***Original Research Article***

# MILK FORTIFICATION: A NEED OF THE HOUR IN INDIA


Abstract:

Micronutrient deficiency is caused by a diet deficient in important vitamins and minerals, and it continues to be a serious public health issue for many low- and middle-income countries' populations.

According to a survey by the National Nutrition Monitoring Bureau (NNMB) and a report by the ICMR's expert group, India has a very high burden of Vitamin A and D deficiencies among both young children and adults, particularly in urban areas where people are less physically active and have limited exposure to sunlight. Milk fortification is one of the treatments for vitamin deficiency. Milk is one of the most nutrient-dense foods available. In India, it is a staple dish that is consumed by people of all age groups.

milk is an excellent carrier for fortification. Calcium absorption is aided and promoted by vitamin D.As a result, it is critical to have Vitamin D to get the best calcium absorption from milk. Regular consumption of fortified milk led to an 18% reduction in diarrhoea, a 26% reduction in pneumonia, 7% fewer days with a high fever, and 15% fewer days sick with severe sickness. Only 198.4 million tonnes of fortified milk are produced per day out of a total of 198.4 million tonnes of milk produced, reaching approximately 121 million people. There is still a significant gap between production and fortification. Governments must take appropriate steps to improve milk fortification and make India a healthy country.



Key Words: Fortification, Milk Fortification, Micronutrients, Deficiencies of Vit. A, India


**Introduction:** Malnutrition, especially micronutrient malnutrition such as iron and vitamin deficits, is a major problem in India. Vitamin D is a fat-soluble vitamin that is essential for

**Comment [U1]:** This manuscript is more appropriate to include a systematic review because it is not based on data from reference citations

**Comment [U2]:** Title : general, suggest a more specific title : fortified milk with vitamins A and D

**Comment [U3]:** Font writing....??

**Comment [U4]:** check the same amount 198.4 million ???

**Comment [U5]:** paraphrase sentences to reduce similarity (highlight green color)

human health. Vitamin D insufficiency is common all over the world. Apart from the well-known skeletal problems, this deficiency has several unexplored implications. The severe deficiency of Vitamin A and Vitamin D in India necessitates the fortification of milk with these vitamins. (1, 2,)

Milk is a nutrient-dense beverage. It is a complex biological fluid that contains fats, proteins, minerals, vitamins, enzymes, and carbohydrates, and it is a good supply of an adult's daily vitamin requirement.

It includes fat-soluble vitamins A, D, E, and K, as well as water-soluble vitamins B1, B2, niacin, biotin, pantothenic acid, B6, folate, and B12, as well as ascorbic acid (vitamin C). Milk contains varying levels of various salts in its soluble and colloidal phases (approximately 20 trace elements are found in milk, including copper, iron, silicon, zinc, and iodine). Milk has a mineral (ash) component of about 0.7–0.8 percent.

**Table 1. Vitamins in milk and milk products**

| Products | Retinol (µg) | Carotene (µg) | D (µg) | E (mg) | B1 (mg) | B2 (mg) | B3 (mg) | B6 (mg) | B12 (µg) | Folate (µg) | B5 (mg) | Biotin (µg) | Vit C (mg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cow Milk Whole | 150 [a,b] | | 4[a] | 0.09 | 0.04 | 0.17 | 0.1 | 0.06 | 0.4 | 6 | 0.35 | 1.9 | 1 |
| Buffalo milk Whole | 240 [a],b | | 7 [a] | - | 0.04 | 0.14 | 0.1 | - | | - | - | - | 1 |
| Toned Milk | 115 [a,b] | | 3 [a] | - | 0.04 | 0.15 | 0.1 | - | | - | - | - | 1 |
| Cow milk skimmed | Tr,[b] | | 0 | Tr | 0.04 | 0.18 | 0.1 | 0.06 | 0.4 | 6 | 0.32 | 2.0 | 1 |
| Buffalo milk Skimmed | Tr,[b] | | 0 | - | 0.04 | 0.18 | 0.1 | - | | - | - | - | 1 |
| Butter | 3300 [a,b] | | 92 [a] | - | Tr | 0.01 | 0.1 | - | 0.05 | - | - | - | 0 |
| SMP | 40 [a,b] | | Tr | - | 0.35 | 1.96 | 1.1 | - | 36 | - | - | - | 7 |
| Ghee | 3800 [a,b] | | 99 [a] | - | 0 | 0 | 0 | - | 0 | - | - | - | 0 |
| Cheese (Surti) | 830 [a,b] | | 20 [a] | - | 0.01 | 0.2 | 0.1 | - | 4 | - | - | - | 0.6 |
| Skimmed Pasteurized Milk | 1 | Tr | Tr | | 0.04 | 0.18 | 0.1 | | 0.4 | | | | 1 |
| Sterilized whole milk in containers | 52 | 21 | 0.03 | 0.09 | 0.03 | 0.14 | 0.1 | 0.04 | 0.1 | Tr | 0.28 | 1.8 | Tr |
| Evaporated Whole Milk | 105 | 100 | 0.09 | 0.19 | 0.07 | 0.42 | 0.2 | 0.07 | 0.1 | 11 | 0.75 | 4.0 | 1 |
| Cheddar Cheese | 325 | 225 | 0.26 | 0.53 | 0.03 | 0.40 | 0.1 | 0.10 | 1.1 | 33 | 0.36 | 3.0 | Tr |
| Edam | 175 | 150 | (0.19) | 0.48 | 0.03 | 0.35 | 0.1 | 0.09 | 2.1 | 40 | 0.38 | 1.8 | Tr |
| Gouda | 245 | 145 | (0.24) | 0.53 | 0.03 | 0.30 | 0.1 | 0.08 | 1.7 | 43 | 0.32 | 1.4 | Tr |
| Processed Cheese Plain | 270 | 95 | 0.21 | 0.55 | 0.03 | 0.28 | 0.1 | 0.08 | 0.9 | 18 | 0.31 | 2.3 | Tr |
| UHT, Drinking Yoghurt | Tr | Tr | Tr | Tr | 0.03 | 0.16 | 0.1 | 0.05 | 0.2 | 12 | 0.19 | 0.9 | 0 |
| Low-Fat yogurt plain | 8 | 5 | 0.01 | 0.01 | 0.05 | 0.25 | 0.1 | 0.09 | 0.2 | 17 | 0.45 | 2.9 | 1 |
| Whole Milk yoghurt Plain | 28 | 21 | 0.04 | 0.05 | 0.06 | 0.27 | 0.2 | 0.10 | 0.2 | 18 | 0.50 | 2.6 | 1 |
| Ice cream | 115 | 195 | 0.12 | 0.21 | 0.04 | 0.25 | 0.1 | 0.08 | 0.4 | 7 | 0.44 | 2.5 | 1 |

Source: Technews, issue. N0.93, **July- September 2017,** National Dairy Development Board
+- Possible; o- trials needed; - Not available

Milk, which is produced by a variety of mammals, contains a variety of nutrients, including protein and lactose. However, the natural vitamin and mineral content varies by feed and season. Milk, for example, has an average vitamin A level of 1200 IU/L. Due to fluctuations in feed, it ranges from 600 to 1800 IU/L during the seasons. When milk fat is removed during processing, vitamins A and D are lost.(3,4)

**Table 2. Stability of Vitamins during Processing**

| Vitamins | Pasteurization | UHT | Sterilization (In bottles) | Pasteurization & Evaporation | Drying |
|---|---|---|---|---|---|
| Vitamins A and carotene content | No Loss | Negligible loss in > 100°C Losses of vitamin A can occur in UHT milk during its long shelf-life at ambient | | 20% and carotene is not affected | 56-65% Carotene 30% loss when Pasteurised, |

| | | | | | |
|---|---|---|---|---|---|
| | | temperatures. | | | Homogenized and Spray-dried |
| Vitamin B Complex | There is no loss of Riboflavin, nicotinic acid, pyridoxine, pantothenic acid and biotin by heat treatment.<br>B1, B12: 10-20%<br>B3, B5, B7: Stable during processing<br>B9: <5% | Thiamine (B1) & B12 10-20%<br>Folic Acid: 10%<br>B6:Negligible losses<br>B6: 27% | B12: 90%<br>Thiamine: 35%<br>Folic Acid: 50%<br>B6: 20% | B1: 30-50%<br>B12: 90% (in bottle) | -- |
| Fortified milk (Vitamin D): | 1.15% Loss in pasteurization<br>Boiling 1.45% | -- | 1.92% | -- | -- |
| Vitamin D | Negligible/No losses of vitamin D2 of these heat treatments upon milk and stable in most dairy operations | | | | |
| Vitamin C | 10% HTST<br>20%: Holder/Batch | 10% | 50% | 15%-60% | Roller Dried:30<br>Spray Dried:20 |
| | Vitamin C present in fresh milk as relatively heat-stable ascorbic acid is oxidized by dissolved oxygen to Dehydroascorbic acid which is then readily destroyed by subsequent heat-treatment and storage. | | | | |
| Vitamin E | Vitamin E content of milk is not influenced by pasteurization or evaporation but a loss of 9 % may occur after drying and reconstitution. | | | | |
| Vitamin K | No effect | | | | |

Source: Technews, issue. N0.93, **July- September 2017,** National Dairy Development Board

MILK fortification is required because, according to the World Bank, more than 70% of India's children under the age of five are vitamin D deficient, and 57 percent of all children in the country are vitamin A deficient. Vitamins A and D are essential for immune system strength, which is especially important during the present COVID-19 pandemic. Vitamin A and D deficiency has a negative influence on morbidity, mortality, productivity, and economic growth. Vitamin D deficiency is common in people of all ages, including those who are at high risk.(5,6) Milk fortification with micronutrients such as vitamin A and D is a useful technique to address micronutrient deficiency of these micronutrients because milk is consumed by all population segments. Fortification of milk is a simple and effective way to improve public health.

**Comment [U6]:** Milk

**Table 3. Milk can be fortified with the following micronutrients**

| Nutrients | Products | Liquid Milk | Milk Powder | Milk With cereal |
|---|---|---|---|---|
| Vitamins | β-Carotene | + | + | + |
| | A | + | + | + |
| | D | + | + | + |
| | E | + | + | + |
| | $B_1$ | + | + | + |
| | $B_2$ | + | + | + |
| | $B_6$ | + | + | + |
| | C | + | + | + |
| | Niacin | + | + | + |

| | | | | |
|---|---|---|---|---|
| | **Folic acid** | **+** | **+** | **+** |
| | **$B_{12}$** | **+** | **+** | **+** |
| **Minerals** | **Fe** | **0**** | **+** | **+** |
| | **Ca** | **+** | **+** | **+** |
| | **Zn** | **+** | **-** | **+** |

Source: Technews, issue. N0.93, **July- September 2017,** National Diary Development Board

Because it is simple to do so, many countries have made it mandatory to replace the vitamins that have been lost. The nutrients lost during processing are replenished, which is why it's termed replenishment.

**Table 4. Mandatory fortification of food with nutrients in different countries**

| Nutrient fortificant | Food Fortified | Country/Region |
|---|---|---|
| Vitamin A | Sugar | Guatemala, Honduras, Costa Rica, El Salvador, Nicaragua, Panama, Zambia, Brazil |
| | Dried skimmed milk for complimentary food programs | Brazil |
| | Skimmed milk | Guatemala |
| | Sterilized, pasteurized low-fat milk | Mexico |
| | Milk | Honduras, Mexico |
| | Dried milk powder | Venezuela |
| | Evaporated milk, condensed milk | Malaysia, Thailand, Mexico |
| | Filled milk | Philippines, Malaysia |
| | Margarine | Chile, Colombia, Denmark, Ecuador, El Salvador, Guatemala, Honduras, Peru, South Africa, India, Indonesia, Malaysia, Philippines, Turkey, Mexico |
| | Oil products (ghee) | Pakistan, West Africa, Brazil |
| | Noodles | southeast Asia |
| | Wheat flour | Pakistan |
| | Monosodium glutamate | Indonesia and Philippines |
| Vitamin D | Dried skimmed milk for complementary food programmes | Brazil |
| | Skimmed milk | Guatemala |
| | Milk | United States, Honduras |
| | Sterilized low-fat milk, pasteurized low-fat milk, evaporated whole and low-fat milk | Mexico |
| | Dried milk powder | Venezuela |
| | Filled milk | Philippines |
| | Margarine | Chile, Colombia, Ecuador, Honduras, Peru, South Africa, Indonesia, Malaysia, Philippines, Turkey, Mexico |
| | Wheat flour | Bolivia, Canada, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, USA, Venezuela, Indonesia |
| | Pasta | Chile, Guatemala |
| | Precooked maize flour | Venezuela |
| | Enriched flour | Nigeria |
| | Filled milk | Philippines |
| | Wheat flour | Australia |
| | Wheat flour | Bolivia, Canada, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, USA, Venezuela, Indonesia |
| | Pasta | Chile, Guatemala |
| | Precooked maize flour | Venezuela |
| | Enriched flour | Nigeria |
| | Enriched maize meal | South Africa |
| | Wheat flour | Bolivia, Canada, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, USA, Venezuela |
| | Pasta | Chile, Guatemala |
| | Precooked maize flour | Venezuela |
| | Enriched flour | Nigeria |
| | Enriched maize meal | South Africa |
| | Wheat flour | Bolivia, Canada, Chile, Colombia, Costa Rica, Dominican |

| | | |
|---|---|---|
| | | Republic, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Venezuela, USA, Canada, 20 Latin American Countries, Australia |
| | Precooked maize flour | Venezuela |
| | Wheat flour | Bolivia, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, USA, Venezuela, Peru, Indonesia |
| | Pasta | Chile, Guatemala |
| | Precooked maize flour | Venezuela |
| | Enriched flour | Nigeria |
| | Biscuits | South Africa |
| | Salt | India |
| | Sugar | Brazil |
| | Wheat flour | Guatemala, USA |
| | Enriched flour | Nigeria |
| | Wheat flour | Indonesia |
| | Sugar | Brazil |
| | Salt | Switzerland, Philippines, United States, Australia, India |
| | Wheat flour, Bread | Australia |
| | Biscuits | South Africa |

Source: Technews, issue. N0.93, **July- September 2017,** National Diary Development Board

**Comment [U7]:** Not yet list in references...

**Table 5 Recommended values Milk and Milk Products Fortification in other countries**

| Country | Products | Vitamin A (IU) | Vitamin D (IU) |
|---|---|---|---|
| Argentina | Fluid & dry milk(whole & skim) | 2,500/L | 400/L |
| Brazil | Dry skim milk for complimentary food programs | 15,000 - 25,000/kg | 2000 - 2400/kg |
| Guatemala | Skim milk | 2,000 -3,000/L | 400 -600/L |
| Honduras | Milk | 2,000/L | 400/L |
| Malaysia | Evaporated/unsweetened Condensed milk | 6,700/kg | - |
| Malaysia | Sweetened condensed Milk | 6,700/kg | - |
| Malaysia | Filled evaporated/filled condensed milk | 6,700/kg | - |
| Mexico | Sterilized low-fat Milk | 4,000/L | 400/L |
| Mexico | Pasteurized low-fat milk | 4,000/L | 400/L |
| Mexico | Evaporated whole & low-fat milk | 4,000/L | 400/L |
| Philippines | Filled evaporated/filled condensed milk | 4,866/kg | (973/kg) |
| USA | Fortified nonfat dry milk (reconstituted) | 2,115/L | 425/L |
| USA | Evaporated milk | (4,225/L) | 845/L |
| USA | Evaporated skim milk | 4,225/L | 845/L |
| Venezuela | Dry milk powder | 4,000/L | 400/L |
| India | Processed Milk | 770/L | 550/L |

Source: Technews, issue. N0.93, **July- September 2017,** National Diary Development Board

## Fortified vs. unfortified milk

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Vitamins A and D are abundant in fortified milk. Milk also contains a variety of additional vitamins and minerals. The chart below compares the nutritious content of fortified and unfortified 2 percent milk in 8 ounces (240 ml).(7,8,9)

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| | Fortified 2% milk | Unfortified 2% milk |
|---|---|---|
| **Calories** | 122 | 123 |
| **Protein** | 8 grams | 8 grams |
| **Fat** | 5 grams | 5 grams |
| **Carbs** | 12 grams | 12 grams |
| **Vitamin A** | 15% of the Daily Value (DV) | 8% of the DV |
| **Vitamin B12** | 54% of the DV | 54% of the DV |
| **Vitamin D** | 15% of the DV | 0% of the DV |
| **Riboflavin** | 35% of the DV | 35% of the DV |
| **Calcium** | 23% of the DV | 23% of the DV |
| **Phosphorus** | 18% of the DV | 18% of the DV |
| **Selenium** | 11% of the DV | 11% of the DV |
| **Zinc** | 11% of the DV | 11% of the DV |

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**Benefits of fortified milk**

**Fills in nutritional voids in your diet**

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Fortification helps to prevent nutrient deficiency disorders like rickets, which is a weakening of the bones caused by a lack of vitamin D. Other vitamin deficits that aren't as serious but dangerous can be addressed with fortification. Iron deficiency anemia is a prevalent disease among children, especially in underdeveloped countries, and fortified milk can help avoid it.

Milk in these areas is frequently supplemented with iron and other elements like zinc and B vitamins. Older children's brain function may be improved by fortified milk.

**Encourages children's healthy development:**

Iron deficiency anemia is a prevalent disease among children, especially in underdeveloped countries, and fortified milk can help avoid it. Milk in these areas is frequently supplemented with iron and other elements like zinc and B vitamins. Older children's brain function may be improved by fortified milk.

**Improves bone health**

Bone health may be improved by drinking fortified milk. Higher bone mineral density, or stronger, thicker bones, is linked to the use of fortified milk and dairy foods.

According to government statistics. In India, milk production is expected to reach 198.4 million tonnes in 2019-20. It has increased by 5.70 percent in comparison to 2018-19. The rural sector is anticipated to account for 57% of overall consumption. Even in 2030 predictions, per capita consumption in urban regions (592 ml) remains higher than in rural areas (404 ml). The government has taken several steps to boost animal productivity, which has resulted in a large increase in milk output, according to the report.

India continues to be the world's largest milk producer. The per capita availability of milk was 407 grams per day in 2019-20.

## Milk fortification in India

India currently produces 198.4 million tonnes of fortified milk per day, reaching over 121 million people.

With obligatory fortification on the horizon, these figures are expected to rise dramatically across the country, helping to enhance the Indian population's nutrition and health.

## Challenges for MILK FORTIFICATION IN INDIA:

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India has more dairy farms than any other country in the world, at 75 million. Pakistan, with 14 million dairy farms, is the country with the next-highest number. (According to the UN Food and Agricultural Organization, the great majority of dairy farms in both of these countries contain fewer than 10 cows.)

Even though India is the world's largest dairy producer and one of the world's largest consumers of milk, only 35 to 40% of marketed milk travels through established channels including milk unions, dairy producer firms, and the private sector. The organized milk industry is expanding at a rate of 15% per year. Milk cooperatives provide roughly 220 Lakh Litres per Day (LLPD) to the fortifiable milk quantity, while the private sector contributes approximately 196 LLPD.

More milk from the unorganised sector needs to be converted to processed and packaged milk, and then to fortified milk. There are also additional types of milk available on the market, such as cow milk and full cream milk, for which fortification criteria have not yet been established.

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**Conclusion:** There is a significant burden of vitamin insufficiency in all age groups of the population, particularly in metropolitan areas, due to their lifestyle, which involves spending more time indoors and thus being less exposed to sunshine, making them more susceptible to vitamin D deficiency. The necessity for milk fortification appears to be a viable option for supplemental vitamin pills. Milk is the greatest option to supplement with additional vitamins as part of a daily diet to counteract the effects of deficiencies. Vitamin A and D deficiency is extremely common in India, affecting both young children and adults. With 146.3 million tonnes of milk produced annually, India is the world's largest producer, yet only around 9% of the milk is fortified with vitamins and minerals. There is still a long way to go in making India a healthy country. The Indian government must take steps such as requiring fortification of milk given to the public by diary, encouraging corporations to adopt communities, and distributing fortified milk. The government must encourage colleges to perform various malnutrition awareness programs, as well as involve students in various activities to raise awareness among rural and urban youngsters

**Comment [U14]:** revised more systematically according to the purpose of writing.

**Comment [U15]:** This sentence should be the focus or urgency of this writing

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