

Home fortification with micronutrient sprinkles – A new approach for the prevention and treatment of nutritional anemias

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Despite global goals set by United Nations' agencies over the past decade for significant reductions in iron deficiency anemia (IDA), it remains a largely unaddressed public health problem affecting more than two billion people, one-third of the world's population. The negative impact of IDA on health and human potential are greatest in the developing world, where it is estimated that 51% of children younger than four years of age are anemic, mainly due to a diet that is inadequate in bioavailable iron. Studies in both developed and developing countries have consistently shown mental and motor impairments that may not be reversible in children younger than two years of age with IDA. From a public health standpoint there are four possible interventions for the prevention of anemia: dietary diversification to include foods rich in absorbable iron; fortification of staple foods including targeted fortification of complementary foods for infants and young children; the provision of iron supplements; and 'home-fortification'. In response to a United Nations Children's Fund (UNICEF) request to develop a new approach to IDA, our research group developed 'Sprinkles' for home-fortification of complementary foods. Sprinkles are single-dose sachets (like small packets of sugar) containing micronutrients in powder form (encapsulated iron, zinc, vitamins A, C and D, and folic acid), which are easily sprinkled onto any home-prepared complementary food. Sprinkles were developed to overcome many of the side effects and disadvantages of iron drops. We have demonstrated that Sprinkles are as effective as iron drops in the treatment and prevention of anemia. Sprinkles are easier to use and are, therefore, better accepted than iron drops, which may improve adherence to iron interventions.

Key Words: Anemia; Fortification; Infants; Iron; Micronutrients; Sprinkles

Les suppléments à domicile au moyen de micronutriments en poudre : Une nouvelle démarche pour prévenir et traiter les anémies nutritionnelles

Malgré les objectifs mondiaux établis par les organismes des Nations Unies depuis dix ans en vue de réduire le taux d'anémie ferriprive (AF) de manière substantielle, ce problème de santé publique qui touche plus de deux milliards de personnes, soit le tiers de la population mondiale, demeure en grande partie ignoré. Les répercussions négatives de l'AF sur la santé et le potentiel humain sont les plus marquées dans les pays en voie de développement, où l'on estime que 51 % des enfants de moins de quatre ans sont anémiques, en grande partie en raison d'un régime ne contenant pas assez de fer assimilable. Les études menées tant dans les pays industrialisés que dans les pays en voie de développement ont toujours démontré la présence d'une détérioration intellectuelle et motrice susceptible de ne pas être réversible chez les enfants de moins de deux ans présentant une AF. Du point de vue de la santé publique, il existe quatre interventions possibles pour prévenir l'anémie : la diversification alimentaire afin d'inclure des aliments riches en fer assimilable, l'ajout de suppléments aux denrées de base, y compris la vitaminisation ciblée d'aliments complémentaires pour les nourrissons et les tout-petits, la distribution de suppléments de fer et la prise de suppléments à domicile. Par suite d'une demande du Fonds des Nations Unies pour l'enfance (UNICEF) en vue d'élaborer une nouvelle démarche face à l'AF, notre groupe de recherche a mis au point « Sprinkles », une poudre pour enrichir les aliments complémentaires à domicile. Cette poudre se présente sous forme de sachets monodoses (semblables à de petits sachets de sucre) qui contiennent des micronutriments (fer encapsulé, zinc, vitamine A, vitamine C, vitamine D et acide folique) et se saupoudrent aisément sur les aliments complémentaires préparés à domicile. Cette poudre a été élaborée pour surmonter de nombreux effets secondaires et inconvénients des gouttes de fer. Nous avons démontré que Sprinkles est tout aussi efficace que les gouttes de fer pour traiter et prévenir l'anémie. Plus facile à utiliser, Sprinkles est donc mieux accepté que les gouttes de fer, ce qui pourrait améliorer l'adhésion aux interventions pour contrer les carences en fer.

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Despite global goals set by United Nations' agencies over the past decade for significant reductions in iron deficiency anemia (IDA), it remains a largely unaddressed public health problem affecting more than two billion people, one-third of the world's population (1). The negative impact of IDA on health and human potential are greatest in the developing world, where it is estimated that 51% of children younger than four years of age are anemic, mainly due to a diet inadequate in bioavailable iron (2). In Canada and the United States, among the general population, approximately 5% of children aged one to five years suffer from IDA (3); however, IDA continues to be a major problem within pockets of high risk groups in both countries. Among the many risk factors that contribute to IDA in children are low birth weight, early cord clamping, maternal anemia, high rates of infectious disease including malaria, *Helicobacter pylori*, helminth infection, poverty, poor access to iron-rich foods and other nutritional deficiencies.

There is ample scientific evidence linking IDA to impaired development in children and supporting early action in preventing anemia in infants and young children. Studies in both developed and developing countries have consistently shown mental and motor impairments that may not be reversible in children younger than two years of age with IDA compared with those without IDA (4). Poor cognitive, intellectual and social development have been associated with IDA in childhood, likely due to negative behavioural consequences which affect a child's ability to learn and interact with his or her environment. Animal studies suggest that IDA may impair myelination of nerve cells during brain development in infancy and neurotransmitter metabolism, including that of dopamine, which may explain the negative outcomes (5,6).

The age group at greatest risk for iron deficiency anemia is infants and young children between six and 12 months of age due to rapid growth and doubling of blood volume, resulting in high iron requirements during this stage of development. In general, full term, normal birth weight infants are born with adequate iron stores in the liver and bone marrow to meet requirements up to four to six months of age (7). Moreover, exclusive breastfeeding, which is preferable, or the use of iron-fortified formula, supplies a sufficient amount of iron to maintain iron status during this period. Because iron stores are generally depleted by six months of age, dietary sources of iron become critical to sustain the rapid rate of erythropoiesis (8). Thus, to prevent the development of anemia, the World Health Organization (WHO) and other international organizations recommend the introduction of iron-rich complementary foods, including iron-fortified foods, as well as foods containing ascorbic acid, which enhance iron absorption at the age of six months (1). Unfortunately, the dietary gap is often unmet in socioeconomically disadvantaged children, either due to the poor nutritional quality of the complementary diet and the unavailability and/or unaffordability of iron-rich foods, including commercially prepared iron-fortified cereals.

From a public health standpoint there are three possible interventions for the prevention of anemia; dietary diversification to include foods rich in absorbable iron; fortification of staple foods including targeted fortification of complementary foods for infants and young children; and provision of iron supplements. In terms of prioritization, when dietary or fortification strategies are not logistically or economically feasible within a population, supplementation of individuals and groups at risk is an alternative strategy. Taking this perspective, the WHO has recommended blanket supplementation, without screening, to all infants and young children six to 24 months of age in regions where the prevalence of anemia exceeds 20% to 30% (9). Yet, limited options exist for iron preparations for infants and young children. For the past 150 years or more, oral ferrous sulfate syrup or drops have been the primary source of iron for the treatment and prevention of IDA (10). However, much to the dismay of policy makers and programmers, adherence to long term ingestion of oral iron drops in unsupervised program settings is often poor. Low compliance is often a result of the unpleasant metallic after-taste from the drops, staining of the child's teeth unless the teeth are wiped off immediately and abdominal discomfort if the dose is high (11). Furthermore, other disadvantages of iron drops include cumbersome and expensive transportation costs due to the weight of liquid packaged in bottles, and difficulties in proper dosing, because the caregiver is required to measure a decimal volume from a dropper, which can present a problem among illiterate populations.

In 1996, a group of United Nations Children's Fund (UNICEF) consultants determined that the treatment and prevention of IDA was a UNICEF priority, yet available interventions for IDA (syrup and drops for infants and children) were not effective (12). The challenge for the development of a new method of iron delivery was put forth based on two observations from the 'West' (13) where micronutrient deficiencies, including IDA, are rare: fortification of targeted commercially available food provides essential micronutrients; and if the addition of micronutrients imparts no significant change in the colour, texture or taste of the food, compliance is likely to be enhanced. From these premises, and inspired by a legacy at the Hospital for Sick Children, Toronto, Ontario where Pablum was invented in 1931 to improve infant nutrition, the concept of 'Sprinkles' evolved as a novel method to deliver iron and other micronutrients to children at risk, using a home fortification approach.

Sprinkles are single-dose sachets (like small packets of sugar or artificial sweetener) containing micronutrients in powder form (encapsulated iron, zinc, and vitamins A, C and D, and folic acid), which are easily sprinkled onto any complementary food prepared in the household. Essentially, homemade or unfortified foods can be fortified by the addition of Sprinkles, hence the term 'home fortification'. They are meant to be used once daily and are simple to use. Sprinkles were developed by our research group to overcome many of the side effects and disadvantages of

iron drops, as well as to deliver adequate amounts of vitamins and minerals to prevent and treat common micronutrient deficiencies among children. Lipid encapsulation of the iron prevents interaction with food, thus there are no changes to the colour, taste, or texture of the food to which Sprinkles are added. Other advantages of Sprinkles are that they are relatively inexpensive to produce and are light weight for commodity transportation and distribution.

Many research activities have been initiated to evaluate the use of Sprinkles. Preliminary efficacy studies were conducted in Ghana, West Africa, between 1998 and 2001. In these studies we were able to demonstrate that Sprinkles, similar to iron drops, were able to treat anemia successfully among 60% to 75% of infants within two months, in a malaria endemic region (14,15). In addition, we documented that Sprinkles were well tolerated by infants with few side effects and were well accepted by caregivers who found them easy to use. Supported by Health Canada, we are assessing the efficacy of Sprinkles in First Nations and Inuit infants where the prevalence of anemia is as high as 32% (16).

As this solid research foundation continues to be built upon, our next goal for the development of Sprinkles is to scale-up for wide-spread, international distribution. This scale-up involves three important components: having access to a reliable, high quality, inexpensive supply of Sprinkles; assessing their appropriateness and acceptability in a nonstudy setting; and developing a sustainable method of distribution. We have accomplished the first of these tasks and have ongoing projects to solve the latter two. To support these efforts and to ensure an adequate supply of Sprinkles, a partnership has been struck with the HJ Heinz Company of Pittsburgh, Pennsylvania. This partnership is a humanitarian initiative by HJ Heinz, providing support for overseas research initiatives, expertise in evaluation of consumer needs and supply of Sprinkles for research. Sprinkles for humanitarian and noncommercial distribution are supplied on a cost-recovery basis and Heinz enjoys the benefits of being publicly associated with a significant public service initiative. Heinz, as one of the largest producers of single-serve sachets in the world, is well-positioned to provide advice on manufacturing, distribution and commercial sustainability of Sprinkles across the world. As a component of sustainability and the scale-up process, manufacturers will likely produce Sprinkles locally, in the country where they will be distributed. Opportunities for Heinz and other manufacturers to supply Sprinkles on a commercial basis can also be explored as the demand increases.

As an important component of our research, the acceptability of Sprinkles by both caregivers and children has been assessed in Ghana and China and will continue to be evaluated in ongoing projects in Mongolia, India and Pakistan. To date, parents have found the sachets easy to use and more acceptable than drops. Children do not object to their use because they do not change the taste of the food to which they are added. Moreover, other than changes in

TABLE 1
Potential distribution models

Health care services
Nongovernmental organizations
Governmental organizations (United Nations Children's Fund, World Health Organization, etc)
Public-private partnerships
Market integration (commercial market)

the colour of a child's stool (all iron products contribute to a darkening of the stool), no major adverse effects have been associated with the use of Sprinkles.

Currently, in partnership with World Vision Canada, we are evaluating the acceptance and distribution of Sprinkles (containing iron, zinc, ascorbic acid, vitamins A and D, and folic acid) to over 13,000 young children in Mongolia. Evaluation of the 18-month program includes both process indicators of the distribution system and biological outcome indicators to be assessed at the end of the project in March 2003. Due to the initial success of the program in Mongolia, both United Nations Children's Fund (UNICEF) and the Ministry of Health in Mongolia are actively pursuing registration of Sprinkles so that nationwide scale-up can be planned for in the future.

The final component of the scale-up process is, by far, the most difficult. This is the identification of sustainable methods of distribution that will be able to reach and provide Sprinkles to the most vulnerable populations in the developing world. We have identified five possible models for distribution (Table 1). From our experience in Mongolia, we have determined that it is feasible to distribute sprinkles in partnership with a nongovernmental organization (NGO). However, without committed, long term financial input from the parent NGO, sustainability is not guaranteed. Sustainability over the long term can most likely be achieved if a program can become self-financing. This may be best achieved through commercial market integration or public and private partnerships that use effective social marketing campaigns.

Future Sprinkles projects will involve continued partnering with United Nations' agencies or NGOs to conduct pilot programs to identify appropriate delivery systems within a country and to assess sociocultural acceptance and biological impact on reducing the prevalence of anemia among the population. Our long term goal is to make Sprinkles a widely available option for infants and young children worldwide. The role of public-private partnerships is becoming exceedingly important in establishing global health interventions that are both feasible and sustainable. Our partnership with the HJ Heinz Company, USA is, we believe, a good example of a successful partnership. This partnership is a humanitarian initiative that appropriately links industry and public health in contributing to the reduction of a major, global childhood problem.

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