

The cultural uniqueness of each developing country must be considered when offering alternatives for improving the safety and nutritional value of weaning foods. Guidance from the medical profession regarding appropriate formulation of weaning foods should be encouraged. Joint efforts of international agencies, private foundations, and governmental public health agencies within each developing country will be required to assist in the planning of self-help programs geared toward effective family planning and local improvement of those conditions most detrimental to satisfactory transition of the suckling infant through the hazardous weaning period to the relative safety of postweaning childhood.

More widespread recognition of the devastating effects of contaminated weaning foods must be achieved. Progress in assuring purity of communal water supplies is of utmost importance in reducing infection and subsequent malnutrition of children introduced to weaning foods. The importance of malnutrition as a detriment to achievement of intellectual potential must become more widely recognized. Only through progress in these areas can each developing country better protect its most important resource, its children.
REFERENCES

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DISCUSSION

**Dr. Guesry:** You state that the protein content of beikost should be adapted to the protein content of human milk or infant formula. However, in many developing countries, the beikost is low in protein, in which case don't you think the formula should be adapted accordingly—in other words, the infant formula should be higher in protein than in those found in industrialized countries.

**Dr. Anderson:** There may be a solid nutritional rationale for this. I have never considered it before, but indeed the converse could be true, that the milk or formula could complement what the normal nutritional composition of beikost in a specific area might be.

**Dr. Poskitt:** We need to ask ourselves what we really need for the child at weaning and I think the point repeatedly made by Professor Vis is very important: are we giving "complements" or "supplements"? To my mind, what the baby who is continuing to have breast milk or formula really needs is energy, vitamins and minerals. Proteins come further down the list even if the baby does not receive significant amounts of milk, because the protein requirements, per kilogram, of a 5- or 6-month-old child have dropped quite considerably since birth. I am therefore surprised that you put your protein range as high as 15%. I would have thought that the energy content of the weaning food is much more important, certainly if you are giving the baby reasonable amounts of milk, which at this stage I think should be formula or breast milk rather than cow's milk. What struck me is the low energy content of a lot of these prepared baby foods in jars. It is always said that home-prepared foods have a higher energy content. The energy content of jar foods is around 60 kcal/100 g; this is considerably less than, say, the steamed banana that the African child is brought up on, which is nearer 100 kcal/100 g. What one would like to have for children who tend to be underfed during this period, rather than overfed, is weaning foods that are varied in quality so that they have vitamins and minerals (which may be low in the breast milk) and which at the same time are fairly energy-dense. I agree that the situation in the United States may be a little different.

**Dr. Anderson:** It is true that home-prepared baby food is of higher caloric density than when commercially prepared. Fernando Viteri’s Committee of the National Academy of Sciences has suggested that beikost in developing countries should have at least 10% energy as protein, 20 to 30% energy as fat, and be low in fiber; they recommended 50 kcal/100 g, which seems a bit low because it is less than that of the milk which it would be supplementing or complementing. The other point, as to whether beikost is a complement or a supplement, really is a sliding scale: Initially a very small part of total energy intake comes from beikost but this gradually increases, until it reaches 50% later in the first year. So, the trick is to

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accomplish this so that one doesn't compromise the production of human milk too early by introducing too much beikost, thereby inhibiting milk production. But as you gradually change from an all-milk diet to a mixed diet, if this can be accomplished in an orderly fashion then you avoid a reduction of milk intake coming too early.

Dr. Poskitt: I was interested in what you said about juices. Widdowson recorded the dietary habits of a large number of children in the 1930s. She made the comment that the most obvious change in children's diets over the previous 100 years or so had been the change in the beverages they took; in the 18th and 19th centuries, children tended to be fed small beer, which was a sort of home-brewed beer, whereas by the 1930s they were drinking tea. She points out that the number of children then drinking juices was less than 10%, but certainly this has again changed and now virtually 100% of children less than 1 year old must be drinking some sort of juice. In Britain, juice is one of the first things that is introduced. This is good in that it provides vitamin C, except that there are firms that, in order to get away from food additives, which have a bad name, have started introducing infant drinks which contain no food additives but no vitamin C either. The public may be a bit misled by this. If the fruit juice drinking becomes too much of a habit, it can easily prevent the child taking an adequate diet. I see a number of children who are drinking large quantities but do not eat. This can lead to failure to thrive in 1- to 3-year-olds. In developing countries, juices and soft drinks are very often given as substitute for more solid food and can lead to much more serious failure to thrive and to marasmus.

Dr. Anderson: You certainly have to be a little bit wary of the reasons for the increase in juice intake that has taken place over a 5-year period in the United States. It is a strange cultural phenomenon.

Dr. Shanti Ghosh: In most of the developing countries and certainly in India, there is hardly any use of these precooked preparations, except in very elite urban circles, and very few are, of course, available. We are recommending more and more the home-based foods, which we advise the mothers to cook and which, on the whole, are just a modification of the family diet or family dish. The real problem, to which we do not know any easy solution so far, is the bulk of that diet. Even though various methods like grinding are advised, it will take a very long time to spread this knowledge to the ordinary middle-class or poor mothers. So, we advise mothers to feed more frequently, but still, ultimately the bulk of the diet is too much and in spite of good intentions the baby may not be getting adequate amounts of energy, vitamins, and minerals. I wonder if we could have some information from work which might have been done elsewhere?

Dr. Anderson: There are a number of ways in which fiber can be treated and in which some of the adverse effects of fiber intake can be minimized: reduction in particle size, for instance can physically change some of the actions of fiber; removal of phytate from certain fiber-containing cereals is desirable from the point of view of interference with trace mineral absorption. So, while this isn't practical in terms of home preparation for baby food, it is possible, through application of a certain food technology, to minimize some of the adverse effects of the fiber contained in this diet, through physical change and also chemical modification of fiber-containing foods.

Dr. Schmitz: Dr. Ghosh, what makes infant feeding in India so bulky? What is the constituent of this bulk?

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Dr. Shanti Ghosh: Well, as you know, a lot of diets on this continent are based on cereals, pulses, and vegetables. So, the base of the diet would be either made from wheat, rice, legumes, or millet. It could even be from coarser grains like sorghum, etc. So, however it may be cooked, a lot of water is absorbed, which ultimately makes it very bulky. Recently a lot of work has been done in some of our nutrition institutes regarding grinding of the grain. This has definitely reduced the viscosity considerably, but it will take a long time before this knowledge can be spread to the rural areas. Of course the addition of fat would also reduce viscosity, but fat is so expensive that the majority of the poor people cannot obtain it.

Dr. Rey: Dr. Anderson, what is the usual sucrose content in soft drinks in the United States, and is the use of noncarbohydrate sweeteners allowed in soft drinks for infants?

Dr. Anderson: The sucrose content is being replaced with corn sweeteners. High-fructose corn syrup is now being used by most of the major manufacturers of soft drinks in the United States, simply because it is cost effective to use a sweeter compound (about 1.5 times as sweet as sucrose on a weight basis). I am not sure about the corn sweeteners, but when sucrose was used the sugar content was around 10%. There is no proscription for use of artificial sweeteners in soft drinks for infants. The only warning on labels with regard to aspartame is that its phenylalanine content may be of concern to certain susceptible individuals.

Dr. Merchant: You made a statement that to a great extent lactose is now being replaced by sucrose. Could you tell us something about the importance of lactose in brain development?

Dr. Anderson: I cannot speculate on this. There is a figure comparing brain weight in adult animals to the lactose content of the milk they consumed when young; there is almost a straight-line relationship between brain weight, expressed as percentage of body weight, and lactose content of milk. I am not sure anyone knows what that means from the standpoint of brain development. The soya-based formulas, which now comprise about 25% of total sales of formula in the United States, are essentially lactose-free. Most of these formulas contain corn sweeteners or mixtures of sucrose and corn sweeteners. There are only two formulas that contain sucrose as the sole source of carbohydrate.

Dr. Boulton: A few points about sugar: Regarding human babies, one consideration is the possibility of training babies to expect things to be sweet. The second aspect has to do with teeth, which we have not yet talked about. The problem of severe caries of primary teeth, which has been caused, for example, by the higher sugar content in the “honey dummy,” has given rise to a substantial health problem in developed countries amongst poorer, uneducated people. The last point concerns the use of honey. We do not recommend giving babies honey during the first year of life because of the risk of botulism. I am not sure if this is a problem in Europe, but it certainly is one in Australia, where several cases have now been described of babies presenting with a very gradual paralysis and constipation, due to botulism. A few of these babies died of respiratory failure before botulism was diagnosed, and it was recognized that honey could be a contributing factor.

Dr. Anderson: Yes, the use of honey is also proscribed in the United States because of concern about botulism.

Dr. Davies: There is sometimes too much emphasis put on non-milk foods and too little on the amount and type of milk which should be given. In Hong Kong there are at least 30 milks widely available on the shelves. This is confusing not only to the consumers but also to those who have to educate the consumers. I wonder if the role of the new “follow-up” milk formulae which, according to the manufacturers, should be introduced between the
ages of about 4 to 6 months in preference to fresh cow's milk, can be clarified: Are they recommended for the mother who is breast-feeding and who, at the time of introducing beikost, needs to continue to give milk but cannot breast-feed?

Dr. Anderson: What is occurring in the United States is that women who no longer choose to breast-feed are feeding formula rather than whole cow's milk, so that the transition is not from breast-feeding to cow's milk but from breast-feeding to infant formula, which is appropriate for feeding from birth. Some of the reduced-calorie formulas, which are similar to the composition of 2% milk with a slightly lower protein content, are not as popular as they were in previous years.

Dr. Poskitt: I was just going to add that many British pediatricians, pediatric dieticians, and health visitors feel that there is no point in the few "follow-up" formulas that have been introduced in Britain and that they should be discouraged. There is a lot to be said for mothers continuing with formula until infants are about 1 year old, in that the risk of hypernatremia remains if the infants get sick. There seems to be no indication for giving milks other than the formula given to the infants before 6 months.

Dr. Rey: I completely disagree with Dr. Poskitt. As Dr. Guesry said when the discussion started, the composition of the milk needs to be adapted to the diversified diet after 6 months of age, and not the contrary. The calcium content in adapted "starter" formulas is rather low in order to improve fat absorption. The European Society for Pediatric Gastroenterology and Nutrition (ESPGAN) has recommended a calcium content of around 16 mg/100 kcal. The protein content of an adapted formula needs to be low, usually around 2.5 g/100 kcal, and there is no need at all to supplement a formula with iron before the age of 4 to 6 months. When a diversified diet is introduced the amount of milk ingested by the baby decreases progressively from around 0.8 liter/day to less than 0.5 liter/day. At this point it is very difficult to cover the calcium requirements with an adapted formula, and the child may need more protein if vegetables or fruits are given. To start a diversified diet, I personally recommend more vegetables and fruit than cereals. Finally, the iron requirements after 6 months of age rise to at least 1 mg/day during the second semester. I therefore think that the calcium and protein content of a formula designed for babies after 6 months of age should be around that of ordinary cow's milk, and that an iron supplement is necessary. That is what I call a follow-up formula.

Dr. Poskitt: In Britain, our baby formulas are supplemented with iron, and therefore there is no reason to change a formula at 6 months in order to get iron. I am not sure about the calcium, but certainly in Britain a lot of babies are still taking a pint of milk per day, about 560 ml or more, at 1 year of age or after, and I do not see the need for an increased milk protein intake at all. If infants are taking about 500 ml of milk, they do not need much else in the way of protein. What they really need is energy, which I should have thought would have come very nicely from cereals, and a variety of fruits to give the minerals and the vitamins.

Dr. Rey: For what reasons should a formula for very young babies contain a supplement of iron?

Dr. Poskitt: There is no reason to add iron to a formula for very young babies, except that they will continue to take the food without a problem a bit later on when they start to need iron. The prevention of iron deficiency probably starts by giving adequate iron before 6 months, although admittedly infants do not necessarily need it at 1 or 2 months of age.

Dr. Ashfaq Ahmad: I think there is a need to add iron to the milk, especially in developing countries, because the iron stores of babies born in a developing country are much lower.
than in those born in developed countries. This iron supplement might do some harm only when iron stores are normal, which is unlikely, since most mothers are malnourished and anemic and therefore most babies are born with reduced iron stores.

Dr. Ajenifuja: Since most of our babies are underweight, is there not a need to add even more iron?

Dr. Shanti Ghosh: Our ideas of developing countries seem to be very different. In India, processed milk reaches a very minute fraction of the population, and malnourished mothers, who are mostly in the rural areas, have no access to this kind of milk. They are relying on whatever kind of milk is available locally—that is, cow’s milk, buffalo’s milk, goat’s milk, or camel’s milk. Therefore, mothers in developing countries have no access to iron-fortified milk because they cannot afford it and it is not available. The only powdered milk available in India, for example, is a straightforward dried milk. Only very recently have some modified milks become available.

Dr. Vis: We need to be careful about trace element levels in human milk, because tremendous differences may be observed in different areas. This applies to iron, but also to zinc, copper, selenium, etc. The World Health Organization collaborative study on breast milk composition in six different countries will be published soon. So, let us not make general rules from experiences in one area.