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Milk Fortification with Vitamin A & D: A Need of the Hour in India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Short Communication

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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. 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.

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. 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. Out of 416 LLPD produced, about 198.4 LLPD gets fortified currently in India, reaching about 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.

Keywords: Milk fortification; vit. A & D; Vit.A & D deficiencies India.

1. 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 required for good health. Vitamin D deficiency is widespread throughout the world. Apart from the well-known skeletal problems, this

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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 (Table .1) 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.

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]. During sterilization, pasteurization and drying process, some amounts of vitamins lost (Table.2).

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. (Table: 3).

Because it is simple to do so, many countries (Table: 4, 5) have made it mandatory to replace the vitamins that have been lost. The nutrients lost during processing are replenished.

1.1 Fortified vs. Unfortified Milk

Vitamins A and D are abundant in fortified milk. Milk also contains a variety of additional vitamins and minerals. The Table: 6 compare the nutritious content of fortified and unfortified 2 percent milk in 8 ounces (240 ml) [7, 8, and 9].Fortified 2% milk offers 15%of the daily value of Vitamin A & D.

1.2 Fills in Nutritional Voids in Your Diet

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 fortified with iron and other nutrients such as zinc and B [10] vitamins. Older children's brain function may be improved by fortified milk.

1.3 Encourages Children's Healthy Development

Iron deficiency anemia is a prevalent disease among children, especially in underdeveloped countries, and fortified milk can help it. Older children's brain function may be improved by fortified milk [11].

1.4 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.

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.

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		4a	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

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 temperatures.		20% and carotene is not affected	56-65% Carotene 30% loss when Pasteurised, Homogenized and Spray-dried
Vitamin B Complex	There is no loss of Riboflavin, nicotinic acid, pyridoxine, pantothenic acid and biotin by heat treatment. B1, B12: 10-20% B3, B5, B7: Stable during processing B9: <5%	Thiamine (B1) & B12 10-20% Folic Acid: 10% B6:Negligible losses B6: 27%	B12: 90% Thiamine: 35% Folic Acid: 50% B6: 20%	B1: 30-50% B12: 90% (in bottle)	--
Fortified milk (Vitamin D):	1.15% Loss in pasteurization 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 20%: Holder/Batch	10%	50%	15%-60%	Roller Dried:30 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

Table 3. Milk can be fortified with the following micronutrients

Nutrients	Products	Liquid Milk	Milk Powder	Milk With cereal
	β-Carotene	+	+	+
	A	+	+	+
	D	+	+	+
	E	+	+	+
Vitamins	B1	+	+	+
	B2	+	+	+
	B6	+	+	+
	C	+	+	+
	Niacin	+	+	+
	Folic acid	+	+	+
	B12	+	+	+
	Fe	O**	+	+
Minerals	Ca	+	+	+
	Zn	+	-	+

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

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

Nutrient fortificant	Food Fortified	Country/Region
	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
Vitamin A	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
Vitamin D	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,

Nutrient fortificant	Food Fortified	Country/Region
		Indonesia, Malaysia, Philippines, Turkey, Mexico
	Wheat flour	Bolivia, Canada, Chile, Colombia, Costa Rica, Ecuador, El
		Salvador, Guatemala, Honduras, Nicaragua,
Thiamine		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
Riboflavin		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
Niacin		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,
Folic acid		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,
Iron		Panama, Paraguay, USA, Venezuela, Peru, Indonesia
	Pasta	Chile, Guatemala
	Precooked maize flour	Venezuela
	Enriched flour	Nigeria
	Biscuits	South Africa
	Salt	India
	Sugar	Brazil
Calcium	Wheat flour	Guatemala, USA
	Enriched flour	Nigeria
Zinc	Wheat flour	Indonesia
	Sugar	Brazil
	Salt	Switzerland, Philippines, United States, Australia,
Iodine		India
	Wheat flour, Bread	Australia
	Biscuits	South Africa

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

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

Table 6. Benefits of fortified milk

	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

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

1.5 Milk Fortification in India

Out of 416 LLPD produced, about 198.4 LLPD gets fortified currently in India, reaching about 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.

1.6 Challenges for Milk Fortification in India

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.).

Despite the fact that 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 passes through established channels such as 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.

Fortification costs of Milk.

The cost of fortification is approximately 2 paise per litre of milk. As a result it becomes a cost-effective, long-term, and supplemental intervention. Milk fortification, unlike pills, is a straightforward, preventive, and low-cost way to address vitamin deficiencies [12,13]. However, with the exception of required iodine fortification of salt, India lags behind other countries in embracing milk fortification as a scalable public health intervention.

2. 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. Vitamin A and D deficiency is extremely common in India, affecting both young children and adults. India is the world's largest producer, yet only around 9% of the milk is fortified with vitamins and minerals. 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. Technical and financial support should be provided to cooperative and private dairies in India Government of India should provide proper training dairy employees and/or the external implementing agency's manpower.

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.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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