Concluding Remarks

The focus of this workshop was ‘Issues in Complementary Feeding’, and the meeting opened with the generally agreed assertion that complementary feeding should be started around 6 months of life. However there are a number of important exceptions, for instance in the prevention or amelioration of the symptoms of celiac disease, as emphasized further on. There is a growing body of evidence supporting the rationale for anticipating the administration of gluten-containing food. It is also important to keep in mind that this advice about awaiting the administration of a complementary food must be issued on an individualized basis, because it depends on very personalized circumstances.

A second relevant point is that complementary feeding should not interfere with breastfeeding. It is known from previous observations that adding fats (especially oils) as a source of energy for breastfed infants during complementary feeding displaces the same amount of energy intake from human milk. In consequence, emphasis should be placed on solid foods that are true complements and not supplements, and that, if used as supplements, they should not replace the central role of human milk in infant nutrition. With respect to quality from a microbiological standpoint, complementary feeding should be appropriate. Concerning its nutritional characteristics, complementary feeding should provide adequate amounts of energy with satisfactory density so as to fulfill the requirements of growing infants.

There is an emerging body of evidence about the susceptibility of infants to the effects of early nutritional influences and insults – generally encompassed in the programming hypothesis. There are considerable experimental data but, unfortunately, they are rather limited in the case of humans. Present knowledge indicates that rapid growth during a critical window of sensitivity may program metabolic processes and pathways in ways that may be detrimental to later health, and this programming may even influence the appearance of some types of endocrine disorders and malignancies in mature or old age. However, those who have to manage the nutrition of low birth weight infants must be aware of the fact that their first duty is to supply adequate amounts of nutrients to enhance their possibilities of survival. Theoretical considerations about the possible consequences of early life programming should not represent a hindrance that could limit nutrient intake aiming at fast growth. It is known that during the first weeks and months of life, particularly for those infants born after 23–24 to 30 weeks of gestation, the risks of mortality are high, energy and protein requirements are high, and growth and...
neurodevelopment are tightly associated. Therefore, considerations about increased risks of later obesity, diabetes mellitus and hypertension should be considered as secondary to the need to assure the survival and development of these infants.

The role of breastfeeding and its protective effects compared to formula feeding at later ages were emphasized in this workshop. The advantages of breast milk are important in different areas and this was underlined during the discussions. There is accumulating and convincing evidence that breastfeeding during the first months of life is associated later in life with a lower risk of obesity, lower levels of arterial blood pressure and blood cholesterol. This latter aspect is important considering that breastfed babies have higher blood cholesterol levels, probably as a result of the high cholesterol levels in breast milk. In all probability this represents an example of programming in which the lipid metabolism of infants becomes conditioned early in life to handle the large amounts of cholesterol supplied initially by their maternal milk diet. The better cognitive development of young infants has recently been associated with the level of maternal intellectual capacity, but it is not known whether this is the result of the particular composition of the milk of mothers from a better socioeconomic strata, or due to the fact that mothers with higher education levels are better adapted to satisfy their infants’ requirements, including not only nutrition but also psychomotor stimulation. As discussed later in this workshop, breastfeeding is also negatively associated with the risk of autoimmune disorders such as type 1 diabetes and immune diseases including Crohn’s disease and even celiac disease. During the discussions it was stressed that epidemiological studies on the long-term effects of breastfeeding should be interpreted carefully, paying special attention to sample sizes, and considering that, in general, larger populations are better suited to adjustments for major confounders. The value of human milk was also emphasized not only on a quantitative basis but also from a qualitative standpoint, particularly for the feeding of special groups of infants such as preterm babies and those with inborn errors of metabolism. From an evolutionary perspective, these abnormal genes may be surviving in the human population due to the tempering effects breastfeeding and human milk may have on the consequences of their metabolic derangements.

Besides successful breastfeeding, the availability of safe weaning foods represents a key point for successful weaning programs, particularly in developing countries where the various partners have to be taken into consideration and the traditions of the population respected while trying to improve the quality of complementary feeding. Particularly in rural settings, it may be advantageous to improve the quality of traditional complementary foodstuffs through a holistic approach that includes educating women, particularly mothers, and the creation of effective networks incorporating all participants in the healthcare system, contacting families at their homes, and establishing systems for the control of food quality, preservation, and safety, and taking

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into account the economical constraints of poor families. Networks such as the one outlined could represent a key to improve the quality of complementary feeding in developing and transition countries. As long as a baby is breastfed, in all probability he/she will never become underfed, but after 6 months appropriate complementary feeding that does not displace human milk should be initiated, otherwise the risk of malnutrition increases considerably. It is worth underlining that commercial complementary foods in those countries may carry potential contaminants if production quality control systems are deficient. Fortunately it is now possible to rely on efficient quality control in the production chain, in which specialized professionals anticipate emerging problems by means of constant sampling and testing and early warning systems along all steps of the food preparation process from ‘Mother Earth’ to the final product and its final consumer. Finally, efficient coordination systems should be established between national and international regulatory bodies, food processing industries and consumer groups, taking into consideration the rapid development of a new ‘industrial food production science’ whose purpose is to improve the quality of the products offered to the population.

In addition to dangerous bacterial contaminants from the surrounding milieu, the human body, especially the colon, harbors ‘good’ bacteria. The way in which the body acquires this complex bacterial population is intriguing because there is accumulating evidence that this is not a process that occurs at random. The gut of newborns, which is initially sterile, is ready for colonization because its epithelial lining presents receptors for certain bacterial species and strains that gain access to the lumen. The potential risks associated with altered colonization processes start during delivery: the vaginal route is associated with a different colonization (normal?) pattern compared with that resulting from birth by cesarean section. The elucidation of the short- and long-term consequences of both birth mechanisms vis à vis the establishment of the resident microbiota is important because of the increasing rates of cesarean sections, and the potential risk of delayed colonization with the bacteria that are considered beneficial. Breastfed infants also receive bacteria through maternal milk. The origin of bacteria is still a matter of debate but they probably reside in the galactophores. Considered as a whole, the mechanism of delivery and the first feedings interact to create in the infant gut the ecological system and the microbiota that will remain with him for the rest of his life. Within this context, molecular biology currently represents a revolution for microbiology as it makes possible the identification of hitherto unknown bacterial species and strains through the analysis of their genes. This is generating more information on the complexity of these systems than was ever available, especially about the enormous number and variety of the microflora and the fact that beneficial, neutral and plainly potentially dangerous bacteria coexist sharing space and receptors, with the former normally controlling the latter. Beneficial bacteria (Bifidobacteria, Lactobacilli, and probably Ruminococci) generally displace the unfavorable
bacteroides and clostridia from the human gut during breastfeeding. In the coming years many more species and strains are going to be identified and this will provide more information about the influence of this huge microbiota on health and disease, including obesity, tumorigenesis, etc.

Clearly, food safety has to be associated with satisfactory nutrient quality and availability and this combination represents the real challenge of complementary feeding in the developing world. Food fortification is an effective way of achieving this goal and could be an acceptable way to implement the changes required by disadvantaged population groups. There are many ways in which food fortification can be provided: incorporated directly into local staples or processed foods, or added by parents or caregivers as sprinkles or spreads. One of the basic aspects of any supplementation program is that the target population should accept the supplements being provided. This is achieved by providing information about its effects, by respecting the beliefs and taboos of the population, and by consulting the opinion leaders before the process of fortification is started. One of the important aspects that should be taken into consideration is that the population should not feel that they are the recipients of ‘food for the poor’. In this respect there is experience from many parts of the world about resounding successes and failures when these aspects have not been taken into consideration. This holistic approach, taking all aspects of a sound fortification program into consideration, is required for the optimization of resources and to improve knowledge about the healthcare and nutrition of the population. Every fortification program should be evaluated at defined intervals, or when special circumstances arise, to quantify the cost-benefit ratios and to evaluate the opinions of its beneficiaries. Within this context, it is interesting to keep in mind that a wide variety of foodstuffs, including cereals, are possible targets for supplementary programs.

In relation to cereal fortification programs in developing countries, it was emphasized that fortification/supplementation activities must have reasonable costs and attain levels and coverage that are truly effective if the nutritional problems they are focused on are to be solved. Cereals are useful vehicles for fortification/supplementation programs as it is possible to use them as vehicles for functional components such as prebiotics, probiotics, nucleotides and combinations of vitamins and micronutrients that enhance their nutritional value. A number of easily detected and quantifiable parameters must be applied for the periodic evaluation of the results. It is also important to understand and take into account the magnitude of the difficulties that may be encountered in expanding from the pilot level to massive distribution programs. Stability, palatability and adequate vehicles are also factors that must be taken into consideration. Furthermore, it is important to keep in mind that if the infants who receive the supplement/fortification are being breastfed, the results of the program may not be as obvious and this may explain why some studies show no apparent effects.
For maximal effect, micronutrients and functional components have to be provided together with adequate levels of dietary protein and energy. The efficiency of the supplements may be decreased by microbiological contamination of the environment (including food and drinking water) that may impair, sometimes to a considerable extent, the efficiency of nutrient absorption and utilization, including that of the supplements/fortifiers. Other points to be considered include the possibility of interactions and synergies between nutrients and the need not only for short-term but also for long-term assessments to appreciate the quality of the results attained. In planning the dosages of supplements to be administered it is important to keep in mind that these have to take into account the possibility that genetic polymorphisms may be the cause of unexpected results, including a lack of response or untoward reactions.

Providing complementary feeding to children with pathologies must address their particular requirements. The complementary food category most commonly introduced early in life is cereals; this occurs later in breast-fed than in formula-fed infants. There is little evidence supporting the choice of the age at which this should be done or the types of cereals that should be used for this purpose. It is now agreed that introducing solid foods before the 4th month of life is detrimental to the infant and there continues to be some discussion as to the age at which solid foods, including those containing gluten, should be introduced. Introducing cereals after 7 months of age results in an increased risk for the appearance of islet cell immunity and insulin-dependent diabetes mellitus compared with introduction at 4–6 months. If the cereals are introduced while the infant is being breastfed, the risk of 'celiac disease autoimmunity' decreases. A protective role for breast-feeding in celiac disease has been ascertained by studies in Scandinavia and the United States. According to these studies, gluten introduction should occur between 4 and 6 months of age for infants at risk of this disease, and while they are still on breast milk. This may lessen the severity of their symptoms or delay the age when the disease will become clinically manifest. Gluten should be provided initially in small amounts as large amounts probably increase the severity of the symptoms. As celiac disease has a strong genetic component, it is advisable to perform measurements of antibodies, anti-tissue transglutaminase and anti-endomysium in those infants in whose families there are antecedents of this disease. The possibility of using oats in the diet of celiac patients is now accepted, although an occasional case may present adverse effects.

In relation to the repercussions of allergic disease on the nutritional status of infants and the role of complementary feeding, it was agreed that in many cases poor growth may result from extreme dietary restrictions and, as a result, this may be considered an iatrogenic effect. This stresses the need for proper evaluation of the relationship between allergic symptoms and the consumption of complementary foods. On the other hand, it is important to keep
in mind that the mainstay of the dietary management of food allergy is avoidance of the offending antigens in the diet. Another point that was emphasized is the possibility that infants may be allergic to more than one antigen and that the inflammatory reaction caused by such a situation amplifies the negative nutritional effects of food allergy and restricts the possibilities of achieving adequate nutrition. Unfortunately, elimination diets that exclude potential allergens do not prevent the appearance of allergy to other foods or of other manifestations of allergies and for this reason novel approaches are necessary, such as protocols that aim at inducing tolerance to proven allergens or to potential allergens. It is also important to understand that the diet normally provides components that may play a role in the modulation of allergy, such as polyunsaturated fatty acids, antioxidants and micronutrients that in allergic infants may stimulate the development and normal responses of their immune system. An active approach should include the administration of probiotics that modulate the innate immune system and the immunoregulatory pathways. Developments in this field may reach a point in which it will become possible to demonstrate that positive prevention through the use of dietary components, including special strains of probiotic microorganisms, may have advantages over passive elimination diets.

In many parts of the world, in low-income societies, infants become malnourished very early in life, even if they are still being breastfed, because the complementary foods available for them after 6 months of age may not satisfy their requirements for some nutrients, particularly energy. Among the causes that explain the appearance of malnutrition in these infants are hereditary and congenital abnormalities, underlying chronic infections, lack of adequate foods, low birth size and, finally, adaptive poor growth as a result of intrauterine growth restrictions. Each of these etiologies requires specific forms of intervention and, in addition, the management of each infant should be as individualized as possible, keeping in mind that growth too slow or too fast is undesirable, and that the late repercussions of nutritional rehabilitation that is too accelerated, such as obesity and type 2 diabetes mellitus, should be prevented as much as possible. It is important to keep in mind that the foremost consideration in treating malnutrition is the survival of the infant. In the extreme situations that many infants face in the less developed world, it is important to make them gain weight rapidly to decrease the risks associated with malnutrition: high mortality rates from increased susceptibility to infection, and the possibility of intellectual impairment.

The participants concluded that unmodified cow’s milk (UCM) cannot be considered as a complementary food and, furthermore, that it may exert negative effects which manifest themselves on iron nutrition and renal function. The effects of UCM on iron nutrition stem from its low iron content, and from the fact that if not subjected to thermal treatment, it induces blood loss through the feces in about 40% of infants. The cause of this blood loss remains unknown and it decreases with age and disappears by 1 year of age.
The magnitude of the fecal blood loss is such that it may contribute importantly to iron deficiency anemia at a stage when iron stores are low. Iron absorption is also decreased by UCM due to its high casein and calcium contents that inhibit the intestinal transport of the iron provided by other foods. UCM also generates a high solute load for the immature kidneys of infants, derived from its high protein and electrolyte content. This load has to be excreted and requires additional water which, if not provided, and especially in the presence of warm weather and/or acute diarrhea and vomiting, may result in hypernatremic dehydration which carries a high risk of brain damage and death in infants. As for the reasons that children are fed UCM, these are mostly traditional, as milk in all its forms (full-fat, half-skimmed and skimmed) is considered a source of high quality nutrients. Feeding skimmed milk to young infants has the additional inconveniences of its low energy content, its even higher renal solute loads, and higher concentration of lactose. Another cause of concern is that high renal solute loads are considered as one of the factors that condition the appearance of hypertension later in life. It is now recommended in most countries that UCM should not be introduced before 9 months of age and preferably after 12 months of age.

In addition to the concerns about iron nutrition, preoccupation also exists about the fat composition of UCM, with its high percentages of saturated fatty acids, rather low and variable amounts of linoleic (LA) and linolenic (ALA) acids, although the LA/ALA ratio is favorable. These characteristics make the fat of UCM very different from that of human milk and from modern formulae. There is little evidence that the fat in UCM may have undesirable effects on fat metabolism in adult life, including adiposity. The intake of UCM should not exceed 500 ml/day, with the remaining nutrients provided by a varied diet.

The intake of high amounts of protein in cow’s milk has been linked to the genesis of obesity through the stimulation of IGF-1 secretion, which increases cell multiplication and accelerates bone maturation. Although this aspect has been discussed at length, this matter has not been entirely settled and, furthermore, it has been shown that individuals who regularly drink milk are on average taller than non-consumers and may have lower systolic blood pressure.

The value of meat in the nutrition of infants is based on the high quality of its proteins, its content of iron, zinc, and other important trace elements which complement those of cereals and other plant-based foods. The viscera also represent useful sources of nutrients, although in the case of the liver, its fat and cholesterol content is high. Cellular animal protein sources are also good sources of energy, taking their fat content into account. When the feed provided to animals contains polyunsaturated fatty acids, these are incorporated into the meat, the eggs, the milk and the viscera. The high protein content of foods of animal origin may have implications for metabolic conditions resulting in a propensity to obesity later in life. The need for studies that will evaluate both the efficacy and the effectiveness of foods of animal origin in complementary feeding is clearly apparent.
Fermentation is a useful tool for the preservation of a variety of foodstuffs. Fermented foods have been used for millennia to feed children since the first months of life. This type of food is useful in the management of lactose intolerance, highly prevalent in many areas of the world and which limits milk consumption by adults. Until recently the lactic acid bacteria (LAB) were chosen on an empirical basis, but they are now being investigated for a number of beneficial properties. In addition to the management of lactose intolerance, these include the treatment and prevention of infantile and traveler’s diarrhea, the production of bioactive peptides with antibiotic, and blood pressure- and cholesterol-lowering effects. Fermented foods have been shown to play a role in the prevention or the amelioration of allergy. Fermented foods, such as the milk of different mammalian species, cereals, vegetables, fruits, and honey, are still consumed in many parts of the world, although the microbiota responsible for the fermentation processes remain unknown. LAB are not synonymous with probiotics, as there are LAB which are not probiotics, and probiotics that are neither LAB nor bacteria. The study of fermenting microorganisms and their effects is a rapidly expanding field that is benefiting from the application of techniques borrowed from molecular biology, classical microbiology, gastrointestinal physiology, immunology, nutrition and metabolism, and clinical studies. In all probability, this expansion of knowledge will result in a better understanding of the interrelations between human beings, their nutrition, their resident microbiota, and the environment.

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