ABSTRACT

Residues from the raw agricultural products processing such as fruits, vegetables, meat, poultry, dairy products and crops are known as agricultural wastes which can potentially be used to produce various value added products like bio-fuels; animal feeds etc. and can be utilized to manufacture several such products including Xylooligosaccharide (XOS) which may exhibit prebiotic effect when consumed regularly. Several research based evidences show that functional foods can have an impact on a number of diseases.

Studies have shown that Xylooligosaccharides (XOS) is a stable prebiotic which can withstand heat up to 100°C under acidic conditions (pH=2.5-8) and has a potential to be incorporated into food products.

However, its prebiotic properties needs to be established in terms of bile resistance, acid tolerance, fermentability to produce short chain fatty acids (SCFA) and growth of *Lactobacillus plantarum* and *Bifidobacterium adolescentis and Escherichia coli*. XOS also needs to be exploited for its potential to be incorporated into various food products and study their organoleptic properties similar to fructooligosaccharides (FOS) which have proven technological benefits in terms of its miscibility and organoleptic qualities.

The agricultural wastes selected in this study to be explored for the extraction of XOS were corncobs, orange peels, raw green banana peels and green pea shells. From the several methods of XOS extraction, enzymatic hydrolysis was selected as the method of extraction in this study as enzymatic hydrolysis with xylanase does not produce any toxic by-products unlike other methods.

XOS also needs to be exploited for its potential to be incorporated into various food products and study their organoleptic properties similar to fructooligosaccharides (FOS) which have proven technological benefits in terms of its miscibility and organoleptic qualities.

However, after reviewing the literature, it was found that few researches have been conducted on XOS incorporated food product development. This also gives a future scope to study the organoleptic properties of XOS upon its addition in different food products.

XOS is known to be a potential prebiotic with several health benefits; however we need to find sources for its high content. Most agricultural wastes which have no 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. 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.

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.

XOS obtained from the xylan of 60g corn cob, green banana peel, orange peel and green pea shells were 1.8g (18.75%), 1.01g (18.70%), 1.41g (18.80%) and 0.79g (18.80%) respectively at ($p \leq 0.01$) with an optimal condition of 12h incubation time, pH 5.4 at 40^{o}C. No degradation of XOS was observed on exposure of XOS to bile at 0h, 1.5h and 3h with bile concentration 0.5%, 1% and 1.5%. XOS recovery was observed to be 100% on its exposure to pH 1.5, 2 and 3 at 0h. At 1.5 h, recovery of XOS was found to be 98.4%, 98.9% and 97.9% at pH 1.5, pH 2 and pH 3 respectively. XOS recovery was 96.2%, 97.3% and 96.3% on its exposure to pH 1.5, pH 2 and pH 3 respectively at 3 h.

Growth of *Lactobacillus plantarum (LP)* and *Bifidobacterium adolescentis (BA)* were higher at 0.5%, 1% and 2% of XOS addition. For *Escherichia coli (E.coli)* the growth gradually decreased as the concentration of XOS increased from 0.5% to 2%. *Bifidobacterium adolescentis* produced 408.6 mMol(↑331%) propionate on its exposure to XOS. *Lactobacillus plantarum* produced 405.62 mMol(↑188%) propionate on its exposure to XOS. When *Escherichia coli* were exposed to XOS production of propionate reduced 339.55 mMol (↓20%). *Bifidobacterium adolescentis* produced 343.28 mMol(↑331%) butyrate on its exposure to XOS. *Lactobacillus plantarum* produced 340.72 mMol (↑188%) of butyrate on its exposure to XOS. When *Escherichia coli* were exposed to XOS production of butyrate reduced 285.22 mMol (↓21%). *Bifidobacterium adolescentis* produced 1833.27 mMol(↑35%)

acetate on its exposure to XOS. *Lactobacillus plantarum* produced 1883.82 mMol of acetate when exposed to XOS and produced 0 mMol when exposed to glucose. When *Escherichia coli* were exposed to XOS production of acetate reduced to 324.65 mMol (↓48%).

F test revealed no significant difference on the organoleptic scores of XOS added *Black rice kheer, Gajar Ka Halwa, Paneer Butter Masala* and *Prawn patia* at all levels of addition (5g, 8g and 10g) prepared by substituting sugar with varying levels of XOS.

In *Paneer Butter Masala*, most of the panelists found its taste to be superior or equal to the standard ($p \leq 0.001$) at all the three levels of addition. The overall acceptability and other sensory attributes of *Paneer Butter Masala* were equal or superior at 8g.

In *Prawn patia,* difference test revealed that the sensory attributes of *Prawn patia* with different levels of addition of XOS were either superior or equal to the standard product ($p \leq 0.001$).

Most of the panelists found colour of *Black rice kheer* to be superior or equal to the standard ($p \leq 0.01$) at all the three levels of addition. The overall acceptability and other sensory attributes of Black rice kheer were equal or superior at 8g and addition of 10g XOS rendered *Black rice kheer* less sweet.

Most of the panelists found the taste of *Gajar Ka Halwa* to be superior or equal to the standard ($p \leq 0.01$) at all the three levels of addition. The overall acceptability and other sensory attributes of *Gajar Ka Halwa* were equal or superior at 8g and addition of 10g of XOS made it equally acceptable as compared to the standard.

Hence, it can be concluded that XOS could be extracted from all the four selected agro wastes. The concentration of XOS obtained from corn cob was found to be highest. However, all the four agro wastes yielded XOS. The prebiotic potential of XOS in terms of acid tolerance, bile resistance, growth of probiotic bacteria and production of SCFA was successfully established in this study. XOS was well accepted by the panel members in all the four products up to 10% indicating that many foods may be enriched with XOS as a prebiotic.

Therefore, this study has created a strong evidence-based data to prove the prebiotic potential of XOS. However, further studies can be undertaken to demonstrate the clinical efficacy of XOS intake with respect to various non communicable diseases.