CHAPTER 1

INTRODUCTION

India is endowed with a remarkably heterogeneous geographical area characterized by a great diversity of agro climatic zones, allowing for production of a variety of horticultural crops such as fruits, vegetables, flowers, spices, plantation crops, roots and tuber crops, and medicinal and aromatic crops.

India is the second largest producer of fruits and vegetables in the world (NHB, 2015). Food processing sector is one of the largest sectors in India in terms of production, growth, consumption, and export. India's food processing sector covers fruits and vegetables; spices; meat and poultry; milk and milk products, alcoholic beverages, fisheries, plantation, grain processing and other consumer product groups like confectionery, chocolates, cocoa products, soya-based products, mineral water and high protein foods (APEDA, 2017).

Production of Banana, oranges, green peas and corn in India:

- In 2015-16, India produced 34.64 metric tonnes and in 2017-18, 34.86 metric tonnes of bananas (Horticultural statistics at a glance, 2018).
- In 2015-16, India produced 10.36 metric tonnes and in 2017-18, 11.91 metric tonnes of oranges (Horticultural statistics at a glance, 2018).
- In 2015-16, India produced 4810.77 metric tonnes and in 2017-18, 5422.14 metric tonnes of green peas (Horticultural statistics at a glance, 2018).
- In 2015-16, India produced 4810.77 metric tonnes and in 2017-18, 5422.14 metric tonnes of (World agricultural production, 2020).

Production of Banana, oranges, green peas and corn Worldwide:

- In 2015-16, 112,599,836 million tonnes and in 2017-18, 113,918,763 million tonnes of bananas were produced worldwide (World banana production, 2019).
- In 2015-16, 47.06 million metric tonnes and in 2017-18, 48 million metric tonnes of oranges were produced worldwide (Shahbandeh, 2019).

- In 2017-18, 20,699,736 tonnes of green peas were produced worldwide (FAOSTAT, 2018).
- In 2017-18, 1,123.33 million tonnes of corn were produced worldwide (World agricultural production, 2020).

The residues from the growing and processing of raw agricultural products such as fruits, vegetables, meat, poultry, dairy products and crops are defined as agricultural wastes. Agricultural wastes can be in the form of solid, liquid or slurries depending on the nature of agricultural activities (Foster, 2015). Agricultural wastes such as peels, seeds and pulps do not get much commercial importance and makes almost 50% of the raw processing units. Some percent of these agro wastes either gets used as animal feedstock, water pollution control etc. while the rest just adds on to the dumping grounds or landfills which has an immense negative effect on the agro-ecosystem as it produces smoke, smog that cause air pollution, pollutes the water bodies and disturbs the environment.

It is therefore, important to make use of these agro residues or wastes in the agriculture production system to help improve the environment. Therefore, the huge amount of residual plant biomass/ agricultural waste that comes out from these industries, considered as “waste” can potentially be used to produce various value added products like bio fuels, animal feeds, chemicals, enzymes etc. Enough scope exists for the value addition and utilization of these biomass for food applications such as production of xylooligosaccharides, xylitol, xylose, etc. (Aacharya et al, 2009).

There is emerging evidence that functional foods ingredients can have an impact on a number of gut related diseases and dysfunctions (Aacharya et al, 2011). A prebiotic is a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits (Gibson et al, 2004). Xylooligosaccharides (XOS) have great prebiotic potential and can be incorporated into food products. Prebiotics of various types are found as natural components in milk, honey, fruits and vegetables, such as onion, garlic, artichoke, banana, rye, barley etc. (Mussatto and Mancilha, 2007). XOS has been identified as a novel food (NF) (EFSA, 2018). Generally, XOS are mixtures of oligosaccharides formed by xylose residues linked through

β – (1 $\rightarrow$ 4) - linkages (Acharya et al, 2008).

A study reported that 4g of XOS per day for 3 weeks improves the intestinal microbiota in the elderly people > 65 years (Chung et al, 2007). There are several reports on the preferred utilization of XOS by beneficial colonic bacteria like bifidobacteria and other lactic acid bacteria (Kabel et al, 2002, Zeng et al, 2007). These bacteria ferment xylooligomers producing short chain fatty acids which have many beneficial effects. In addition to providing many health benefits, XOS have immense potential to improve the quality of many foods by modifying food flavour and improving their physiochemical characteristics (Jain et al, 2015).

XOS can be extracted by enzymatic, chemo-enzymatic, partial hydrolysis of xylan from various sources such as barley hulls, rice hulls, corn cobs, peanut pods, sugarcane bagasse, wheat straw, cotton stalks, orange peels, mango peels etc.

The prebiotic potential of XOS have been explored the least whereas, inulin, FOS, resistance starch etc. have been explored to a great extent.

Besides providing the health benefits, oligosaccharides are known to extend technological advantages in favour of improved organoleptic qualities of the food products. XOS needs to be exploited for this purpose as it has its chemical and structural qualities much similar to fructooligosaccharides (FOS) which have proven technological benefits in terms of its miscibility and organoleptic qualities.

Xylooligosaccharides are stable after heating to 100°C under acidic conditions (pH=2.5-8) that cover the pH values of the vast majority of food systems (Courtin et al., 2009; Vazquez et al., 2000). In food processing, XOS show advantages over inulin in terms of resistance to both acidity and heat, allowing their utilization in low-pH juices (Vazquez et al., 2000). XOS is a known prebiotic with potential health benefits; however we need to find sources for its high content.

Most agricultural wastes which have no economic/ low economic value can be converted to more valuable products such as XOS which may benefit the fruit, vegetable and oil industries to exploit the use of their waste products and convert it into value added products and thereby add to the country's economic growth.

Global Xylooligosaccharides (XOS) market size will increase to 130 Million US$ by 2025, from 94 Million US$ in 2018, at a CAGR of 4.1% during the forecast period. The Xylooligosaccharides (XOS) market reported an in-depth analysis of the competitive landscape of this business vertical, constituting companies like Longlive, Kangwei, HFsugar, Henan, Shengtai, YIBIN YATAI, HBTX, YuHua, ShunTian (Marketwatch, 2019).

However, after reviewing the literature, it was found that there are limited researches being conducted on XOS and only one research paper by S. Mumtaz et al, 2008 was found on food product development. This also gives a future scope to study the organoleptic properties of XOS upon its addition in different food products.

Thus the present study entitled "Extraction of Xylooligosaccharides (XOS) from agricultural waste, determining its prebiotic properties and organoleptic qualities of Indian traditional foods upon its addition" was undertaken in the following three phases:

PHASE I: Extraction of xylooligosaccharide from agricultural wastes.

PHASE II: Determining the prebiotic properties of XOS.

PHASE III: Organoleptic evaluation of XOS added Indian traditional foods.