FOOD GRADE FILLER PARTICLES

Reeba Mary George1, Kaaviya Sri RR1 and Rituja Upadhyay1\*

1Division of Food Processing Technology, School of Agricultural Sciences, Karunya Institute of Technology and Sciences,

Karunya Nagar, Coimbatore, Tamil Nadu, India

# \*Corresponding author:

# Rituja Upadhyay, PhD., Associate Professor, Division of Food Processing Technology,

# School of Agricultural Sciences,

# Karunya Institute of Technology and Sciences

# Karunya Nagar, Coimbatore, Tamil Nadu, India

# Email: rituja@karunya.edu

# Phone: +91-7778000255

ABSTRACT

Food grade filler particles refer to materials that are safe for consumption and are used to increase the volume or improve the texture of food products without significantly altering their taste or nutritional value. These particles are typically added to various food items such as sauces, dressings, frozen desserts, meat products, and bakery goods. Fillers can be derived from natural sources such as fruits, vegetables, grains, legumes, and seaweed. They can also be synthetic substances that are specifically manufactured for food applications. The particle size of these fillers can vary, with some being fine powders and others larger granules. The incorporation of fillers in food formulations serves multiple purposes. They can enhance the mouthfeel and give a smoother texture to the final product. Additionally, by increasing the bulk of a food item, they can provide a better value for money, as the cost per unit weight is reduced. Fillers can also aid in stabilizing emulsions, preventing separation or settling of ingredients over time. Food fillers must adhere to strict regulations and guidelines to ensure their safety for human consumption. These regulations govern factors such as the composition of the filler particles, levels of contaminants, and potential allergenicity. In addition to these safety considerations, fillers should also be selected based on their compatibility with the specific food product, as they should not negatively impact taste or affect the overall quality of the food. As consumer demand for healthier and more natural ingredients in food products increases, the development of food grade fillers that are organic, non-GMO, and free from artificial additives is becoming more prevalent. Manufacturers are also exploring innovative techniques to enhance the functionality and nutritional value of these fillers, such as incorporating fortifying ingredients like vitamins and minerals. In summary, food grade fillers are particles that are added to food products to improve texture, increase volume, and enhance stability. They can be derived from natural or synthetic sources and must comply with safety regulations. With growing consumer interest in healthier and more sustainable food options, the development of food grade fillers is an ongoing area of research and development in the food industry. This abstract discusses the use of sweeteners as fillers in various food products and identifies the different types of sweeteners commonly employed for this purpose. Many food manufacturers enhance the sweetness of their products by incorporating sweeteners as fillers. Sweeteners fulfil a dual role - they add taste while also increasing the bulk and volume of the product, thereby reducing costs. Several types of sweeteners are used as fillers depending on the desired qualities and requirements of the food product.

Keywords: Food Fillers, Sweeteners, Types, Functional Ingredient.

# INTRODUCTION

Consumption of dietary fats and sugar contained foods products pose health problems in humans. One such health effect caused by the intake of dietary fats is due to the increase in total cholesterol (TC) and low-density lipoprotein (LDL) cholesterol levels, which leads to cardiovascular diseases. The sugar contained food products add calories to our diet which could lead to diabetes, obesity, and cardiovascular diseases (Sahin et al., 2019). According to World Health Organization (2017), there are over 1.9 billion adults over 18 years and 41 million children under 5 years of age, suffering from obesity. Thus, an alternative to high-calorie foods is essential for maintaining a healthy body. This could be achieved by the use of food fillers. The future of the filler for food market looks promising with opportunities in the processed meat, seafood, dairy & bakery, food supplement, and beverage industries. The global filler for the food market is expected to reach an estimated $819.3 million by 2027 with a CAGR of 3.6% from 2021 to 2027 (Lucintel, 2021). The major drivers for this market are increasing demand for processed food and growth in food supplement products. Food-grade fillers are additives that are used to add bulk to food products with low-cost ingredients, which in turn reduces the cost of the product (Heinz & Hautzinger, 2007). These fillers are being used as fat substitutes/ fat replacers, meat extenders, sugar replacers, and bulking agents, finding application in many of the food sectors such as processed meat and seafood, food supplements, dairy and bakery, beverages, etc. They add little or no calories to the foods thus helping in the effective management of one’s body weight. In addition, fillers help to increase the shelf-life of food products, keeping the price of the product low.

The Food Fillers industry presents significant potential for companies looking to achieve sustainable growth. With a focus on market segmentation and customer preferences, the report identifies the most potential growth opportunities in the industry.The Food Fillers industry report findings identified five large-scale factors that are having a significant impact on the industry. From supply chain adaptability, digitalization, the impact of advanced technologies, consumer preferences and awareness, and sustainability, diverse challenges and opportunities are observed in the global Food Fillers Industry. There is indeed a market for these fillers due to the growing consumer demands for processed meat and bakery products as well as food supplements being the major drivers of this market. Due to the increase in demand for low-fat dairy and bakery products, starch is one of the fillers, witnessing higher growth than the rest of the fillers. Some of the filler foods manufacturing companies include Imerys, Elementis, Omya, Mineral Technologies, and Rayonier Advanced Material (Lucintel, 2021). As familiar with, sugar is a contributor to sweetness, mouthfeel, texture shelf-life, and bulking. Because of the above-mentioned attributes, sugar is considered a very difficult food component to be replaced (Erickson & Carr, 2020).

According to a guideline published by the World Health Organization, 2015, a reduced sugar consumption less than 10% of the recommended daily calorie intake. Because of the increased consumption of sugar contained foods, the government has imposed sugar tax on such foods. In the United States, the imposition of sugar tax of about 1-8%, had not brought out any changes in the sugar consumption. The British government has recommended that the bakery industry reduce the sugar content of the products by 20% by 2020 (Tedstone et al., 2017). Sugar replacers that could be used include non-nutritive sweeteners which provide less calories than sugar. The Food and Drug Administration (FDA) had approved the use of certain artificial sweeteners such as acesulfame-K, aspartame, neotame, saccharin, sucralose and stevia. As sugar is an important ingredient in the food product because of the properties that it has, which includes reduction of water activity, freezing point depression and browning reaction.

Thus, replacing sugar is a challenge faced by the food industry. Browning reaction and caramelization are important for the development of colour and flavor in certain food products. (Erickson & Carr, 2020). Meat products contain various nutrients like protein, zinc, iron, vitamin etc in which proteins has many essential amino acids required for growth (Williams, 2007; Elango et al., 2009). But these processed meat products contain high amount of fats which are unhealthy for the body. Some meat products contain about 20-30% fat content. So, the consumers are more into the products that does not contain any ingredients that affect their body health.

In meat industry, processed meat products such as hamburgers and sausages are the best foods to contain fillers. These fillers and extenders could help in reducing the final cost of the product by 10-30 percent. There are both meat and non-meat fillers used. Example of meat filler is the mechanically deboned meat (MDM) that are cheaper material obtained from animal carcasses. Examples of non-meat fillers include cereal binders, bread crumbs, maltodextrin, rusk etc. Reduction of fat content or replacement of fat is a challenge for the food industry because of the low-quality meat products produced with poor technological and sensory properties. This could have an influence on the marketability and consumer acceptability of the product (Alves et al. 2016).

This article discusses about the various kinds of filler particles along with their limits in different foods, advantages of using these fillers, applications, health effects, challenges and future scopes.

# TYPES OF FILLERS

## SWEETENERS AS FILLERS

Sweeteners are compounds that are used to provide sweetness to food and beverages without adding calories or carbohydrates like conventional sugar does. People who want to limit their calorie intake, manage their blood sugar levels, or control their weight frequently use them as sugar substitutes.

Sweeteners come in a variety of forms, including:

1. Sugar alcohols, also known as polyols, are carbohydrates found naturally in several fruits and vegetables. Xylitol, sorbitol, and erythritol are a few examples. Sugar alcohols are only partially absorbed by the body and have less calories than sugar. If ingested in excessive quantities, they can have a laxative effect.

2. Artificial sweeteners are chemical substances that deliver sweetness without adding calories. Aspartame (Equal, NutraSweet), sucralose (Splenda), saccharin (Sweet'N Low), and acesulfame potassium (Sunett, Sweet One) are a few examples. Because artificial sweeteners are more intensely sweet than sugar, lesser amounts are required.

3. Natural sweeteners come from natural sources such as plants. Stevia, which is produced from the leaves of the stevia plant, and monk fruit extract, which is derived from the monk fruit, are two examples. Natural sweeteners are typically thought to be lower in calories than sugar, however their amount of processing and purity might vary.

It's worth noting that the safety and health impacts of sweeteners as fillers are still being researched and debated. While regulatory authorities usually see them as safe, several studies have raised concerns about potential side effects. Individuals with certain health issues should contact with their healthcare professional before consuming sweeteners, as with any meal or product.

## Polyols

Polyols, known as sugar alcohols are neither sugars nor alcohols, but are either in the form of white crystalline powders or syrups. They are the most common replacer used in the area of sugar reduction. They are hydrogenated form of carbohydrate where the carboxyl group such as aldehyde or ketone is reduced to a primary or secondary hydroxyl group.

Polyols provide less energy because it has less sweetness than sucrose and they do not cause dental caries. The recommended intake for adults is 40-50g per day and for children is 30 g per day because when consumed in higher amounts could lead to gastrointestinal problems including osmotic diarrhea (Ghosh & Sudha, 2012). Thus, the foods exceeding 10% added polyols must be labeled as “excessive consumption may produce laxative effects” (Sahin et al., 2019). This group includes a variety of polyols such as sorbitol, xylitol, maltitol, lactitol, erythritol, mannitol and isomalt which will be discussed in detail.

### Sorbitol

Sorbitol also called by different names such as glucitol, sorbogem and sorbo is a sugar alcohol mostly found in nature in pomaceous and stone fruits, but on a large scale its is manufactured by hydrogenation of hydrolysed starch. Sorbitol is one of the water-soluble polyols that are hygroscopic in nature which makes them a good humectant for various foodstuffs. It is 0.5 times sweeter when compared with sucrose and finds application in sugar free cakes, cookies, muffins etc. There was an increase in the amount of air cells produced in the cake batter which were replaced by sorbitol and steviol glycosides when observed under the microscope (Ghosh & Sudha, 2011; Struck et al., 2014).

### Xylitol

Xylitol is a five-carbon polyol having sweetness similar to that of sucrose which are found in small amounts in fruits and vegetables but on a large scale manufactured from xylan. Water activity of xylitol is lower than sucrose thereby increasing the shelf-life and microbial stability of the food product. Xylitol has water solubility, same as that of sucrose at a temperature of 30oC (Struck et al., 2014).

Food and Drug Administration (FDA) has approved the usage of xylitol since 1960s stating that it is safe for children. This polyol is being used in bakery products such as biscuits, cakes and breads, as a sugar replacer. A Single dose not exceeding 30g would not cause any health problems like increase in blood sugar level but when consumed in large quantities may lead to diarrhea caused by intestinal bacteria being unable to metabolize such large doses. Xylitol is being used as an ingredient in tooth paste and other oral hygienic products because of it not fermentable by cariogenic microbes present in the oral cavity. There were studied conducted on rats with xylitol diets and cariogenic diets and found that there was a complete removal of dental caries in those rats fed with xylitol diets. Same results were attained in the case of human beings (Grunberg et al. 1973; Scheinin and Mackinen 1975; Struck et al., 2014; Ghosh & Sudha, 2011).

In the manufacture of cookies replaced with xylitol, a similar sweetness to sucrose, cooling effect and aftertaste was observed. But found no aftertaste, flavor and textural changes were observed during the storage which increased the shelf-life of the cookies. In the cakes formulated with xylitol, there was found to be an increase in specific volume and decrease in crumb hardness and browning reaction . They have also been used in bread manufacture with an increase in springiness and loaf volumes (Struck et al., 2014; Sahin et al., 2019).

In the case of biscuits, there was found to be no adverse effect on the browning of biscuits but decreased the spreading and hardness properties (Emmanuel I. Zoulias et al., 2000; Sahin et al., 2019). In burger buns, a total replacement of sugar with xylitol caused a decrease in browning and affected CO2 production leading to low specific volume and hard crumb texture whereas a partial replacement of 50% did not cause any impact on the product (Sahin et al., 2018).

### Maltitol

Maltitol is a sugar alcohol consisting of glucose and sorbitol is made by catalytic hydrogenation of maltose. It is a bulk sweetener with fewer calories. The intensity of sweetness varies between 0.8 and 0.9 as that of sucrose. They are less hygroscopic in nature than the other polyols and are heat stable. The various trade names under which they are known are Maltisorb, Maltisweet and Lesys. Maltitol does not cause tooth decay and does not have much effect on the blood glucose. Studies have shown that there was low glycemic and insulinemic indexes in healthy persons who consumed chocolates with added maltitol Maltitol is being used in food products like breads, cakes, cheesecakes, muffins, nutritional bars etc. Total replacement of maltitol in cupcakes produced a light brown colour with a good crumb and good rise but was poor in sweetness and crumb moisture. But cupcake made with a 1:1 ratio sucrose to maltitol, had a golden brown colour with a good texture and sweetness. The cookies and biscuits produced with maltitol was found to be hard in nature but had an acceptable sensory quality (Zoulias et al., 2000; Sahin et al., 2019 Ghosh & Sudha, 2011).

### Lactitol

Lactitol is a sweet tasting synthetic disaccharide comprising of sorbitol and galactose with nutritional, physiological and pharmaceutical properties. They are highly soluble in water and is of low hygroscopic nature . The molecular weight of lactitol is similar to that of sucrose, therefore their impact on water activity is also the same as sucrose (Ghosh & Sudha, 2011).

The intensity of sweetness varies between 0.3 and 0.4 when compared to sucrose and without an aftertaste. Because of its low sweetness, it is mostly used along with high intensity sweeteners. According to EC, consumption of 20g/ person/day of lactitol does not cause any laxative effects. Lactitol, that remain unabsorbed by the body have a chance of causing diarrhea, bloating and abdominal pain. Cookies prepared with lactitol produced product with softer and less brittle texture and a large diameter (Zoulias et al., 2002; Struck et al., 2014; Ghosh & Sudha, 2011).

### Erythritol

Erythritol is a 4-carbon polyol which are naturally found in fruits such as grapes, pears, melons and in mushrooms but on a large scale produced from wheat or corn starch by fermentation. They are the only ones which are produced by fermentation method. They are only moderately soluble in water and thermally stable and are considered as safe for use in foods (EFSA ANS Panel, 2013b). The intensity of sweetness varies between 0.6 and 0.8.

The estimated calorific value of erythritol was found to be ≤ 0.4 kcal/g. Erythritol is non-caloric, non-cariogenic, and non-glycemic and has high digestive tolerance, which makes them to be used in functional foods. Erythritol is classified as non-toxic and non-cariogenic. When administered orally to normal male subjects, the glucose and insulin levels were found not to increase. It is only polyol which is efficiently absorbed by the intestine and transported to kidneys to be excreted through urine. Except erythritol, all other polyols have a laxative effect when consumed in excess. The maximum dose for males and females for not causing laxative effect is 0.66 g/kg BW and 0.80 g/kg BW respectively. The ingestion of erythritol at doses of 1 g/kg BW per day showed good tolerance by humans in the repeat-dose study (Sahin et al., 2019: Ghosh & Sudha, 2011).

In DSC muffin batter measurements using sucrose or polyols, erythritol because of its lower molecular mass, was the one to produce the lowest onset and peak temperature during the gelatinization of starch. Because of decreases height and increased hardness, erythritol was not considered as suitable sugar replacer than other polyols in production of muffins. Whereas in chiffon cakes, replacement of sugar upto 75% with erythritol did not have any impact on the physical and sensory properties of the cake. A partial sugar replacement in cakes and muffins resulted in soft crumb. In biscuits, it increased dough strength and elasticity in addition to decreased fragility and lower textural quality. According to Martinez-Cervera et al (2014), total replacement of sugar with erythritol is not at all feasible in the case of biscuits and cakes (Sahin et al., 2019; Struck et al., 2014).

### Mannitol

Mannitol, which is a white crystalline compound, is an isomer of sorbitol. It was the first ingredient to be used in food as “sugar-free”. It is found in the sweet exudates of ash tree (Ghosh & Sudha, 2011). The intensity of sweetness is half the sweetness of sucrose making it to be profitable for use in bakery products . Because of its non-hygroscopic nature, it is being used as an excipient in pharmaceutical tablets (Struck et al., 2014). The solubility of mannitol in water is less with a solubility of 220 g/kg water at 258oC whereas other sweetners have solubilities ranging from 1650 to 2350 g/kg water (Ghosh & Sudha, 2011). Replacement of sucrose with mannitol resulted in products with increased crumb firmness and decreased springiness in cakes and cupcakes. Lowest sensory scores were obtained for samples with mannitol as a sugar replacer compared to other polyols. Because of the low solubility of mannitol, additional water is being added to cookie doughs but the doughs were found to be very firm making them difficult to sheet.

Because of that this polyol is not considered as a suitable sucrose replacer due to the less spread ability and unpleasant flavor in biscuits (Zoulias et al., 2000; Struck et al., 2014).

### Isomalt

Isomalt is a disaccharide comprising of glucose and mannitol and is an odorless, low-calorie non-hygroscopic polyol (Strater,1986; Strater,1988; Ghosh & Sudha, 2011). It is known as palatinose since its discovery in 1957. The intensity of sweetness is in the range of 0.45 to 0.6 and has no aftertaste (Ghosh & Sudha, 2011). During mastication, it shows a cooling effect and does not put up to Maillard reactions . The low hygroscopicity makes it useful for incorporation into low moisture bakery products such as cookies. The replacement of 33% sucrose with isomalt in cupcakes, resulted in sensory scores that were close to control in terms of colour, structure, appearance and flavor (Edelstein et al., 2007; Struck et al., 2014). Isomalt is a suitable sugar replacer in muffins with similar thermosetting properties of the batter and good textural and sensory properties (Gomez, 2008; Martinez-Cervera et al., 2014; Struck et al., 2014).

### Hydrogenated starch hydrolysate (HSH)

This group of polyols contains hydrogenated oligo and polysaccharides. It has a sweetness intensity that ranges between 0.4 to 0.9 compared to sucrose. It has a reduced glycemic potential relative to glucose for individuals with or without diabetes, because of its slower absorption (Wheeler et. al., 1990; Ghosh & Sudha, 2011). Due to its humectant nature, this sweetener can partially replace sucrose or corn syrup in baked products such as cakes, cookies and granola bars (Ghosh & Sudha, 2011).

## High intensity sweeteners

High intensity sweeteners/ non-nutritive sweeteners are the artificial sweeteners having a higher degree of sweetness than sucrose. They are non-cariogenic, does not increase the blood sugar level and affect the digestible energy of the product. The use of these sweeteners differs from country to country i.e., it might be permitted in one country but might be prohibited in another (Struck et al., 2014). Intense sweeteners alone does not contribute to the bulk, viscosity and texture to the foods but should be used along with bulking agents such as polyols or dietary fibres to acquire these properties . Artificial sweeteners or high intensity sweeteners include saccharin, aspartame, sucralose, alitame, acesulfame-K, neotame, advantame and cyclamate. Among all these, FDA has approved six of these artificial sweeteners such as saccharin, aspartame, acesulfame-K, sucralose, neotame and advantame. (FDA, 2017).

### Saccharin

Saccharin is one of the oldest non-nutritive sweeteners accidentally discovered by Remsen and Fahlberg at John Hopkins University in 1879. Initially, saccharin was not being used as a sweetener but used as an antiseptic and preservative. Commercially this sweetener is manufacture from toluene and is available as sodium and sometimes as calcium salt. It has a sweetness intensity of about 200-700 range. An important property of saccharin is that, the sweetening power is not reduced upon heating, thus making it an excellent additive in low calorie sugar free products. It is the only approved high intensity sweetener that is able to withstand processes such as heating and baking and high acid conditions. This sweetener is marketed for over 100 years under the brand names such as Sweet’N Low, Sugar Twin and Necta Sweet. It finds application in many of the food products such as soft drinks, baked goods, jams, canned fruit, salad dressing, chewing gums etc. and in many household items such as mouthwash, lip gloss, toothpaste, vitamins and pharmaceuticals. Saccharin is one sugar substitute that can be consumed by diabetic patients because it doesn’t get metabolized in the gastrointestinal tract and does not increase insulin levels (Shankar et. al., 2013).

### Aspartame

Aspartame is the methyl ester of aspartic acid and phenylalanine. It was discovered by a chemist, James Schalatter in 1965 but was not FDA approved until 1981. The different brand names under which it was sold are Equal, NutraSweet and Natra Taste. It provides about 4 Kcal/g. It has a sweetness of about 200 times higher than that of sucrose and because of that this sweetener is often used in smaller amounts to sweeten foods. The acceptable daily intake of aspartame for both children and adult are 50 mg/kg body weight as assigned by FDA. Aspartame is used to sweeten products like chewing gums, yoghurt, puddings, diet soda, dry drink mixtures, instant tea and coffee. In a study conducted on the impact of artificial sweeteners on food intake and satiety, aspartame was found to have more pleasant take than the sweeteners like stevia or sucrose. It is said that aspartame does not cause the same response to the brain and pancreas as sugar does.

In a magnetic resonance imaging study, there was found to be a decline in the activity of hypothalamus after consumption of sucrose whereas aspartame did not decrease the activity because, for a hypothalamus reaction to take place, there should be combination of stimuli of sweet taste and energy content. Even in the pancreas, aspartame does not stimulate an insulin response as in the case of sugar (Shankar et. al., 2013).

### Cyclamate

Cyclamate is a sweetener that was discovered by Michael Sveda in 1937 at Abbott Laboratories, Chicago. FDA had approved it as a food additive in 1949 and achieved GRAS status in 1958. In 1969, it lost its GRAS status and was banned in USA in 1970 because of the tumour that was caused in rats, and later on in UK and other countries which resulted in the deterioration in the taste of soft drinks and an incentive to develop new sweeteners. In some countries like Spain, Germany and Switzerland, this sweetener is permitted for some applications. Cyclamate has one tenth sweetness of the same weight as that of saccharin. In 1950s, they produced a desirable sweetness when used in combination at the ratio of 10:1. The after taste of saccharin was masked by using cyclamate and the low sweetness of cyclamate could be increased by saccharin. This combination used became the first commercial multiple sweeteners, finding application in a variety of foods such as soft drinks, salad dressings, low-calorie frozen dessert, jams, jellies etc.

Another combination used are along with aspartame or in combination with aspartame and saccharin, which were also found to give a good taste and improve sweetness in foods like soft drinks, dry beverage mixes, chewing gums and table-top sweeteners (Gelardi, 1987; Smith, 2013).

### Sucralose

Sucralose is a non-caloric sweetener discovered in 1976 which was given permission to be used as a sugar replacer in 15 food and beverages by FDA. It has a similar taste to that of sugar with no unpleasant aftertaste. This sweetener is being marketed under the brand name, Splenda. It is made by selectively substituting chlorine for hydroxyl groups on sucrose core. It has a sweetness 600 times higher than that of table sugar. This sweetener passes through the GI tract with small amounts being absorbed and finally eliminated through feces without being changed (International Food Information Council Foundation, 2009). When sucralose is subjected to high heat and acidity, it retains its sweetness, i.e., they are exceptionally stable. Sucralose is considered as a safe artificial sweetener for long term use because of the lack of bioreactivity and bioaccumulation in humans and animals. Because of no effect on the carbohydrate metabolism, this sweetener is safe for patients with. It does not either affect the rate of glucose absorption from small intestine nor does it increase glycaemic response or incretin hormone levels such as glucagon-like peptide 1 and glucose dependent insulinotropic polypeptide in healthy persons given an intraduodenal/intragastric infusion . In addition, sucralose does not stimulate the release of insulin or slow down gastric emptying, and therefore maintaining glucose homeostasis. There are studies which suggests that sucralose does not have any effect on appetite in normal healthy weight adults (Shankar et. al., 2013).

### Acesulfame-K

Acesulfame K is a potassium salt derived from acetoacetic acid which was discovered in 1967 by Hoechst AG who was an employee of a pharmaceutical company and is marketed under the name Sunett. This sweetener is about 200 times sweeter than sucrose. Initially, this sweetener was been allowed in the US to be used in foods such as sugar free baked goods, chewing gums and gelatin desserts. But in July 1998, this sweetener was permitted by FDA to be used in soft drinks. Other than Sunett, there are other brand names that acesulfame-K has, which are Sweet One and Swiss Sweet. Acesulfame-K is heating stable sweetener that can be used in cooking and baking operations. (Center for Science in the Public Interest, 2012; Shankar et. al., 2013) Acesulfame-K has a synergistic effect of upto 30% of sweetness intensity or more than 30% when used in combination with aspartame and cyclamate. When used along with aspartame at the ratio of 1:1 by weight for acesulfame-K and aspartame and along with cyclamate at the ratio of 1:5 by weight for acesulfame-K and cyclamate, it was observed to get most favorable sensory properties. It was also found to have a synergistic effect with sorbitol, isomalt and fructose. Acesulfame and thaumatin combination is less costly and provides a similar taste in some food products than that of aspartame, which is a costly sweetener. (Von Rymon Lipinski, 1986; Smith, 2013). Acesulfame-K is excreted through the body without being changed (International Food Information Council Foundation, 2009; Shankar et. al., 2013). Acetoacetamide is one of the byproducts that is formed after the breakdown of acesulfame, which is very toxic in large doses. But this sweetener is used in lower amounts in beverages thereby not causing any health hazard (Kroger et al., 2006; Shankar et. al., 2013).

## Natural sweeteners

These are the sweeteners that are naturally present in the environment that provide sweetness and possess low energy content. They are found in different plant parts such as roots, seed, flowers and leaves from which they are extracted and further purified. Tegatose, stevia and fructans (oligofructose and inulin) finds application in foods to be used as a sugar replacer. Other sweeteners such as thaumatin, brazzein and monatin have not been applied (Struck et al., 2014).

### Tegatose

Tegatose is a ketohexose which when compare with sucrose, has a sweetness of 0.92 and lower energy content of approximately 1.5 Kcal/g because of it being partially absorbed in the GI tract. It is found in smaller amounts in fruits and dairy products but can be commercially produced from lactose. Tegatose is a non-hygroscopic, prebiotic and synergistic sweetener that enhances the sweetness or reduce bitterness when used with other sweeteners. It exhibits a low water activity than sucrose at the same concentration because of the lower molecular mass. It has achieved GRAS status so it is used as a sweetener and sugar replacer in foods and beverages (Struck et al., 2014). Tegatose when used in cakes, cookies and muffins at 3% or 6%, found no change in flavor or sweetness of the food product (Armstrong et al., 2009; Struck et al., 2014). In cookies 20-100% of the sucrose was replaced by tegatose and found no difference in the dough hardness, cohesiveness and resilience (Taylor et al., 2008; Struck et al., 2014). In cookies, tegatose increased the height and reduced diameter of the cookie which is due to the poor water binding capacity of tegatose, which makes available more water for gluten formation and enhances browning (Struck et al., 2014).

### Steviol glycosides

Stevioside and rebaudioside A are steviol glycosides extracted from Stevia rebaudiana Bertoni plant species and widely used in Japan for more than 20 years (Chan et al., 2000; Shankar et. al., 2013; Struck et al., 2014).

They are about 300 times sweeter than sugar and are thermally stable making them to be used as a sucrose replacer. At smaller amounts, both of them have a clean sweet taste (sucrose equivalency level ≤6) but at higher concentration (sucrose equivalency level >6) had a bitter taste. Steviosides have increased bitterness and black licorise aftertaste when compared with rebaudioside A (Prakash et al., 2008; Struck et al., 2014).

The European Union had approved this sweetener as an additive for specified foods in 2011 with an acceptable daily intake of 4 mg/kg body weight (Anonymous, 2011; Struck et al., 2014). There are over 10 different types of steviol glycosides which has been identified, but only stevioside and rebaudioside A are commercially available in appropriate purity (Carakostas et. al., 2012; Struck et al., 2014). These sweeteners are used in combination with artificial sweeteners such as saccharin or aspartame without any loss in stability (Kroyer, 2010; Struck et al., 2014). Synergistic effects were observed in combination with aspartame or acesulfame-K but not in combination with cyclamate (Frank et al., 1989; Struck et al., 2014).

In an experiment conducted in muffins with 30% sucrose replaced by steviol glycosides and inulin, there was found to be a reduction in the glycaemic response. Ground stevia leaves used in cakes increased the hardness, cohesiveness and toughness of the cake whereas an aqueous extract from stevia leaves was able to replace sucrose in reduced energy yoghurt cake. As steviol glycosides exhibits only high intensity of sweetness and not bulk properties, they cannot replace sucrose completely. The cookies with added stevia leaf powder (15-20%) decreased diameter, thickness and hardness of the cookie. The steviol glycosides when combined with hydrocolloids, bulking agents or fibres resulted in acceptable quality characteristics in sugar free products ( Struck et al., 2014).

### Fructans

Fructans are polymeric carbohydrates with a linear, branched or cyclic structure and fructosyl-fructose linkages. They are regarded as prebiotic dietary fibres because of the growth of beneficial microbes such as bifidobacterial and lactobacilli. They are found to reduce serum cholesterol and triacylglycerols, promoting absorption of minerals and preventing colon cancer. This group of carbohydrate includes inulin and oligofructose. Inulin is a fructan used in combination with high intensity sweeteners for the delivery of bulk characteristics. Under certain conditions, inulin forms a gel in aqueous system and can be used as a fat replacer and texture modifier (Zoulias et al., 2002; Struck et al., 2014). The most important sources of inulin are chicory and Jerusalem artichoke. The degree of polymerization (DP) after extraction is between 2 and 60. The DP of inulin is determined by factors such as plant source, climatic conditions or harvesting time. Inulin’s and other fructans are undigestible in the small intestine which may be partially digestible in the large intestine by microbes into short chain fatty acids, lactic acid and gas which increase the stool weight. Oligofructose are short chain fructans obtained by partial enzymatic hydrolysis of inulin. It has a degree of polymerization (DP) of 2-8 Inulin and oligofructose used as a sugar and fat replacer in could produce quick breads with good quality characteristics i.e., increased crust hardness, volume and surface colour and also showed more uniform crumb structure (Roble et al., 2011; Struck et al., 2014). Cakes formulated with oligofructose decreased hardness, increased volume and surface browning of the cake. Short chain inulins have a higher solubility and water retention capacity compared to sucrose and therefore because of not recrystallizing, the crumb structure is softer. In cookies formulated with oligofructose, it reduced height and increased diameter of cookies because of its high hygroscopic nature compared to sucrose and resulted in low gluten formation ( Struck et al., 2014).

# CONCLUSION

Food grade filler particles are essential components in the production of various food products. These inert substances, such as starches, fibers, hydrocolloids, minerals, and other miscellaneous particles, fulfill important functions in enhancing the texture, stability, and overall quality of foods. By carefully selecting and incorporating these particles, manufacturers can create products that meet consumers' expectations in terms of taste, appearance, and functionality. Moreover, food grade fillers play a crucial role in various food products by providing desirable attributes such as texture, mouthfeel, and improved shelf life, the use of food grade filler particles ensures that the nutritional value, safety, and sensory aspects of the food are not compromised. Ultimately, these filler particles contribute to the creation of enjoyable and appealing food products that cater to a wide range of consumer preferences and dietary needs. However, due to health and safety concerns associated with the use of certain fillers containing harmful particles or chemicals, the food industry is actively seeking alternative replacement options. The search for suitable replacements involves considering several factors such as the nature of the filler, its functionality, cost-effectiveness, and compatibility with different food matrices. Several potential replacement options have been explored, ranging from natural ingredients to innovative technologies.Natural ingredients, such as fiber-based fillers derived from fruits, vegetables, or grains, have gained attention as they not only provide similar functional properties but also offer additional health benefits. These fillers often contain dietary fiber, vitamins, and minerals, which can contribute to improved digestion and overall well-being. In addition to natural options, advancements in technology have paved the way for innovative solutions such as microencapsulation and nanotechnology.

These techniques involve the encapsulation or modification of fillers at the micron or nanoscale level to enhance their functional properties without compromising food safety. For example, encapsulated particles can be used to control taste release, prevent oxidation, or provide targeted nutrient delivery. Although the use of alternative fillers shows promise, further research and development are necessary to ensure their long-term safety and scalability. Furthermore, consumer acceptance and perception of these alternative fillers will play a crucial role in their successful implementation. Public education and transparent communication about the benefits and safety of these replacements are key to creating consumer trust and acceptance.

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