CHAPTER I

INTRODUCTION

India is undergoing rapid nutritional transition due to globalization, resulting in excess consumption of calories in the form of carbohydrate and fat. The food consumption patterns are highly skewed towards fat and sugar based products which eventually lead to nutrient deficiencies (Government of India - GOI, 2008).

Nutrient deficiencies leave an unendurable burden not only on individuals and the nationwide wellbeing but also on the entire cultural, societal and economic structure of the country. They comprise one of the greatest and most preventable obstacles in the fulfillment of human potential. Though the cost of dealing with the effects of nutrient deficiencies is high, the prevention of nutrient deficiencies is much less. Investing in nutrition, therefore, not only is a moral imperative, but also makes economic sense as it reduces health care costs, improves productivity and economic growth and promotes education, intellectual capacity and social development (Food and Agricultural organisaton- FAO, 2010).

Individual nutrients have received variable attention and proteins, vitamins and minerals are among them. The levels of intake of nutrients have been a cause of concern for being potentially on the low side. Two such nutrients that are deficient in the diet of all ages are protein and calcium. The primary function of dietary protein is to provide amino acids that are required for the replacement of endogenous loss of body proteins due to wear and tear, synthesis of new tissue proteins during growth, pregnancy and lactation and synthesis of enzymes, blood proteins and hormones of protein nature. Adequate amount of protein in the diet is therefore needed to carry on with these vital processes (Swaminathan, 2008).

Calcium is essential for the formation of bones and teeth, clotting of blood, regulation of permeability of capillary walls, contraction of heart and muscles and regulation of excitability of nerve fibers. Calcium deficiency symptoms include muscle aches and pains, muscle twitching and spasm, muscle cramps and reduced bone density (Srilakshmi, 2002).
The importance of diet for a healthy life has been amply demonstrated. Changing culinary and social habits have led to low intakes for some vitamins and minerals compared to those being recommended for all groups of population. Proteins, vitamins and minerals may be ingested from a variety of foods that are eaten as part of the daily diet (Silver, 2009).

Nutrition-sensitive, food-based approaches are consequently needed to focus on food, whether natural foods or processed foods, for improving the quality of the diet and for overcoming and preventing deficiencies.

1.1 **Nutritional significance of protein**

Proteins have many functions. Some proteins are utilised in building tissues for growth. They may also be used in replacing worn out or damaged tissue. Many parts of the body including muscles, skin, hair etc. are proteins and many cellular structures contain proteins. Hence, when new cells and tissues are formed as in growth of children or in repair process in healing, large amount of proteins are needed (Swaminathan, 2008).

Enzymes are partly or wholly proteins and there are thousands of enzymes present in cells catalysing various biochemical reactions including metabolic reactions necessary for digesting various foods for deriving energy and useful materials from them. Proteins are also needed for nuclear processes such as DNA replication, RNA synthesis etc. There are many proteins that act as hormones. Insulin is one example that regulates blood glucose levels. Insulin regulates glucose metabolism and thus the blood levels of the same (Shills, Obson & Shike, 2000).

Antibodies are proteins and are extremely essential for immunity and health. Several immunoproteins are synthesized in response to invasions that neutralise pathogens thus making one immune to the disease (Joshi, 2002).

Proteins also act as transporters for nutrients through body fluids like blood. The solubility of these substances is low. So they combine with proteins (haemoglobin, lipoprotein etc.) to be transported through blood to other parts of the body where they are needed. Proteins are essential in blood clotting. Clot formation
is facilitated by fibrin protein that forms interlacing network in which blood cells get trapped and a clot is formed that plugs the opening through which bleeding occurs and consequently stops bleeding. Thus the proteins synthesized by the body perform a variety of important physiological functions like production and maintenance of structural proteins, enzymes and hormones, transport proteins, lipoproteins and antibodies and maintenance of proper fluid balance and acid-base balance (Shanmugam, 2012).

When protein intake is inadequate, the body enters a state of accommodation in which physiologic functions are compromised and the muscle mass is reduced. Muscle recovery from exercises such as strength training may also take longer when dietary protein is low. In addition, loss of muscle mass can yield symptoms such as physical weakness and lowered body weight (Young & Marchini, 1990).

When inadequate or poor quality proteins are consumed, protein malnutrition is experienced with consequent loss of muscle mass, decreased immunity, weakening of heart and respiratory system and finally death. When infants and children experience protein malnutrition, serious added problems occur including mental retardation and growth failure. Protein-energy malnutrition that results because of a low intake of both protein and calories is especially common in children in underdeveloped nations. So it is essential to have adequate amount of good quality protein in the diet (Groff, Gropper & Hunt, 1995).

1.2 Nutritional significance of calcium

Calcium has several important functions in the human body. Ninety nine per cent of the calcium is concentrated in the bones. Calcium helps form bones throughout the formative years (childhood up to about the age of 20-25 years) during which longitudinal (length) bone growth occurs (Whitney & Rolfes, 2001).

The remaining one per cent of calcium (that is not stored in the bones and teeth) is present in the blood, in extracellular fluid, inside cells, in muscle and vascular tissues, and is critical in such vital functions as: (1) Nerve impulse transmissions; (2) Muscle and blood vessel contractions; (3) Membrane permeability; (4) Blood coagulation and blood clotting; and (5) To help maintain the pH balance of
the blood. These vital functions are so important that in the facade of inadequate calcium intake or absorption, calcium stored in the bones is sacrificed (i.e., drawn out of the bones) to maintain adequate calcium levels in the blood and tissues necessary for the vital functions to occur. The amount of calcium concentration in the blood and tissues is believed to be maintained by interactions with several hormones and other nutrients, most notably magnesium and phosphorus. Magnesium balances calcium, and how it is used in the human body (Mahan & Stump, 2008).

A long-term deficiency of calcium in growing children, adolescents and adults can lead to softening of the bones and subsequently osteopenia and osteoporosis (Mahan, 2008). Calcium is known for its association with osteoporosis, a bone disease prevalent among elderly women. Osteoporosis is a disease characterized by loss of bone mass, accompanied by micro architectural deterioration of bone tissue, which leads to an unacceptable increase in the risk of skeletal failure and fracture (Nieves, 2005). The bones gradually lose calcium, thereby becoming weakened and are prone to breaking. The Indian Council of Medical Research (ICMR) recommends that women consume at least 600 mg of calcium daily to help offset the age related loss of calcium from bones (Gopalan, Rama Sastri & Balasubramanian, 2010). Particularly during adolescence and early adulthood, women should increase their food sources of calcium. The most important time to get sufficient amount of calcium is while bone growth and consolidation are occurring, a period that continues until approximately age 30 to 35 years (Willis, 1993).

Considerable epidemiological data state that peak bone mass that is attained during adolescence or young adulthood, can be maximized by raising calcium intake to the adequate intake levels. Higher calcium intakes have been related to higher bone mass in children, young adults and post menopausal women in 64 out of 86 observational epidemiological studies (Heaney, 2000).

In adults and old people, prolonged calcium deficiency can lead to brittle bones and fractures. Indian data show early onset of osteoporosis among Indian women compared to women from west. Most of these women belonging to the underprivileged sections of the society subsist on a diet low in calories, proteins and as well as calcium. Results have indicated that conservation of calcium occurs either through increased absorption or reduced excretion or both (Anon, 2004).
Many changes in ageing affect the movement of calcium in the bones. Among them are decreases in female hormone at menopause, lack of exercise and possible shortage of calcium in the diet. Amongst these, diet and exercise are factors that can be worked on. Many adults abandon milk drinking habits of their youth without taking any other source of calcium. This may contribute to the gradual loss of calcium from bones over the next 40 years of life. One way to curb this slow loss is to be sure to obtain the RDA for calcium each day (Nettleton, 1987).

1.3 Food based strategies in combating deficiencies

Food-based strategies are defined as a preventive and comprehensive strategy that uses food (i.e., whole, refined forms, processed, fortified or a combination) as a tool to overcome nutrient deficiencies. This entails intersectoral involvement in the design, implementation, management (including monitoring) and evaluation of flexible programmes to increase production and consumption of micronutrient-rich foods and their absorption and utilization in the body. Sustainable improvements brought about by such food-based strategies will contribute to nutritional wellbeing and in the long run provide overall economic benefits at both local and national levels (FAO, 2011).

Food-based approaches have a very strong potential for meeting the challenge of reducing and eliminating nutrient deficiencies (Tontisirin, Nantel & Bhattacharjee, 2002). The significance of coexisting micronutrient deficiencies in developing countries is gaining recognition, prompted by the disappointing responses often observed with single micronutrient supplements. Further, of concern is the feasibility and sustainability of supplementation as a mode of delivery in poor resource settings. Consequently, there is increasing emphasis on food-based approaches: fortification, dietary diversification and modification, value addition and biofortification (Thompson & Amoroso, 2011).
The benefits of food-based strategies go beyond the prevention and control of micronutrient deficiencies.

- They are preventive, cost-effective and sustainable.
- They can be adapted to different cultural and dietary traditions and locally feasible strategies.
- Because they are broad-based, aiming to improve the overall quality of the diet of a population, they can address multiple nutrient deficiencies simultaneously.
- Because the amounts of nutrients consumed are within normal physiological levels, the risk of toxicity is minimized.
- Food-based strategies support the crucial role of breastfeeding and the special diet and care needs of infants and young children.
- Food-based approaches foster the development of sustainable, environmentally sound food production systems.
- Food-based strategies build partnerships among governments, consumer groups, the food industry and other organizations to achieve the shared goal of overcoming micronutrient malnutrition (FAO, 2011).

Such an approach is often described as a sustainable approach because the process empowers individuals and households to take ultimate responsibility over the quality of their diet through own-production of nutrient rich foods and informed consumption choices. These strategies are said to be “the ideal long-term goal toward which society strives - provision of assurance of access to a nutritionally adequate diet achieved through diversity of food availability, wise consumer selection, proper preparation, and adequate feeding” (Howsen, Kennedy & Horwitz, 1998).

Food based strategies have been overlooked in recent decades as governments, researchers, the donor community and health-oriented international agencies have sought approaches for overcoming micronutrient malnutrition that have rapid start-up times and produce quick measurable results (Boutrif, 2010).
Even though many lives have been saved and much suffering has been avoided as a result of these efforts, many developing countries now realize that food-based strategies are the only viable, cost-effective and sustainable solution to micronutrient malnutrition. Today, many assistance agencies, non-governmental organizations (NGOs) and donor organizations provide more-comprehensive programmes to eliminate micronutrient deficiencies, including support for food-based approaches (FAO, 2011).

Food-based strategies are therefore essential to meet the challenges of nutrient deficiencies in the developing world. Increasing dietary diversification is the most important factor in providing a wide range of nutrients and to achieve this objective in a development context requires an adequate supply, access and consumption of a variety of foods. Simple appropriate methods for the preservation of nutrient-rich foods need further development and promotion for their year-round availability (Tontisirin et al., 2002). Sustainable food-based approaches such as improvement in nutrient content through food-to-food fortification, enrichment, value addition and dietary diversification should be scaled-up to enable adequate intakes of micronutrients by most of the population.

Food based approaches to improve complementary feeding often prioritize the consumption of locally available and affordable animal source foods. Utilizing animal source foods in food based approaches, offer potentially sustainable solutions to multiple deficiencies (Thompson & Amoroso, 2011). Certain types of fish may be cost-effective in food based strategies to enhance micronutrient intake (Kawarazuka & Béné, 2011). Small fish are an affordable source of animal protein for a wide cross section of the population in developing countries when compared to other animal sources (Hansen et al., 1998). Small fish with bones are excellent sources of highly bioavailable protein and calcium and phosphorous (Odote & Kazungu, 2008).

1.4 Fish in food based strategies

Fish, the collective term used for fresh and sea water fin fish, shell fish including prawns, crabs, lobsters, clams, mussels and other aquatic animal life, is a highly nutritious food, rich in vitamins, minerals, high quality proteins and low in
saturated fat. Fish has always been seen as a food necessary for good health. Research over the past few decades has confirmed the importance of the nutritional components of fish in brain development and reproduction and highlighted a role for fish in a variety of other functions in the body. There is strong evidence that fish plays a major role in protecting against heart disease and may also play a role in the prevention of other illnesses. Components of fish are also important in the development and maintenance of the eyes, skin, skeletal and nervous system (Jeyasekaran, Jeya Shakila & Sundararaj, 2002).

The long-chained omega-3 polyunsaturated fatty acids found in marine fish have a range of health benefits. Epidemiological studies have shown that the prevalence of cardiovascular diseases is low in North Atlantic regions where fish intake is high and it is well accepted that some fatty acids ameliorate the risks of cardiovascular failures, stroke, and development of dementia in adults. In young children, omega-3 fatty acids are important for the development of membranes of the brain and the retina (Roos, Wahab, Hossain & Thisted 2007).

Fish is an excellent protein source of high nutritive value due to a favorable essential amino acid composition (Alipour, Shabanpoor, Shabani, & Mahoonak, 2010). However, viewing fish as a source of protein alone has been the dominant perspective in studies on nutritional security. This view is primarily not in the right direction, since it fails to highlight the critical role of fish as a wholesome source of poly unsaturated fatty acids, minerals such as calcium, phosphorous, iron, vitamins like A, B₁, B₂, B₁₂, D etc. and trace elements such as iodine and zinc. These attributes make fish a vital contributor to nutritional security of the most deprived and vulnerable populations (Singh & Anilkumar, 2003).

Small fish which are an exceptional source of calcium and phosphorous are generally eaten with bones, although some bones may be discarded as plate waste, whereas in large fish most or all bones are discarded as plate waste. Therefore, small fish are an excellent source of calcium. In studies with both humans and rats it has been shown that the bioavailability of calcium from whole small fish is as high as that from milk. In humans, the fractional calcium absorption was found to be 24 ± 6 per cent from small fish and 22 ± 6 per cent from milk. Therefore, fish bone being a
natural resource of calcium and phosphorus may serve as an important dietary contributor of these nutrients, especially within population groups with low intakes of milk and dairy products (Larsen, Thilsted, Kongsbak, & Hansen, 2000).

Chen, Ho and Lam (2009) examined the association of the intakes of different types of fishes with bone mass and osteoporosis risk in a population-based cross-sectional study among 685 Chinese postmenopausal women. They found that higher intake of sea fish was independently associated with greater bone mass and lower osteoporosis risk among postmenopausal Chinese women.

Luu and Nguyen (2009) studied the utilization of calcium from Catfish bone, Salmon bone and Snapper bone. Calcium bioavailability of fish bone extract powder fortified white bread was measured and compared with the other calcium sources. Calcium from fish bone was found to be more absorbable than calcium from calcium citrate. Thus they concluded that fish bone extract powder could be a good alternative calcium fortificant for improving the calcium intake among human beings.

Thus, fish can potentially contribute to reducing protein and calcium deficiencies. A few studies investigating this issue have been published in recent years. However, most of these studies are isolated stand-alone analyses, focusing on specific aspects of the problem (Kawarazuka & Béné, 2011).

The contribution of fish to human nutrition and its impact on health have been examined from different perspectives in both developed and developing countries. In developed countries, the major focus has been on PUFA from fish and fish oil, which lowers blood pressure, reduces the risk of heart disease (Wang, Harris & Chung, 2006) and boosts infant growth and cognitive development (Koletzko, Cetin & Brenna, 2007). In contrast, in developing countries, focus has been on the role of fish in tackling undernutrition and micronutrient deficiencies. It is estimated that around 60 per cent of people in many developing countries depend on fish for over 30 per cent of their animal protein consumption (Devadasan, 2006).

Less attention has been given so far to the role of fish as a source of micronutrients. However, recent research suggests that small fish species that are consumed whole with bones, heads and viscera play a critical role in micronutrient
intakes, as these parts are where most micronutrients are concentrated. Small fish also offer other nutritional advantages: they can be processed and stored for a long period; they are more affordable for the poor as they can be purchased in small quantities; and they can also be more evenly divided among household members (Thilsted, Roos & Hassan, 1997).

Earlier studies conducted in the 1990s on food based approaches in combating nutrient deficiencies were reviewed by Caulfield, Huffman and Piwoz (1999). Although fish was not the main focus in these experiments, recent studies in sub-Saharan Africa used small fish to increase intakes of Fe, Zn and Ca. In Malawi, for instance, Gibson, Yeudall and Drost (2003) introduced fermented porridge mixed with whole dried fish with bones and fruit as a complementary food. After 12 months, the children in the intervention group showed lower incidence of common infectious illnesses and anaemia compared with control children.

In Ghana, a study by Lartey, Manu and Brown (1999) reported that fish powder from smoked anchovies mixed with fermented maize porridge supports growth of infants which was comparable to those obtained from a cereal–legume blend with vitamin and mineral-fortified supplements, indicating the potential role of local fish in the improvement of infant growth.

A study in Uganda used local dried fish mukene as an ingredient of low-cost supplement porridge to feed undernourished children. The experiment showed better outcomes in weight, growth and mortality compared with the diets of imported skimmed milk that are usually used for undernourished children in hospitals (Greco, Balungi & Amono, 2006).

Therefore, on account of all these studies that highlight the nutrient content of small fish, especially in terms of protein, calcium and phosphorous, it is made evident that small fish could be used as a key component in strategies aimed at reducing nutrient deficiencies in developing countries. These studies confirm that small indigenous species caught and/or traded locally do represent a major source of micronutrients in the everyday diet of the poor in developing countries because of their high bioavailability. Existing data suggest that adding fish to plant-based diets enhances protein absorption from food staples. Small fish, frequently consumed by
the poor, are therefore nutritionally important, even in small quantities. These small fish are reported to be more affordable and accessible than the larger fish and other animal source foods. Evidence suggests that these locally available small fish have considerable potential to be a part of cost-effective food-based strategies in enhancing nutrient intakes or as a complementary food for undernourished children (Kawarazuka & Béné, 2011). Eating fish with the main meal or in the form of a snack is a simple way to improve diet quality in terms of highly bioavailable protein and minerals.

1.5 White Bait fish

Fish is a good wholesome food for children, adolescents, pregnant and lactating women and also for the aged. Therefore, as emphasized in the earlier section on the significance of including small fish in our regular diet, it is imperative to make small fish with bones an integral part of our diet.

One such small fish is the white bait which forms the dominant anchovy landings in India. They comprise a group of small pelagic fishes belonging to the genus Stolephorus with length ranging between 35 to 135 mm (Luther, 1995). They are commonly called ‘Nethilli meen’ in Tamil. White bait is a small variety fish which has very fine brittle bones. Therefore it is usually consumed with the bones. Every 100 g of this fish provides 643 mg of calcium and 437 mg of phosphorous (Gopalan, Rama Sastri & Balasubramanian, 2010). White bait fish is therefore an excellent source of calcium apart from being a good source of high quality protein. They could be recommended to prevent and combat calcium and protein deficiencies. This fish is usually consumed fresh. However during seasons of abundance, they are dried and sent to local markets (Gopakumar, 2002).

Whitebaits are annually renewable resources but during seasons of surplus large quantities are wasted due to improvident usage. This fish is generally dried by merely spreading fresh fish on sandy beaches for 1-2 days. The quality of the product is not satisfactory due to insect infestation, yellow discolourisation, off odour, high sand content, breakage of head portion, belly bursting and disintegration (Gopakumar, 2002). This necessitates the development of an alternative method for the utilization of this fish in order to reduce wastage and ensure gainful exploitation of its calcium and protein content.
A key element in increasing the efficient utilization of white bait fish would be to provide it in the form of a processed fish product, preserving the high nutritional value of the fish apart from meeting consumer expectations. Considering the existing market potential for processed fish products like breaded and battered fish items, fish burgers, fish nuggets, fish fillets etc., value addition using white bait fish with bones in the formulation of a ready-to-eat / ready-to-cook product would therefore be a realistic approach to address this concern.

1.6 ‘Fish Wafer’ - A value added fish product

Fish is a food stock that decomposes easily due to high water content. This offers an opportunity for the bacteria to grow quickly. This disadvantage of fish discourages the marketing of fishery products and often brings a big loss, especially when the production is excessive. For this reason people have always attempted to find ways to preserve fish so that they can last longer (Nair, 1998).

Processing and preserving of fish are important aspects of the fishery industry chains. Without such steps any attempt to improve the fishery production will be futile because they cannot be utilized well. Fundamentally, this preservation process is an attempt to decrease the high water content in fish. There are various ways of preserving fish starting from traditional to modern ones.

There is a great demand for seafood and seafood based products in ready-to-eat/ ready-to-cook convenience form. A number of such diverse products have already entered the markets. The factors responsible for the popularity of value added products are increasing trend in the employment of women in the context of shift towards small family norm, increased income and purchasing power, education, awareness and consciousness towards hygiene and health, and increased emphasis on leisure pursuits (Khasim, 2008).

Fish preservation is not only limited to processing into a product in the form of fish but also to any other processed forms after being mixed with other materials. Fish as products of processing and preservation are generally favoured by people because these final products have typical characteristics that include desirable changes in their nature such as in terms of odour, flavour, appearance and texture (Devadasan, 2006).
Value addition and diversification in concepts and contents to satisfy the ever-changing and diverse demands from importing countries as well as urban consumers at home is the most important need of the day. Value addition and introduction of new types of fish products in tune with the changing market trends is therefore necessary. Value addition in fish products is one of the fast developing sectors. Present market trends reflect a rapidly growing demand for healthy ready-to-cook and ready-to-eat convenience products (Gopal & Shankar, 2001).

One such important traditional fish based snack food is the wafers known by different names in many countries of Asia. In India they are called wafers or crackers and in Malaysia they are called ‘Keropok’. They are prepared using deboned fish meat, starch such as tapioca, corn, potato, sago, spices and salt. During frying they swell 2 to 3 times their initial volume. Therefore they are referred to as expanded snacks. An expanded snack is one in which the starch in the precooked product, when expanded by frying in oil or puffing in an oven or micro wave, produces a product with a large network of air cells that is very light. These resemble the traditional South Indian ‘vadaams’ or ‘plain starch wafers’.

In India, ‘vadaams’ are prepared using rice, potato or tapioca starch. However, tapioca starch is preferred in the preparation of this expanded snack due to its high paste clarity and amylopectin content compared to other starches (Matz, 1984). These wafers increase twice their size on frying or puffing in the micro wave and are eaten as a snack or along with main meals. Plain starch wafers are relished by all age groups. However, they are deficient in protein and calcium (Muthappa, Puttaraj, Prasad & Urooj, 2003). Plate 1.1 shows the different types of South Indian Vadaams before and after frying.
Odote and Kazungu (2008) had suggested that a combination of small fish and tapioca starch may perhaps offer one utilizable source of protein when presented in the form of a wafer. The protein content of fish wafers increases with an increase in the proportion of fish used in its making (Yu, 1991; Peranginangin, Fawzia, Sugiyono & Mulyanah, 1997; Huda, Aminah, & Babji, 2000; King, 2002). It is commonly known that fish is a good source of protein while tapioca flour contains a lower amount of protein. Peranginangin et al. (1997) reported that plain tapioca wafers contain only 0.78 per cent of protein and this is increased to 8.13 per cent in the wafers with 40 per cent proportion of fish.

Thus, utilization of white bait fish with bones in the preparation of white bait fish wafers using tapioca starch would help in offering a carbohydrate based ready-to-cook food product that is also rich in nutrients such as protein, calcium and phosphorous.
1.7 Need for the study

Globalization has greatly influenced the food choices of Indians leading to radical changes in their dietary habits which have resulted in increased consumption of sugar and fat based foods (GOI, 2008). A direct consequence of this has been an excess intake of mere calories and the concurrent incidence of nutrient deficiencies, especially that of protein, iron, calcium and phosphorus. In order to deal with this, many people resort to over-the-counter dietary supplements that could pose the risk of toxicity on a long term basis. *This leads to the pressing need of advocating food based approaches that are the most natural and safest way of ensuring adequate intake of all nutrients in place of isolated nutrient supplements.*

Food-based approaches focus on food - whether natural foods or processed foods in recognizing the essential role that food plays in good nutrition. In the recent years, a wide range of ready-to-eat / ready-to-cook processed foods, are being marketed due to increased consumer demands. However, the use of food additives has increased enormously in the last few decades. A food additive is any substance not commonly regarded or used as food, which is added to, or used in or on food at any stage to affect its keeping quality, texture, consistency, taste, colour, alkalinity or acidity, or to serve any other technological function in relation to food, and includes processing aids in so far as they are added to or used in or on food (The Food Labelling Regulations, 1980; Food Intolerance and Food Aversion, 1984). The following adverse effects have been attributed to the consumption of food additives: eczema, urticaria, angioedema, exfoliative dermatitis, irritable bowel syndrome, nausea, vomiting, diarrhoea, rhinitis, bronchospasm, migraine, anaphylaxis, hyperactivity and other behavioural disorders (Smith, 1991). *This emphasizes the need for food based approaches that are devoid of the use of chemical additives which may result in safer foods for human consumption.*

One such food based approach would be the value addition of foods. Animal foods are an excellent resource of high quality and readily digestible protein and other micronutrients that render themselves useful in such a situation (Bender, 1992). The use of fish protein, especially those of small bony varieties, amongst other animal protein sources, has been well recognized due to their availability and affordability by certain cross sections of the Indian population.
There is emerging consumer awareness in the potential health and nutritional benefits of fish and fishery products worldwide. The growing appetite for value added seafood is being mainly fuelled by changing life styles. The fish processing industry is faced with new consumer demands and trends such as convenience without quality loss. This calls for innovative methods of processing fish that would result in the formulation of novel fish based value added product. Although, fish is processed into several value added products as mentioned earlier, the concept of fish wafer processing is relatively new in India. Very few outlets sell fish wafers which are made using big and expensive varieties of deboned fish e.g., Seer fish. Therefore, these wafers cannot be afforded by all. Besides this, fish bones are avoided on deliberation in fish wafer preparation as the presence of bone as small as 3mm might affect the quality of the product (Codex Alimentarius Standard, 2001). This reflects on the low calcium content of the wafer.

White bait being the most abundantly available small pelagic fish species with very brittle bones remains underutilized in terms of the protein and calcium it provides, during seasons of glut, due to improvident preservation methods leading to wastage. *This accentuates the importance of preventing heavy losses of white bait fish by adopting suitable methods of processing that will ultimately meet the present consumer demands.*

Inclusion of fish bones in a form that would not alter the quality of the fish wafer and at the same time would render the highly bioavailable calcium is a challenge in itself. Small fish with bones may better confront this problem than big fish with bones. *For this reason, the researcher of this study felt the need for formulating a fish wafer preparation incorporating white bait fish along with their bones, which may be a guaranteed source of protein, calcium and phosphorous besides being more accessible to all classes and age groups of the population.*

Tapioca starch was used as a starch base in the fish wafer formulation. The dual role of ensuring an effective way of utilizing white bait during seasons of surplus besides increasing the nutritive value of plain tapioca starch that is otherwise deficient in protein and calcium is worth mentioning. Despite the fact that there is adequate research done on fish wafer formulations using deboned fish, there is not
much work done on fish wafer formulations using small fish with bone. The present study therefore aimed at exploring the possibility of utilizing small fish with bones in fish wafer formulation, which may in future open doors for a whole new way of integrating small fish with bones into the regular diets of individuals.

Therefore, food-based approaches to meet nutrient intakes should always be the first priority because food-based approaches to improve micronutrient status depend on improving the general quality of the diet. They can also provide the additional benefits of reducing the consumption of less nutritious carbohydrates and fats, and increasing the intake of the “other micronutrients.” This strategy is therefore consistent with the need to lower the global risk of chronic diseases that is exacerbated by consumption of poor quality diets (Allen, 2008).

The specific priorities of the present study include

1. Minimizing post harvest losses of white bait fish by employing alternative processing methods, that is through value addition.

2. Preparation of a ready-to-cook value added product utilizing white bait fish with bones (white bait fish wafers) without the addition of chemical preservatives.

Based on the fact that fish wafers have a global impact on nutrition and that variations of this product are well accepted (Cheow, Kyaw, Howell, & Dzulkifly, 2004; Salleh, 2007; Singhal, Kennedy, Gopalakrishnan, Kaczmarek, Knill, & Akmar, 2008; Subba & Dilip, 2002), it can be believed that the development of an acceptable fish wafer preparation of high nutritional quality can be a successful strategy for increasing consumption of small fish with bones and that fish wafers can be an alternative to high-calorie, low-nutritional-value, ready-to-eat/ ready-to-cook foods (Neiva et al., 2011).

Scope for the study

Fish can be made available throughout the year for human consumption by the adoption of suitable processing methods during seasons of surplus. The scope for the present study is as follows:
1. Enhancement of the protein and calcium content of tapioca starch wafers using white bait fish with bones that can serve as a nutritious snack or a meal accompaniment in place of plain tapioca starch wafers which are devoid of these nutrients.

2. An innovative and prudent approach for better utilization of white bait fish which are otherwise unhygienically dried during seasons of surplus leading to wastage.

3. A lucrative business proposal that provides income generating opportunities from home for women entrepreneurs.

4. Adoption of small fish in food based approaches that may help improve calcium and protein intake of all age groups.

Fish wafers can also be introduced in school feeding programmes to provide more nutritious meals. Early dietary intervention is absolutely essential to have healthy bones and teeth for which the right choice of food plays a vital role. Among the several foods, small fish being an excellent source of protein and calcium seems to offer a good potential to meet this demand. Starch based snack foods that are popular among all age groups, do not normally contain adequate protein and minerals. Fish wafers could now replace these unhealthy snack foods available in the market by providing utilizable protein and calcium.

The incorporation of fish with its bones in the preparation of wafers will indirectly improve the calcium intake of its consumers besides being a lucrative business proposal for women entrepreneurs. The product can be packed in flexible pouches at low moisture and oxygen transmission. The product has excellent market potential since it contains sufficient carbohydrate, protein and mineral content.

More over, value addition processes generate employment opportunities and serve as a source of income for women. This is more important nowadays because of societal changes that have led to the development of increasing demand for fish based convenience products in ready-to-eat / ready-to-cook forms that require little
preparation before serving. Therefore, there is more scope for women entrepreneurs in income generating activities such as production and sale of fish wafers.

Manufacture and sales of fish wafers can be done at a micro level (home level). With an assured market for these products, this business can be developed at a larger scale. School drop outs, destitute women, widows and single mothers could benefit from this. Women entrepreneurs can be involved in income generating activities like production and sale of fish wafers. This could in one way be a means of supplementary income and may also enable them to develop self-confidence resulting in leading a better quality of life.

Thus, the social, economic and health benefits associated with successful food-based approaches that lead to year-round availability, access and consumption of nutritionally adequate foods are very important. As a result of this, the nutritional well-being and health of individuals will be promoted, incomes and livelihoods will be supported, and the community’s and nation’s wealth will be created and protected (FAO, 2011).