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Fortification Vehicle: Vitamin-D in Processed Food!

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Abstract

The paper is focused on the open market availability of fortified products in India and the effects of socio-economic factors on fortified products. Initially, the data will be collected from a Survey and some information will be used from the official websites. Secondly, the data will be analyzed with Stata MP 17 software. Finally, the expected outcomes will be based on the priorities of the population who prefer their nutritional diet in their daily routine. The policies and strategies initiated by the government will promote fortified products and make them available on the open market.

Keywords- Fortified products, Vitamin-D, Open Market, Nutritional diet, Government Policies

Food fortification refers to the addition of micronutrients to foods. A specific advantage of food fortification is that it can increase micronutrient intakes to large segments of the population at very low cost without requiring radical changes in food consumption patterns [11]. The term "vitamin D" commonly refers to compounds vitamin D3 (cholecalciferol) or vitamin D2 (ergocalciferol) [11]. Vitamin D3 is produced in the skin on exposure to sunlight. Vitamin D3 is derived from 7-dehydrocholesterol by ultraviolet irradiation, specifically through exposure to UVB rays. Sun exposure alone ought to suffice to attain vitamin D sufficiency. However, even in tropical countries like India, despite plentiful sunshine, vitamin D deficiency prevails in as many as 70%–100% of ostensibly healthy individuals, due to several socioeconomic and cultural constraints [11]. A few reports have shown fortification as a requirement to prevent such diseases as goiters in South America by following the addition of iodine in salt and in the United States, promoted vitamin-D fortification in milk to overcome the problem of rickets in children [11].

A research study was conducted while using 10mg vitamin-D fortification per 100g of wheat flour in India. The result was astonishing, and deficiency of vitamin-D decreased from 93% to 50% [1]. According to [12], few limitations stand in the way of using fortified foods, such as the population must eat the food vehicle as the medium for fortified food. Most families can afford to buy the fortified food products. Availability of the nutrients with its limited amount used for fortification is safe for the entire population. Countries (Finland, Canada, and the United States) with fortification policies on different milk products contribute 28-63% of vitamin-D intake. The countries (Norway, Sweden) without a fortification policy or only having dairy products have a negligible contribution [6].

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Fortification Vehicle

As per the research here, different types of fortification are available as well as specific methods used for a particular product. In the USA, specific categories of food are initially focused on because of their demand in the market and their use in a regular routine, which also limits over-fortification [11]. The *NDNS survey 2008/2009 – 2011/2012* represents data based on required nutrition intake (RNI) and upper intake level (UL). They initially focused on a source which can promote fortification and further on the quantity that might have greatest impact to overcome Vitamin-D deficiency [10]. Initially, India followed up with a staple food as it is consumed in high percentage among the population. Furthermore, there are different processes to fortify liquid and dried material. Vitamin-D deficiency might cause chronic disease and hypovitaminosis D with increased prevalence attracting more concern regarding adequacy of current intake levels and the safest and most effective way to obtain vitamin-D [2].

The authors bring some information about the food categories which can be used as fortification vehicles as follows:

Table 1: Foods that may be suitable for fortification with vitamin D in India.

Food Category	Staple Food Fortified	Widely Consumed Related Products Fortified as a Consequence
Foods that May Be Considered for Mandatory Fortification		
Milk and milk products	Milk.	All grades of milk, curd (plain yogurt) and cheese.
Cereal flour and related products	Whole wheat flour	*Chapati*
	Maida (all-purpose wheat flour)	*Naan* (flatbread made of leavened dough), instant (or not) noodles, pasta, *seviyan* (vermicelli), pizzas, bakery products, e.g., bread, rusk, burger buns, biscuits/cookies, cakes, *etc*.
	Corn flour	Corn *chapati*
	Corn starch	All products (extruded products included) using corn starch.

	Rice	All rice dishes
	Rice flour	*Idlis*, *etc.,* and also all extruded products using rice flour.
Foods that May Be Considered for Voluntary or Market Oriented Fortification		
Sugar	Table sugar or *boora* (powdered sugar)	All already cooked beverages, snacks and dishes sweetened with table sugar
Salt	Salt	All already cooked foods to which salt is added after cooking.
Oils and fats used as spreads or to spike already cooked food	Butter	All already cooked foods spiked with butter.
	Ghee (clarified butter)	All already cooked foods spiked with *ghee*.
Dalia (porridge)		
Semolina (*suji*)		
Canned fruit juices		

Table taken from (*Ritu & Gupta, 2014)*

1. **Flour (Wheat and Maize): -**

Flour comes under the strategy of mandatory or mass fortification of staple foods. In this process, the powdered micronutrients are mixed in the milling process. It is a simple process but requires appropriate concentration of the fortificant premixes with respect to the quantity of the flour. Care needs to be taken to achieve adequate mixing of the material in the milling process. In the milling process the quality of the fortificant is determined before mixing so it will not affect the flour, such as: - change in taste or color, visibly or in the finished products [12].

Table 2: Amounts of vitamin D–added foods within the NDNS for the fortification scenario of wheat flour at 10 mg vitamin D/100 g.

S no.	Food	Wheat flour (%)	Additional amount of vitamin D, mg/100 g edible portion
1.	Flour		

a)	White household plain	100	10
b)	Wholemeal	100	10
c)	Brown	100	10
d)	Chapati brown	100	10
e)	Chapati white	100	10
2.	Bread		
a)	White	63	6.3
b)	Wholemeal	60	6
c)	Brown, granary, and wheat germ	60	6
3.	Biscuits	50	5
4.	Buns, cakes, and pastries	45	4.5
5.	Fruit pies	30	3
6.	Sponge-type puddings	30	3
7.	Pizzas	25	2.5
8.	Dumplings	25	2.5
9.	Yorkshire pudding made with whole milk	25	2.5
10.	Welsh rarebit on white toast	25	2.5
11.	Cheese and onion pasty, purchased	25	2.5

Within the population of India, the amount of additive used for the fortification of wheat with effective results is 10 mg of vitamin-D per 100 g***2.*** of wheat flour. In this experiment, the result shows that when the product is consumed, it fulfils the Required Nutrition Level (RNI) as well as the uptake level (UL) for vitamin-D and the daily mean intakes for vitamin-D were increased from 3.7 to 10.8 mg. This change also shows some positive results as the reduction of RNI from 93% to 50% [10].

Milk: -

Milk is widely consumed in all over the world and is also the one of the best fortification vehicles. In India, milk is in demand but fortification of milk with vitamin-D is rare. India is the largest producer of dairy milk in the world. Unhomogenized milk has some factors to focus

on, such as the high concentration of lipids in the upper layer. Because Vitamin-D is fat soluble, it requires the homogenization of the milk to fortify it, and with this process the cost of milk will increase [11].

Strategies of fortification:-

- **Mass/Mandatory Fortification: -**This type of fortification takes place based on analysis of the required micronutrient deficiency among the population (such as milk, flour etc).
- **Targeted Fortification:** -It specifically focuses on particular subgroups having deficiency of micronutrients and provides sufficient amounts of micronutrients to a large proportion of the population on a daily basis (Such as food for infants and institutional programs).
- **Voluntary Fortification:** -This focuses on the marketability and sales of the product because of the micronutrient availability in the processed food [11].

Market observation:

Analyzing the data can show us some unexpected results for the demand of the product. We can even check the substitute products available for that. By comparing it we can even have a result with very negligible error. We can calculate the own-price and cross-price elasticity to confirm the price of the product according to its demand. Some expected results are as follows: -

i. Product price: -Difference between the price of the fortified product and the conventional product.

ii. Demand: -How this product is different from other products and the preference of the consumers.

iii. Market availability: -The availability of the fortified products in the market and how many different brands are available in the market providing fortified products.

iv. Results based on the survey conducted and the preferences of the population according to their different age groups as well as their gender.

v. How socio-economic factors affect the fortified products.

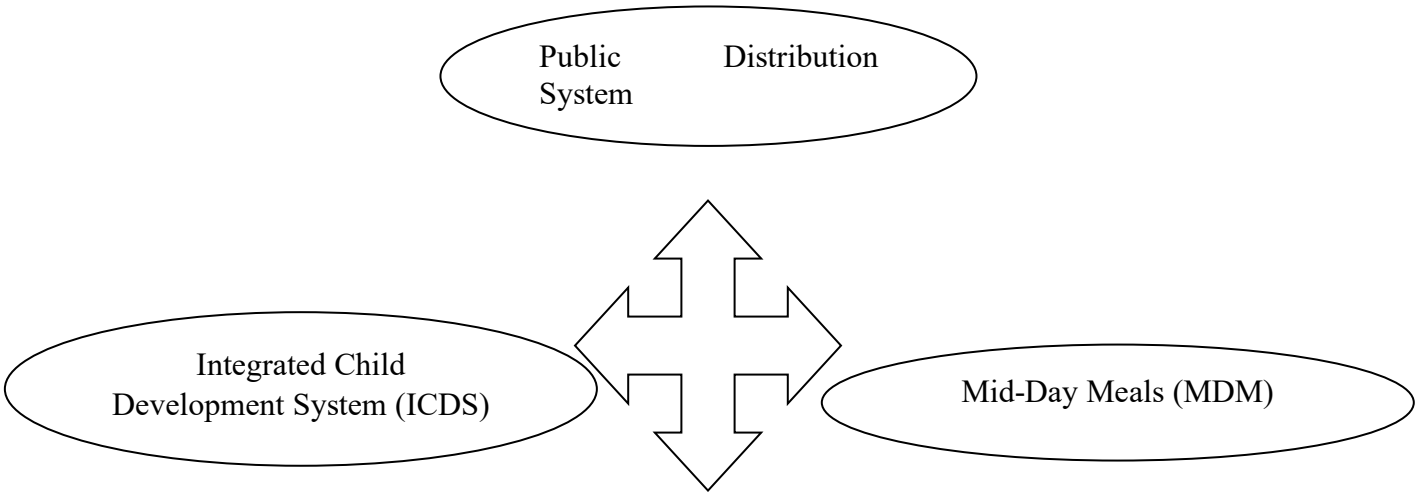
Fortified Rice: - Fortification in rice takes place in two processes.

1.1 Blending of FRK during the milling process (Mill Level) and the states like Odisha in districts Dhenkal and Gajapati (MDM) and Varanasi in Uttar Pradesh (MDM) was implemented successfully.

1.2 The blending of FRK at post milling followed up with the warehouse. Further, they have targeted states like Chandigarh (ICDS and MDM) and four districts of Maharashtra. It results in its successful work [4].

2. **Fortified Wheat Flour**: - The process of fortification takes place at Roller Flour Millers and further follows in wheat grain distributing states. It is successfully adopted and implemented in Uttar Pradesh (MDM), Haryana (ICDS), and Gujarat (ICDS). The other ways are where fortification takes place in a centralized kitchen / NGO's kitchen. Maharashtra (MDM) state had adopted fortification through this process [4].

The fortified food is distributed with the help of Public Distribution System (PDS)



- Overall 26 % of rice and 16 % of wheat were consumed through PDS in year 2011/12.
- There are different categories according to the income, lifestyle of people and the govt. of India had issued some cards on which they can receive 35 kg per household, and it also varies with the states.
  (Kozicka et al., 2016)

3. **Vitamin-D Supplements:** - In India, food fortification is lacking. Pharmaceutical companies are the only means of treatment against Vitamin D deficiency. They introduced the biochemical form of Vitamin-D3. The following supplements are available in the Indian market to recover from Vitamin-D deficiency [8].

Table: 3 Supplements of Vitamin-D in the medical stores.

Brand name	Company	Vitamin D biochemical form	Formulation	Amount of Vitamin D	Available as	Cost (INR)
Rocaitrol	Abott Healthcare Pvt. Ltd.	Cholecalciferol	Capsules	0.25 µg	10 capsules	175.4/17.5*
Calosto	Abott Healthcare Pvt. Ltd.	Calcitriol	Capsules	0.25 µg	15 capsules	198.36/13.22*
Alpha calcirol	Cadila Pharmaceutical Ltd.	Alfacalcidiol	Capsules	0.25 µg	10 capsules	48.87/4.8*
Alfarich	Cipla Ltd.	Alfacalcidiol	Capsules	0.25 µg	10 capsules	54.30/5.4*
Alfado	GlaxoSmithKline Pharmaceuticals Ltd.	Alfacalcidiol	Capsules	0.25 µg	10 capsules	54.30/5.4*
Alfa D3	GlaxoSmithKline Pharmaceuticals Ltd.	Alfacalcidiol	Capsules	0.5 µg	10 capsules	268/26.8*
Rocaltrol	Sun Pharmaceutical Industries Ltd.	Calcitriol	Capsules	0.25 µg	10 capsules	123/12.3*
Alphadol	Panacea Biotec Ltd.	Alfacalcidiol	Capsules	0.25 µg	10 capsules	169/16.9*
Vitanova SG	Zuventus Healthcare Ltd.	Cholecalciferol	Capsules	60,000 IU	10 capsules	250/25*
Quente D3	Stanley Healthcare	Cholecalciferol	Capsules	60,000 IU	4 capsules	86.25/21.5*
Minroset	Win Medicare Ltd.	Alfacalcidiol	Capsules	0.25 µg	10 capsules	56.8/5.6*
Calcit SG	Zudus Cadila Healthcare Ltd.	Alfacalcidiol	Tablets	0.25 µg	10 tablets	94.40/9.4#
Vitalcal	Genesis Biotec Inc.	Cholecalciferol	Tablets	60,000 IU	4 tablets	96.00/24#
Hira D3	Hiral Lab Ltd.	Cholecalciferol	Tablets	60,000 IU	4 tablets	80/20#
Calcit SG	Zudus Cadila	Alfacalcidiol	Tablets	0.25 µg	10 tablets	94.40/9.4#
Arachitol	Solvay Pharma India Pvt. Ltd.	Cholecalciferol	Injection	600,000 IU	1 injection (2 ml)	34
Fovit D3	Forgo Pharmaceuticals (P) Ltd.	Cholecalciferol	Injection	600,000 IU	1 injection (1 ml)	21.90
D3 UP	Abott Healthcare Pvt Ltd.	Cholecalciferol	Granules	60,000 IU	1 sachet	21
Caldikind	Mankind Pharmaceutical Pvt. Ltd.	Cholecalciferol	Granules	60,000 IU	1 sachet	21
Calotec D3	Lupin Laboratories Ltd.	Cholecalciferol	Powder	60,000 IU	1 g	29
Sorvate	Glenmark	Calcitriol	Ointment	0.0003%	20 g	175
Rosical	Sun Pharma	Calcitriol	Ointment	3 µg	15 g	213

INR: Indian national rupees, *: cost per capsule; #: cost per tablet

Table taken from *(Lhamo, et al., 2016)*

Micronutrient's intake was less/declined except for Vitamin-A and C over the period 1975-1979 to 2011-2012. A decrease in the ratio of prevalence of under nutrition for underweight, wasting, and stunting was 34%, 8%, and 38% respectively for the same period among children 1-5 years of age [9].

A newsletter was published, Food Fortification Resource Center (FFRC), and mentioned the fortified variants available in the open market. There are 157 fortified brand variants available, which are as follows: -

80 brands of Fortified edible oil,
55 brands of Fortified milk,
12 brands of Fortified wheat flour,
02 brands of Fortified rice,
08 brands of double fortified salt (*FFRC EXPRESS First Edition, July 2020*).

As per the *Food Fortification Initiative*, 18 states have been targeted in India where they will support fortified wheat flour and rice in an open market by the year 2050. But currently, they are working with four states of India (Haryana, Maharashtra, Rajasthan and West Bengal). In Haryana, they had introduced the fortified wheat flour across 22 districts with the help of the Mid-Day Meal program (MDM) and Integrated Child Development Services (ICDS) by the end of the year 2020 [3].

Hypothesis and Objectives

Socio-economic factors affect the fortified products. The opinion of the public regarding their preferences for either fortified product or other products will influence their acceptance and purchase. We can conduct a survey through which it is easier to explain what the public thinks about the fortified products and what is the

public concerned most about in their nutritional diet to maintain their health.

The objectives of this project are:

1. To investigate socio-economic factors affecting fortified products.
2. To estimate the availability of fortified products in the open market.

Methods: -The survey can help to obtain the most accurate data, which could have some practical conclusions.

1. Survey questions would be as follows: -

a) Personal details (name, age, sex, state, anything they want to share)
b) About fortified product (for them what is it exactly)
c) Products they are using on regular basis (such as fortified milk, fortified skim milk, and so on)
d) What type of product do they want to buy?
e) Anything they want to share.

2. The Survey should be electronic because it can reach to different parts of the country.
3. Data will be obtained from the country's official site where they can be used to check on the price of the product as well as its consumption with respect to states.
4. Analyze the data with help of Stata MP 17 software.

Expected Outcomes: -

1. The survey will be conducted, and the data will be processed in the software. The socio-economic factors should have some impact on buying the fortified products such as difference in age, gender, income, etc.
2. This is the initial stage where fortified products are introduced through the Public Distribution System (PDS). Different organizations are working to supply the fortified food to the open market, but currently there are only 157 brand variants available in the open market for the public.
3. People prefer to have a nutritional diet with most concern for their health.
4. The fortified products are in high demand in the market.

Research questions and Future questions:

I can recommend a few things so that the new research could be followed with specific additional research:

1. What could be the new technology to fortify milk in India and would not have much effect on retail price?

   There are still few things needed to be researched on the basis so that the fortification process can be followed on the products which are high in demand but have some limitations.
2. What is the difference basis on developed and developing based on fortification?

   Difference should be on the types of Fortified products, their availability, their demand, and price difference.
3. What could be the substitutes for the fortified products?

   Effect of the substitute on the fortified product as well as on its cross and own price elasticity.

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