

Nutritional Interventions for Fluorosis Mitigation under INREM Foundation's programme in Jhabua

1. Overall concept

Good nutrition is very important in preventing fluorosis. Some nutrients help in lesser absorption of fluoride within the body and in ejection from the body. On the other hand, continuous fluoride intake also results in certain forms of malnutrition by lesser absorption of certain nutrients within the body. This two-way link of Fluorosis with Malnutrition results in a downward spiral of increasing severity of fluorosis and malnutrition together. In some parts of India where both conditions exist together, we therefore find Fluorosis, Osteoporosis and Anaemia existing together and aggravating the effect of each other. First we understand here the main concepts behind our nutrition based approach.

Calcium: A diet poor in Calcium increases body's retention of fluoride. Fluoride increases bone metabolism and diets deficient in Calcium increases parathyroid hyperactivity. This in turn mobilizes Calcium from bones, which keeps serum levels of Calcium low, which in turn weakens bones causing osteoporosis. Daily requirement of Calcium for pre-school children is 500-800 mg, but for Fluorosis affected patients, this consumption should be higher.

Magnesium: Magnesium helps in elimination of Fluoride by competing with Calcium. Daily requirement of Magnesium is 350-500 mg. It has been observed that daily consumption of Magnesium increases the ejection of Fluoride through Urine.

Vitamin C: The role of Vitamin C in preventing fluoride metabolism is not fully understood, but it can be seen as a first layer of defense against fluoride. The consumption of Vitamin C in higher amounts has been seen to result in more ejection of Fluoride from body and less severity of Fluorosis.

Apart from these, evidences suggest that overall malnutrition has a link with fluorosis severity. It has been advised to have an anti-oxidant rich diet along with proteins, Iron and other micronutrients. The connection of Fluoride with Iron deficiency Anaemia is also important. It has been seen that Fluoride results in temporary destruction of Mucosa membrane causing lower absorption of micronutrients. This directly results in poor absorption of Iron and then, Anaemia. The consumption of safe fluoride-free water has been seen to reverse this effect.

Interested readers are referred to the following texts for further reference:

1. *Treatise on Fluorosis* by Dr. A. K. Susheela
2. *Endemic Skeletal Fluorosis* by Dr. Raja Reddy
3. *Impact of nutrition on fluorosis* by Industrial Toxicology Research Centre, Lucknow and UNICEF
4. *Integrated Fluorosis Mitigation* by NEERI and UNICEF

2. Approaches

Specifically when we look at tribal population such as in Jhabua, MP, affected with a type of fluorosis highly influenced by malnutrition, we need a combination of strategies that can tackle the problem upfront and also have a sustainable influence through food and dietary habits. The local diet is almost completely Maize based with little of Wheat, Tuwar Dal and other pulses. Our studies show that though this current food habits provide important nutrients, they are insufficient to satisfy overall nutrition needs (see Table 1). Meat consumption, once quite common in forest based habits, has reduced due to resource depletion and cultural influences, thereby reducing intake of proteins, Iron and other important nutrients. There is very less to nil, milk consumption with goat rearing more common than cows and buffaloes, which also if existing, yield very less milk. Study with observation of local marketplaces (*Haats*) by INREM also shows that available food quality is poor, food availability is highly intermittent with seasons, purchasing capacity is beyond the ability of people and poor storage capacity at home does not allow for sufficient weekly purchases. Moreover, fluoride has started entering food that is consumed (Table 2).

Table 1: Nutrition content of Maize in Jhabua

	Maize (Sample no. 1110)	Maize (Sample no. 1111)	Maize (Sample no. 1112)
Calcium (mg/kg)	148.93	381.47	238.65
Magnesium (mg/kg)	1074.22	1348.88	1140.18
Iron (mg/kg)	43.95	67.14	129.45
Crude protein (%)	22.16	12.49	6.54

Table 2: Fluoride content of food items in Jhabua

	average			maximum		
	Miyati	Jasoda Khunji	All	Miyati	Jasoda Khunji	All
Chana	3.55	1.18	1.97	3.55	1.45	3.55
Jowar	3.22	0.78	2	3.22	0.78	3.22
Maize	1.08	0.66	0.92	2.78	0.86	2.78

Paddy	2.59	0.63	1.61	4.7	0.78	4.7
Tuwar Dal	2.9	1.24	2.62	5.77	1.24	5.77
Udad	0.81	NA	0.81	1.97	NA	1.97
Wheat	1.17	0.72	0.95	2.68	0.82	2.68

This situational background requires us to tackle the problem from many angles. In the longer term, food habits need to converge towards a more nutritious diet, but this is not possible unless the market supplies it and people can afford it. Since, to some extent, entry of fluoride in food cannot be avoided, we must look at ways of countering it within the body. Also prevention of disease should be of prime importance, eg. focussing on proper food for infants and their mothers so that juvenile fluorosis and pregnancy related fluorosis is avoided. We look at three approaches:

- a) Pharma supplements
- b) Food and herbal/Ayurvedic supplements
- c) Fortification of food

3. Our experiences

Within INREM's fluorosis mitigation programme in Jhabua, many of following approaches have been tried. We list them here:

- a) Til Chikki
- b)

Sesame (*Til*) and Jaggery (*Gur*) are very good sources of Calcium and Magnesium. Sesame has 1000 mg Calcium and 360 mg Magnesium per 100 g, whereas Jaggery has 1638 mg Calcium per 100 g. From our calculations, one *Til-Chikki* (Sesame and Jaggery) or a *Laddu* of weight 20 gms, provides 237 mg of Calcium and 32 mg of Magnesium and overall 282 Calories of energy. Especially in the winter season, this is easier to store and consume. We have provided one such *Chikki* per day to our patients for 3 winter months. This has been a very successful effort in our work, but the problem of delivery remains. It is hard to restrict the consumption to patients only and that too ask them to keep the savouries intact till the next time of delivery.

- c) Calcium-Magnesium tablets
- d)

In order that a basic minimum amount of Calcium and Magnesium is consumed by patients, we recommend pharma-supplements for these. The combination that we provide has a content per tablet of: Calcium (210 mg elemental), Magnesium (100 mg elemental), Zinc (4 mg elemental), Vitamin D3 (200 I. U.). The advantage of providing these tablets has been

that they are easy to deliver and we can be sure that it is being consumed by the patient only. Currently we advise usage of this supplement for 2 years.

e) Dried Amla (Gooseberry)

f)

One of the highest sources of Vitamin C is Amla (Indian Gooseberry). It has 700 mg per 100 g of fruit pulp. However availability is only for 2-3 months a year from December to March. There are many traditional methods of storing Amla for year-around use. Drying in shade, pickles, *Morabba* are some common methods. We have tried dried form of Amla in Salted and Sweet form. The sweet candy form generally is useful for immediate consumption and attracting people towards this. The salted form can be consumed directly or within *Dal*.

The salted Amla we provide are of 1-2 gms size. Generally a few of them are used within *Dal*. Or calculations show that one such piece of 1 gm weight contains around 20 mg of Vitamin C.

g) Soya items

Though there is high Soya production in Jhabua, there is no consumption of Soya as food. However Soyabean oil is used for cooking purposes. Also, textured Soy chunks, also known as textured vegetable protein, locally known as *Vadi* is liked by people due to its texture similar to meat. However, people are mostly not aware that it is made from Soya. Often households have several quintals of Soya production, but they sell it entirely to the market. We requested farmers to keep aside 5-10 kgs, and collected around 100 kgs in 2011-12 season. Using these, we have prepared a Soya Laddu/Chikki/Sukhdi using collected Soya, groundnut and Ghee. Families have been trained to prepare this and response has been very good.

h) Milk powder

Since milk is a very important source of Calcium, we emphasize that milk consumption is a must. However, with no habit of drinking milk and no production, it is very difficult to think of how people can consume milk in this area. Also, towns are far away and buying milk form there is very difficult. We thought of re-packaging commercially available milk powder into small sachets and providing it at cost price to families. We have had very good response and slowly families are obtaining ½ kg and 1 kg packets also now. Our experience shows that there is good commercial potential in Milk powder sold in small packets for these areas. This might be one way to provide milk equivalent nutrition to such places.

i) Amla tablets

When we look at practicality of delivery, storage and acceptance by people, then in the short term, what interests people are “tablets” or the faith people seem to have in them. With Amla,

the sweet is immediately consumed by people and perceived as a savoury. The salted form gets distributed at a family level and some families complain that the taste that it adds to Dal makes it salty. We then thought of Amla powder and along with a Ayurvedic doctor of Anand, Gujarat realized that Amla powder can be made into tablets. Each tablet of 750 mg contains roughly 20 mg of Vitamin C.

j) Ayurvedic sources

We are also currently looking at Ayurvedic sources of nutrients and combinations that help in better assimilation. One such combination is that of a neutralizing mixture of *Yashtimadhu, Ushir, Rakta Punarnava, Gokhru, Prabal and Moti*. The effectiveness of this combination to detoxify fluoride from the body is currently under observation.

4. Current thinking

After our above experiences in nutritional mitigation of fluorosis in Jhabua, we feel that a holistic approach is necessary to look at this aspect. In the short run, we are trying Pharma supplements of Calcium, Magnesium (along with Vitamin D3 and Zinc) and Amla tablets. But our experience with the Ayurvedic neutralizing mixture can tell us later whether we can use such combination for detoxification of fluoride from the body. However for longer term sustainability, we have started providing milk powder at cost price which families are accepting. Also, items like Til Chikki and Soya Sukhdi can provide the much needed additional nutrition. We have not tried fortification of Maize which could be a very effective intervention too. Most importantly however, for the long run, food habits need to change.

Table 3: Different experiences of nutritional interventions in INREM's fluorosis programme

Nutritional Intervention	Type of Supplement	Dosage and frequency
Calcium, Magnesium, Vitamin D3 and Zinc Tablets	Pharma Supplement	1 tablet per day providing 210 mg Calcium, 100 mg Magnesium, 200 I. U. Vitamin D3 and 4 mg Zinc
Amla tablets	Dried fruit extract in tablet form	1 tablet per day providing 20 mg of Vitamin C
Milk powder	Dried powder	Provided at cost price to families
Til Chikki	Food Savoury	1 per day in Winter; 237 mg of Calcium and 32 mg of Magnesium for 20 g piece
Soya Chikki	Food Savory	Significant source of Proteins, Calcium and Magnesium; not estimated yet
Amla (dried)	Dried fruit	20 mg of Vitamin C in 1 g piece
Neutralizing mixture	Ayurvedic	Mixture enabling detoxification of fluoride and absorption of Calcium

Also, we need to be following a “life cycle” approach as provided in Table 4 by Ms Suneetha Sapur.

Table 4: Age group wise possible nutrition interventions

Age Group	Intervention
Pregnant / lactating women	<ol style="list-style-type: none"> 1. Iodised salt 2. Calcium supplements 3. Inclusion of soya/til chikki with amla 4. Soya flour in makki ki roti flour 5. Use of dehydrated green leaves everyday
0-6 months	<ol style="list-style-type: none"> 1. Exclusive Breast feeding
6 months -1 year	<ol style="list-style-type: none"> 2. Traditional Weaning foods 3. Plain <i>Sathu</i> (made from <i>chana</i>) without soya 4. <i>Sathu</i> with the micronutrient fortification
1-5 yrs	<ol style="list-style-type: none"> 1. <i>Sathu</i> with soya and micronutrient fortification
School going children	<ol style="list-style-type: none"> 1. Inclusion of different soya foods in the mid day meal program 2. Pharmalogical intervention (Calcium Capsules to all the school going children 3. Use of dehydrated green leaves everyday

A holistic approach looking at all the above possibilities is needed to first arrest the immediate problem of Fluorosis and then also look at longer term sustainability of such good nutritional habits.