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PREVALENCE OF VITAMIN A DEFICIENCY IN FISHERFOLK CHILDREN (6-8 YEARS) OF EAST GODAVARI DISTRICT AND EFFECT OF SUPPLEMENTATION OF ORANGE FLESHED SWEET POTATO

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ABSTRACT

In today's world, poverty still exists among people from lower strata and isolated communities. In India, 60.7% of the fisherfolk community are below the poverty line (BPL) and 97.3% of the fisherfolk of Andhra Pradesh are under BPL. One thousand artisanal fisherfolk children (6-8 years) from coastal regions of Kakinada were screened clinically for symptoms of Vitamin A deficiency and other micronutrient deficiencies. Among them, 23.4% showed moderate to severe clinical symptoms of Vitamin A deficiency and were selected for the study. The biochemical test results showed that the mean serum retinol of all the subjects was significantly below the standard values (0.2-0.5 mg/L). In the study, 100 gm of boiled orange fleshed sweet potato which provides 788µg of Retinol Activity Equivalents (RAE), thus, meeting 124.7% of the Recommended Dose of Allowance (RDA) was fed to the children 5 days a week for a period of six months. Orange fleshed sweet potato is a rich source of beta carotene and fibre. The subjects showed significant improvement in their clinical symptoms and 67% showed rise in their serum retinol levels after supplementation.

Key Words: Fisher-folk community, School Children, Vitamin A deficiency, Bitot's spots, Blood Serum Retinol, Orange fleshed sweet potato, Supplementation

INTRODUCTION

India has a large coastline, approximately 8,118 km long. Nearly three million fish workers depend on fishing for their livelihood along this coastline. In India, 60.57% of the fishermen families are under the BPL category as per CMFRI (2010-2011) reports. In coastal Andhra Pradesh, 97.3% of fishing families are under BPL except for some employees and mechanized boat owners (CMFRI, Kochi 2011). Out of 1,63,427 marines fishing families in coastal Andhra Pradesh, 1,59,101 families are under BPL. Children ought to be a prime concern of all societies. The early years of a child's life are very important for his or her development.Poverty hampers growth physically, socially, emotionally, and educationally. (Yoshikawa *et al*.2012). 'Hidden Hunger' (iron, vitamin A and iodine deficiency), affects the health, learning ability as well as

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productivity owing to high rates of illness and disability contributing to a vicious cycle of malnutrition, underdevelopment, and poverty (Thompson and Amoroso, 2011). In India, around 0.5 percent of total deaths in 2016 were contributed by nutritional deficiencies (Gonmei and Toteja, 2018).

Vitamin A deficiency is the leading cause of preventable childhood blindness and increases the risk of death from common childhood illnesses such as diarrhoea (UNICEF, 2019). It is recognized as a public health issue in developing and underdeveloped countries. It is also pictured that xerophthalmia which occurs due to vitamin A deficiency is the initial cause of night blindness and Bitot's spots in the early stages which precedes keratomalacia. Children are the most vulnerable and are easily prone to vitamin A deficiencies due to reduced dietary intake and poor absorption leading to depleted vitamin A stores in the body. Factors that add fuel to the issue are a high incidence of infectious diseases like diarrhoea, worm infestations, measles, other respiratory diseases, and economic constraints, geographical isolation, socio-cultural limitations, and high illiteracy levels (Melissa Miller *et al.*, 2002)

A study carried out by Sachdeva *et al.* (2011) among pre-school children in the State of Uttar Pradesh reported a high prevalence of xerophthalmia (9.1%), Bitot's Spot (5.4 %) and severe forms of Vitamin A Deficiency such as corneal ulceration (0.2%) and corneal scar (0.5%). Similarly, a higher prevalence of clinical Vitamin A Deficiency (Bitot's Spot 2.1%) was reported by Naresh, *et al.* (2011) among urban children in the state of Gujarat. Nimmathota Arlappa *et al.* (2016) in their study among rural pre-school children of four South Indian states viz. Kerala, Tamil Nadu, Andhra Pradesh and Karnataka have observed that the prevalence of Bitot's spot, an objective ocular sign of Vitamin A Deficiency among the rural pre-school children of South Indian was 0.6%.

In the face of continuing poverty and malnutrition, an alternate strategy of development becomes a priority thus giving rise to several interventional programs. Holtz *et al*. (2012) in their research stated that the consumption of â carotene-rich orange-fleshed sweet potato helps to alleviate vitamin A deficiency. They have also stated that large-scale intervention to introduce orange-fleshed sweet potato as a staple food, into the diets of women and children to improve their vitamin A status and minimizes the risk of Vitamin A deficiency. Pro-vitamin A-rich orange-fleshed sweet potato works as a good strategy to reduce vitamin A deficiency particularly in children and women in developing countries (De Brauw *et al*., 2019).

Objectives

The study was aimed to assess the prevalence of vitamin A deficiencies in fisher-folk children (6-8 years) of East Godavari District; assess the effect of supplementation of boiled orange-fleshed sweet potato in improving the clinical symptoms of Vitamin A deficiency and Serum retinol level in selected children.

MATERIAL AND METHODS

The study was taken up to assess the nutritional status of artisanal fisher-folk children, aged 6-8 years which also included the assessment of intervention, planning, and execution of an effective intervention module to improve vitamin A status of the selected children

residing in eight coastal villages in and around Kakinada, East Godavari District of Andhra Pradesh during July 2016 to December 2019. The areas selected for the study are the coastal areas in particular, in the District of East Godavari of Andhra Pradesh state with a focus on the children of artisanal fishing communities. Out of all the fishing villages in the district, eight fishermen villages namely, Chollangi, Nemam, Vakalapudi, Valasapaka, Uppada, Mulapeta, Ponnada and Konapaapapeta, were selected on the basis of feasibility of conducting study, availability of subjects and cooperation from the authorities. A total of 15,658 houses identified with the help of population census from panchayat records and from which 8451 houses belonged to the fishermen families. Fishermen families having the below poverty line ration card were chosen and surveyed to extract the data of the children aged 6-8 years and 1000 children aged 6-8 years were identified. They were screened for Vitamin A Deficiency with the help of a medical practitioner. Biochemical test for serum retinol was done for accurate identification of Vitamin A deficiency. The identified children with low serum retinol levels (> 0.2-0.5 mg/l) were then subjected to intervention. As orange fleshed sweet potato is a very rich source of beta-carotene, a detailed study about sweet potato was done at Central Tuber Crops Research Institute (ICAR), Thiruvananthapuram on different varieties of sweet potatoes from which a new variant of orange fleshed sweet potato known as 'Kamala Sundari' was selected for the supplementation due to its high beta-carotene levels and its availability in the study area. Boiled orange fleshed sweet potato of 100g which provides 788µg of Retinol Activity Equivalents (RAE) was fed to the children along with the morning breakfast at their respective schools five days a week for a period of six months. The orange fleshed sweet potato has good concentrations of pro-vitamin A â-carotene, moderate presence of phosphorus and potassium and low concentrations of calcium, magnesium, zinc and sodium. The role of orange fleshed sweet potato was reported in the prevention of Vitamin A malnutrition in developing countries (Satheesh and Workne,2019). So, introducing it in the fishermen's diet was an innovative approach to combat Vitamin A malnutrition in the selected area of research.

This study was approved by the Institutional Human Ethics Committee with the approval no. AUW/IHEC-17-18/FSN/FHP-05. Permission to conduct the study was obtained from the District Medical and Health Department of East Godavari District.

The different methodological procedures adopted for the study have been distinctly presented under the following five phases each evolving from the previous one so that findings were validated, refined, modified and accumulated at every stage. The five phases of the study were:

Phase I — Selection of the area and screening of Fisher-folk children for vitamin A deficiencies.

Purposive sampling has been done for the selection of the area and the community. Secondary data available with the government authorities and school authorities was utilised for the identification of children aged 6-8 years belonging to fisherfolk communities below the poverty line. The clinical assessment of children was done along with a certified medical

practitioner to identify the clinical signs of Vitamin A deficiency which includes Bitot's spots on the eyes, dryness of eyes, night blindness, Conjunctival Xerosis, etc., and symptoms of Iron Deficiency Anaemia such as pale pallor, pale conjunctiva, fatigue and Koilonychia

Phase II — Assessment of Blood Serum Retinol levels in selected subjects.

Serum Retinol was estimated using High-performance liquid chromatography (HPLC) method. Three ml blood was drawn from the subjects after an overnight fasting and wrapped in aluminium foils to avoid excessive light exposure. The serum or plasma was separated and refrigerated. The serum samples procured were treated with retinyl acetate in absolute ethanol and n-hexane. The mixture was the centrifuged after which the clear hexane layer was carefully drawn in another test tube, evaporated and treated with methanol. The aliquot, thus prepared was injected into the HPLC loop for serum retinol level determination.

Phase III — Selection, Preparation and nutritional analysis of boiled sweet potato for supplementation.

A detailed study about sweet potato was done at Central Tuber Crops Research Institute (ICAR), Thiruvananthapuram on different varieties of sweet potatoes from which a new variant of orange fleshed sweet potato known as 'Kamala Sundari' was selected for the supplementation due to its high beta-carotene levels and its availability in the study area. The boiled orange fleshed sweet potatoes were subjected to nutrient analysis namely moisture, protein, fat, carbohydrate, fibre, calcium, iron, thiamine, riboflavin, vitamin B6, Vitamin A, and Vitamin C was estimated at the School of Food Technology, JNTUK Food Testing Laboratory by High-performance Liquid Chromatography (HPLC) and Gas Chromatography (GC) techniques. Organoleptic testing of the boiled sweet potatoes cubes was evaluated for their acceptability by children, teachers and caretakers at randomly selected schools.

Phase IV— Grouping of children and supplementation of the boiled orange fleshed sweet potato.

One thousand children aged 6-8 years were identified in the selected fisherfolk communities residing in 8 villages. Out of them, 234 children were identified with low serum retinol levels (> 0.2-0.5 mg/l) and were placed in 2 different groups (1 experimental group and 1 control group) for intervention. Boiled orange fleshed sweet potato of 100g which provides 788µg of Retinol Activity Equivalents (RAE) was fed to the children along with the morning breakfast at their respective schools five days a week for a period of six months.

Phase V— Assessing the impact of supplementation

The serum retinol levels collected before supplementation and after supplementation were compared with the standard values recommended by the WHO by using appropriate simple statistical methods like mean, standard deviation, percentages and t test.

INCLUSION CRITERIA

Based on the following inclusion and exclusion criteria, the children were selected for the intervention programme.

School going children aged between 6-8 years.

- Children with nutritional deficiencies
- Willingness of the school management and parents to participate in the study
- Children from fishermen families categorized under the poverty line
- Children who are regular to school (at least having 75% attendance)

EXCLUSION CRITERIA

- Children with previous serious health issues like HIV, Cancer, etc.
- Children with physical deformities.
- Children who are already taking supplements.
- Children who are not enrolled into school

TOOLS AND TECHNIQUES

Venipuncture method was adapted for the collection of blood samples by trained professionals for estimating blood serum retinol levels. The concentration of Vitamin A < 0.2mg/L is recommended to indicate Vitamin A deficiency (Li *et al*., 2015).

RESULTS AND DISCUSSION

Phase I — Selection of the area and screening of Fisherfolk children for vitamin A deficiencies.

All the children were screened clinically by the investigator (with the help of a medical practitioner) for symptoms of Vitamin A Deficiency (VAD) such as Bitot's Spot, Night blindness, corneal xerosis, keratomalacia, xerophthalmia, conjunctival xerosis, etc.

The mean prevalence of Bitot's spots, an objective sign of VAD in the fisher-folk children screened, was 0.8 % (Fig.1). The mean prevalence value of 0.8 % for Bitot's spots is well above the cut off value (of > 0.5 %) indicated by WHO (2007). Thus, VAD is a significant health issue of the public among the children of the fisher-folk community screened in the present study. Although Bitot's spots and Night blindness are considered mild stages of eye disease, yet both of them represent moderate- to- severe

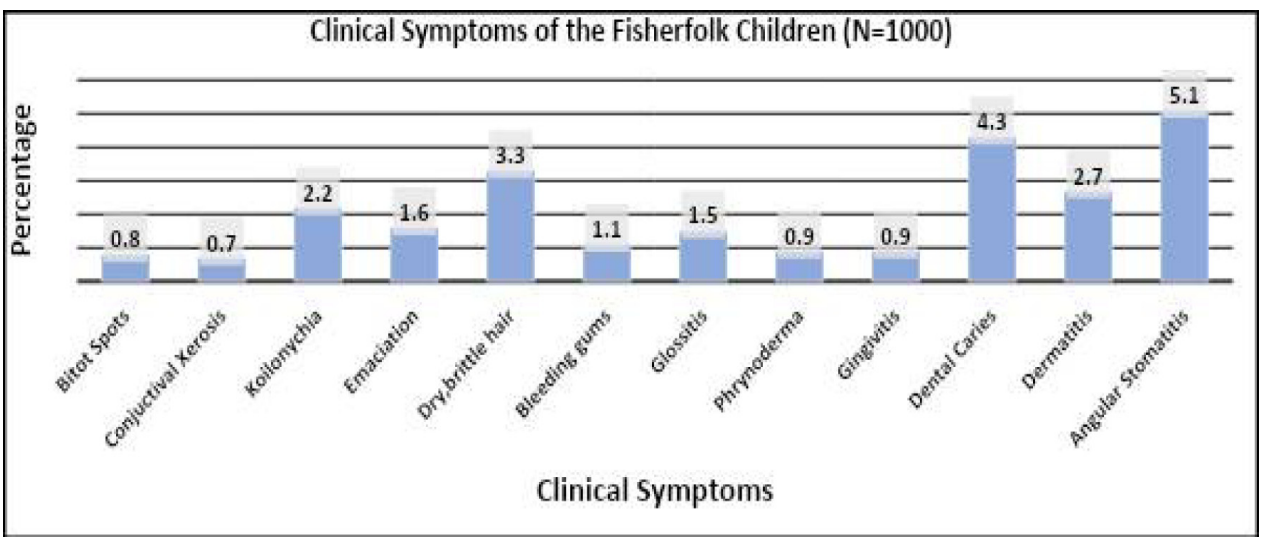

Fig.1 Clinical Symptoms of the Fisherfolk Children (n=1000)

systemic vitamin A deficiency, as they denote and are evidenced by low serum retinol concentrations (Alfred Sommer, 2008). The mean prevalence of conjunctival xerosis in fisher-folk children, a sign of VAD, was 0.7 %. The mean prevalence of koilonychia, the most visible symptom of iron deficiency anaemia in fisher-folk children, was 2.2 %. The mean prevalence of emaciation, a major symptom of protein energy malnutrition in fisherfolk children was 1.6 %. Glossitis was seen in 1.5 %, dry and brittle hair was observed in 3.3 %. The prevalence of phrynoderma was 0.9 %. Bleeding gums, a sign of vitamin C deficiency was observed among 1.1 % of children. Lack of hygiene has been anticipated by symptoms such as gingivitis in 0.9 % of children and dental caries in 4.3 %. Dermatitis was observed in 2.7 % of children and angular stomatitis, a B- complex deficiency in 5.1 % of the fisherfolk children of the present study.

The results of the study coincide with the findings of Nongrum *et al.* (2015) on "High prevalence of vitamin A deficiency among children in Meghalaya and the underlying social factors". They reported a high prevalence of clinical VAD (4.50%) in rural children of Meghalaya and much higher (5.9%) in school going children of age 5 – 15 years which is higher than the WHO global cut off of 0.5% for VAD indicating that clinical VAD is a public health problem in that area (Jenkins *et al.*2015).

The mean serum retinol of all the children was significantly below ($p< 0.01$) the standard values (0.2-0.5 mg/L) in all boys and girls of all age groups. As per WHO (2011), the prevalence in the population with low serum retinol (0.70 µmol/l or below) can be used to assess the severity of vitamin A deficiency in most age groups as a public health problem. If the degree of public health problem is 2-9% it is mild, 10% -

Phase II — Assessment of Blood Serum Retinol levels in selected children

Serum Retinol Levels of the Fisherfolk children

Table 1:Serum Retinol Levels of the Fisherfolk children Vs WHO Standard Values (n=234)

S. No	Age Group (years)	N=234	Standard Values (mg/L)	Serum Retinol Mean (mg/L)	T value
1	**6+ boys**	40	0.20-0.50	0.152 ± 0.01	-12.4**
2	**7+ boys**	41	0.20-0.50	0.155 ± 0.01	-10.5**
3	**8+ boys**	40	0.20-0.50	0.150 ± 0.02	-8.51*
4	**6+ girls**	40	0.20-0.50	0.151 ± 0.01	-11.7**
5	**7+ girls**	35	0.20-0.50	0.156 ± 0.01	-18.1**
6	**8+ girls**	38	0.20-0.50	0.149 ± 0.02	-15.8**

**-Significant at 1% level ($p<0.01$), * - Significant at 5% level

19% is considered moderate and more than 20 is considered to be a severe public health issue. The present study reveals that 23.4% of the fisherfolk children were identified as having low serum retinol concentrations in the blood thus making it a public health problem.

Phase III — Selection, preparation and nutritional analysis of boiled sweet potato for supplementation

Nutrient Analysis of Boiled Orange Fleshed Sweet Potato supplement

Orange fleshed sweet potatoes (OFSP) variety known as 'Kamala Sundari' is a rich source of beta- carotene and is available in the local market was selected, cleaned and boiled to be supplemented to the fisherfolk children.

As per the ICMR (2020) recommended guidelines, the daily recommended allowance for a child aged between 6 – 9 years is 632 µg RAE /day. In the present study, 100 gm of boiled Orange fleshed sweet potato selected for intervention provides 788µg of Retinol Activity Equivalents (RAE). So, each child has been given 100 gm piece of Orange fleshed sweet potato daily which provides 788 µg RAE which is more than the required RDA suggested by the ICMR (2020) since dietary â-carotene is a safe source of vitamin A because intestinal conversion of â-carotene to vitamin A decreases as an oral dose of â-carotene increases (Novotny *et al.* 2010). The efficiency of â-carotene conversion to vitamin A in humans is reduced at increasing doses which is why vitamin A toxicity is not observed in individuals consuming large amounts of â-carotene (Janet *et al.* 2010). Orange fleshed sweet potato also provides 72g of moisture, 1.4g of protein, 0.1g of fat, 17.7g of carbohydrates, 2.5g of fibre, 12.8mg of vitamin C, 0.17mg of Vitamin B6, 0.05mg of riboflavin, 0.06mg of thiamine, 0.7mg of iron and 27mg of calcium.

Table 2: Nutritive analysis of orange fleshed sweet potato (100g)

S.No	Nutrient	Nutritive value
1	Moisture (g)	72
2	Protein (g)	1.4
3	Fat (g)	0.1
4	Carbohydrates (g)	17.7
5	Fibre (g)	2.5
6	Vitamin A(RAE)	788
7	Vitamin C (mg)	12.8
8	Vitamin B6	0.17
9	Riboflavin (mg)	0.05
10	Thiamine (mg)	0.06
11	Iron (mg)	0.7
12	Calcium (mg)	27

Phase IV— Grouping of children and supplementation of the boiled orange fleshed sweet potato

Two hundred and thirty-four children aged between 6-8 years who were detected having Vitamin A deficiencies were selected for supplementation and were placed in 2 different groups (One experimental group and one control group). The selected 234 subjects comprising 121 were boys and 113 were girls. Group 1 comprised 115 children who were supplemented with 100g of sweet potato along with school meal,

Table 3. Mean Serum Retinol Levels of Gr.1 and Gr.2 Children Before and After Supplementation (n=234)

Mean Serum Retinol Levels of Gr.1 and Gr.2 Children Before and After Supplementation								
S. No	**Age**		**No.**	**Standard Values (mg/L)**	**Before (mg/L)**	**After (mg/L)**	**Differ-ence**	**T value**
1	**6 years**	Group 1	115	0.20-0.5	0.15±0.014	0.18±0.015	0.03±0.08	2.54*
		Group 2	119	0.20-0.5	0.15±0.016	0.15±0.014	0.0±0.009	0.78*
2	**7 years**	Group 1	115	0.20-0.5	0.15±0.020	0.17±0.012	0.02±0.01	2.18*
		Group 2	119	0.20-0.50	0.16±0.01	0.16±0.01	0.0±0.009	0003NS
3	**8 years**	Group 1	115	0.20-0.50	0.15±0.017	0.18±0.015	0.03±0.01	7.04**
		Group 2	119	0.20-0.50	0.16±0.02	0.16±0.017	0.0±0.009	0.43*
****-Significant at 1% level (p<0.01), * - Significant at 5% level, NS - Not Significant**								

five days a week for a period of six months. Group 2 comprised 119 children who were the control group and were given only the school meal for a period of six months.

Phase V— Assessing the impact of supplementation.

Effect of Supplementation of Boiled Orange Fleshed Sweet Potato on Serum Retinol Levels in Children

Table 3 shows the serum retinol levels in Group 1 and Group 2 children before and after supplementation.

When compared with the standard values, the mean initial serum retinol levels in both the groups were identified to be below than required. But after supplementation, the mean final serum retinol had increased significantly at 5% and below 5 % level in Group 1 children who were supplemented with 100 gm of boiled orange-fleshed sweet potato (OFSP) for six months by 67%, whereas, Group 2 children who were not supplemented with OFSP showed no improvement. These findings are similar to the study of Jenkins *et al.* (2015), who stated that food-based approaches encouraging the consumption of vitamin A-rich foods, such as orange-fleshed sweet potato have the potential to positively affect vitamin A status in population deficit in vitamin A levels. The results of the study showed that > 50% of the intervention children who consumed orange-fleshed sweet potatoes 3-6 days a week showed a rise in their serum retinol levels. Though the increase in the serum retinol level is less when compared with the findings of a study done in Mozambique, the absorption of Vitamin A might have been reduced due to insufficient intake of fat and fibre in the diet. Carotene bio accessibility depends on the food matrix, the type of fibre and fat in food, and the heat and the homogenization caused by food processing (Veda *et al.,* 2006).

CONCLUSIONS

Vitamin A deficiency is a problem of public health among fisher-folk children. The mean prevalence of Bitot's spots, an objective sign of Vitamin A deficiency in the 1000 fisher-folk children surveyed was 0.8 % which was well above the cut off points (>0.5%) suggested by the World Health Organization. Orange flesh sweet potato has a tremendous potential to tackle the problem of Vitamin A deficiencies. Sixty -seven percent of the children showed improvement in their serum retinol levels after supplementation. The control group showed no improvement in their serum retinol levels. It is revealed that orange fleshed sweet potato consumption helps to increase serum retinol levels and if supplemented for a longer period along with the recommended amount of fat in the diet would help in alleviating Vitamin A deficiencies.

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