

VITAMIN A FORTIFICATION OF MSG- AN ITERIM REPORT

By Harlan S. Hall; May 1989

It has been recognized that in some developing countries acute Vitamin A deficiency contributes significantly to health problems. Vitamin A deficiency is associated with Xerophthalmia (lesions of the eye), which if untreated result in ulceration and scarring leading to partial or total blindness (1). Vitamin A deficiency has also been associated with respiratory disease, diarrhea and increased child mortality (2,3,4). World Health Organization (WHO) estimates that at least 500,000 children per year develop corneal lesions and become partially or totally blind. About half will die, those remaining will be blind for life. It is further estimated that another 7-8 million have less severe adverse health effects (1).

Several different approaches have been tried to improve the vitamin A nutrition in a number of countries. Education and modification of diet are long term solutions to this problem. Until this can be achieved it is necessary to provide nutritional supplementation to minimize health damage.

Megadose intervention involves periodic distribution of Vitamin A capsules to whole populations. This has been shown to be effective (5,6) but presents logistical problems requiring a large number of field workers to see that doses are taken as required and reaching remote populations.

Fortification of foodstuffs is attractive because once established it requires little or no effort on the part of the recipient to maintain proper dose. Examples in the United States include iodized salt; Vitamin A & D fortified milk, and fortified cereals. One difficulty in implementing similar programs in many countries is lack of a centrally processed and distributed food. It is necessary to bring the food to a processing point for fortification and to then distribute it to the entire population.

Attempts have been made to fortify sugar and monosodium glutamate (MSG). In underdeveloped areas these may be among a very limited number of centrally processed items in wide distribution. While feasibility was demonstrated (7,8) technical problems were also identified. Common problems are change in appearance of the fortified item (sugar and MSG are white, vitamin A is bright yellow), lack of uniform mixing of the vitamin into the foodstuff (segregation, see Table I), and poor stability to heat, light and moisture (Table II).

Table I- VARIATION OF VITAMIN A LEVEL IN FORTIFIED MSG
3000 IU/g (11)

Top	1750 IU/g
Middle	2300 IU/g
Bottom	5100 IU/g

Table II- STABILITY vs. STRESS (11)

Water Activity	0.11	0.75	Dry*	Dry*
Light	Dark	Dark	Light	Dark
Temperature	25 C	25 C	25 C	45 C

* Dry = as received

VITAMIN A PALMITATE (Roche 250 CWS)

Half-Life (Weeks)	79	34	45	-----
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VITAMIN A/MSG (3000 IU/g) vs. STRESS

Half-Life (Weeks)	257	1	2	40
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Early attempts utilized petrolatum and vegetable fats (9). A premix was prepared by combining vitamin A beadlets, the oil or fat and fine powdered MSG in a mixer. This resulted in a pale-yellow to white material, the size of which depended on the ratio of ingredients, intensity of mixing and temperature. Initially this material was promising, however problems were encountered when stored under warm conditions. The fat softened or melted, resulting in bleeding of the oil into the bulk MSGT and undesirable changes in bulk flow properties and appearance.

In 1983 Coating Place became involved, working through U.S. Dep't. of Agriculture- Agency for International Development (USDA-AID) and Helen Keller International (HKI) to develop improved binders and methods for making the white premix. The general requirements were that the binder be edible, not adversely affect color, taste, vitamin availability or mouthfeel and be physically stable (not melt) at elevated temperature.

A system was developed which is both simple to prepare and met most of the above criteria. A water soluble edible binder is first dissolved in alcohol, then titanium dioxide (white pigment) dispersed into the solution. This mixture is used to wet 250 CWS Vitamin A Palmitate (Roche, Nutley, NJ, USA) beadlets in a mixer, forming a damp somewhat sticky mass. Fine powdered MSG is then added to the mixer and the mass worked for a few minutes and discharged. The powdered MSG adheres to the tacky beads, improving the appearance of the beads and also preventing the product from forming a solid mass on drying. Size of the White Vitamin A granules is controlled by the ratio of beads: binder solution: MSG. Drying is accomplished by spreading the product in trays and drying in a low temperature oven or in open air. The dry premix is then blended with MSG to make the final fortified product.

In 1984 mixing equipment was obtained and sent to Indonesia Nutrition Research and Development Center in Bagor, Indonesia. Ministry of health personnel were trained in preparation the White Vitamin A Premix described above. This product was pale yellow when prepared in the United States (Wisconsin), but was somewhat more yellow when prepared on site (Indonesia). This was attributed to very high local humidity resulting in slow drying and slight water gain during open air drying. The procedure was modified to eliminate titanium dioxide between the training period and the beginning of field trials.

In 1985 field trials were conducted (2, 10) in Indonesia, placing vitamin A fortified MSG into test villages. The program monitored changes in vitamin A in blood serum and also in breast milk, prevalence of Bitot's spots in eyes of children, height and weight of children, hemoglobin levels and mortality rates. Significant improvement in every measure except weight gain was observed during the 12 month program (Tables III, IV, V).

Table III- MEAN SERUM VITAMIN A LEVELS (2)

	Time Months	Serum Vit. A
Fortified MSG	0	0.67 micromol/L
	5	0.78
	11	0.92
Unfortified MSG	0	0.78
	5	0.71
	11	0.72

Table IV- PREVALENCE OF BITOT'S SPOTS IN CHILDREN (10)

Fortified MSG	0	1.24%
	5	0.32%
	11	0.15%
Unfortified MSG	0	0.77%
	5	0.90%
	11	0.80%

Table V- MORTALITY IN CHILDREN (10)

	Deaths/1000 children by age	
	< 12 Months	12-60 months
Fortified MSG	91	17
Unfortified MSG	102	31

One problem that was noted is that as fortification levels are increased the degree of whiteness of the white vitamin A becomes more significant. The pale yellow color that is aesthetically acceptable at fortification levels of 2000 IU/g MSG is noticeable at 3000 IU/g and higher. It has also been noted that a slow loss of potency of vitamin A occurs, limiting shelf life of the fortified product.

This was addressed in developing a second generation product (175WhiteA) which is more white than that described above. This improved product is prepared in fluid bed coating equipment and results in applying the white coating with minimal wetting of the vitamin A beads. This method results in a more uniform continuous coating, which is more white and also provides improved protection from light.

At the same time mixing/segregation studies were performed by Iowa State University (11) to monitor segregation of vitamin A from MSG during blending, packaging and/or shipping of the fortified MSG. Relative particle size of the two materials is believed to be the most important controlling factor in segregation (12). Based on this information strict size specifications were also established resulting in virtual elimination of segregation as a concern.

Table VI- VARIATION OF VITAMIN A LEVEL IN FORTIFIED MSG 3000 IU/g USING 175WHITEA (11)

Top	2700 IU/g
Middle	2675 IU/g
Bottom	2650 IU/g

The government of Indonesia then began to implement fortification of MSG as a regional program. This required producing 175WhiteA in much larger quantities. In the first large scale (1600 Kg.) production of 175WhiteA attaining the specified coating weight and making a stable product were easily achieved but difficulties had to be worked out in consistently achieving the desired particle size distribution. This has now been achieved. It has also been noted that the first material prepared at large scale is more buff colored (less white) than material produced at smaller scale. This is attributed to wetting of the beads during coating/agglomeration and will be addressed in future production.

The first 1600 Kg. Of 175WhiteA was prepared in November of 1988, but due to delays in getting the fortification program launched no blends were prepared until March, 1989. The blended product then entered distribution in several areas in Indonesia. By July 1989 it was clear that fortified MSG (MSG-F) was degrading with a resultant discoloration. Investigation into this indicates that the very high humidity of Indonesia plays a key role in this loss of stability. Over a period of one to three months under high humidity the MSG-F absorbs water, which is taken up by the water soluble 175WhiteA beads which then lose integrity, leak and discolor. This observation is inconsistent with previously observed stability of the prototype product (2) and demonstrated comparable stability of the product supplied. This inconsistency appears to be related to less rigid control of humidity to which packaged material is exposed.

Based on these observations the fieldwork has been suspended while new prototypes more resistant to water are being developed. Early samples show improved stability and are currently being evaluated to determine if they are suitable for resumption of the field trials. As additional experience is gained it is anticipated that further improvement of the product will be achieved.

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