Trehalose is a nonreducing disaccharide which consists of two D-glucose units linked by α-α (1-1)-linkage and it occurs widely in nature (in mushrooms, yeasts, fungi, and insects) (Elbein et al., 1974). Trehalose is well-known to act as a protectant against various environmental stresses, like desiccation, heat, freezing, or osmotic shock (Sakakura et al., 2011). The multifunctional properties of trehalose may be ascribed to the presence of α-α (1-1)-linkage. Theoretical studies based on molecular mechanics or quantum mechanics indicated that there is only one energy minimum for rotation around dihedral angles of the α-α (1-1)-linkage, meaning that trehalose is restricted to a single stable conformation, whose shape is similar to a clam shell (Sakakura et al., 2011). Due to unique hydration structure, trehalose is able to interact with both hydrophilic and hydrophobic molecules which probably contribute to the multifunctional character of trehalose (Rudolph et al., 1990; Choi et al., 2006; Sakakura et al., 2011).
The major applications of trehalose have been in science, medicine and cosmetic sectors due to its natural functionality, mechanism of action and technical qualities (Colaço and Roser, 1995; Sugimoto, 1995). The limiting factor of trehalose use in the food industry used to be the ingredient cost but with development of a new manufacturing process, the cost of trehalose production has been dramatically reduced (Sugimoto, 1995). This permitted its use in a wide variety of cost sensitive applications, especially in the food sector. It is about 45% as sweet as sucrose. Trehalose structure ensures its stability under low pH values even at elevated temperatures, and unlike other disaccharides trehalose will not readily hydrolyze. Since it is nonreducing sugar it will not take part in Maillard reactions with amino acids and proteins (in different foods). The high stability of trehalose enables the original product characteristics (aroma and colour) to be retained even after heat processing and prolonged storage, ensuring a more fresh-like final product.

Over the years, consumers' demands for high quality foods evolved and nowadays consumers are more aware of the impact of food on their health. Texture, colour and aroma are the main sensory quality attributes of food influencing consumer acceptability of food products. During formulation of fruit products different additives are often used to obtain desired properties of semi-products or final products. The use of additives can influence physicochemical properties, aroma, texture and colour, as well as nutritional value, thus improving the overall quality of the product. Generally, carbohydrates are one of the most used additives insuring different functional properties in product. Also, preparation processes and conditions during preparation have a high influence on final product quality. Sucrose is very often used as an ingredient during preparation of some fruit products like juices, jams, jellies etc. Through partial replacement of sucrose with trehalose or addition of trehalose it is possible to reduce sweetness of the product but also to improve the product quality. The influence of trehalose addition or partial replacement of sucrose with trehalose, in different fruit products like strawberry puree (Komes et al., 2003; Galmarini et al., 2011), apricot puree (Komes et al., 2005), pear puree and cubes (Komes et al., 2007), strawberry cream fillings (Kopjar et al., 2008a; Kopjar et al., 2008b; Kopjar et al., 2011), tomato (Dermesonlouoglou et al., 2007), blackberry juice (Kopjar et al., 2012), has been studied in an effort to determine the impact of trehalose on product quality, and to define if this impact was positive or negative. Nevertheless, there is still a **need to expand the knowledge of trehalose influence on fruit product quality**.
The objective of this project is **continuation and extension of investigation of trehalose addition on aroma, colour and texture, as well as nutritional value of fruit semi-products or products such as juice, puree, pectin gel products and diced fruit in fruit juice and/or homogenate**. High attention should be given to investigation of **trehalose concentration** on **mentioned characteristics** since it was proven that an increase in trehalose amount didn't always have a positive effect on quality parameters. Different trehalose concentrations had a different impact on aroma and texture (Kopjar et al., 2008a; Kopjar et al. 2008b), while with the increase of trehalose concentration, an increase of anthocyanin content and retention of colour occurred (Kopjar et al., 2006; Kopjar et al., 2008a). For **successful product**

formulation it is necessary to achieve the balance between colour, aroma and texture through selection of trehalose concentration for the desired product.
Phenols are well known phytochemicals with a positive effect on human health - since they are acting as antioxidants, they can help prevent cardiovascular problems and some types of cancer. Anthocyanins are one of group of phenols, which are important as pigments and antioxidants in fruit products. They are very unstable pigments, especially during thermal treatments. It is possible to decrease anthocyanin degradation during heating through addition of trehalose (Kopjar and Piližota, 2011), therefore this could be a possible tool for achieving anthocyanin stability and increasing antioxidants content in the product. Considering aroma and colour, trehalose had a positive impact, but influence of trehalose addition on texture should not be neglected, especially when products are characterised on the basis of their texture (pectin gel products) or when semi-products need to be applied over the product base by, for example, heat rollers (Kopjar et al., 2008b).
Selection of processing technology is also of great importance to achieve the higher quality, more nutritious, safer and more economical foods. Influence of different food processes such as freeze-drying, microwave treatments, as well as combination of those two processes with an addition of trehalose on sensory characteristics and nutritional value of products will be also studied in this project. The thermal properties of foods are required for performance of the various heat transfer calculations that are involved in the design of food storage and refrigeration equipment and estimating process times for refrigerating, freezing, heating or drying of foods. They are strongly dependent on chemical composition and temperature. Different amount of trehalose addition and different preparation processes (freeze drying and evaporation) had impact on thermal behaviour of strawberry cream fillings (Kopjar et al., 2013).
Quality degradation of fruit products occurs during storage. Those changes are initiated by different chemical reactions. Trehalose addition in fruit products can reduce some of those changes like colour degradation, loss of aroma, loss of anthocyanins (Kopjar et al., 2008a; Kopjar et al., 2012) thus prolonging stability and shelf-life of fruit products. The extent of sensory quality change will also be studied in this project.

The real mechanism of trehalose action in the complex food matrix is not precisely defined. All investigations that were conducted on trehalose structure and its influence on some ingredients were conducted in model systems, thus complexity of the food matrix and interactions of food ingredients were excluded. One of the objectives of this project is the **explanation of trehalose action in the complex fruit product matrix**, with an attempt to establish a correlation between trehalose structure and its influence on fruit product quality.

Practical application of results of this project can lead to the formulations of **semi-products or final products** which are more **fresh-like** meaning that more key natural aroma compounds would be retained in product and natural pigments stability could be achieved. Since trehalose sweetness is only 45% of sucrose sweetness, prepared products are **less sweet** which is especially significant for people who do not like sweet taste, but want to consume products containing sugar. Also due to the lower sweetness of trehalose in comparison to sucrose, a full aroma potential of the products could be perceived and appreciated by consumers.
Growing awareness the consumers' knowledge about the health promoting effects of antioxidants on human health, but also the consumers' rejection of addition of synthetic antioxidants to food products led to the investigations of the use of natural antioxidants during fruit product formulations and protection of antioxidants naturally present in fruit product. Through our previous investigations it was evident that trehalose had an influence on phenolic compounds, especially anthocyanins, which are well known for their antioxidant activity and benefits to human health. Phenols individually and/or synergistically may provide protection against cardiovascular disease, cancer, inflammation, obesity, diabetes, and other chronic diseases. Retention of those

compounds in products leads to the **formulation of products of higher nutritional value** i.e. functional products.

In addition to its positive influence on the quality of fruit products, trehalose also has some health benefits. Trehalose showed a substantially reduced cariogenic potential compared with sucrose and therefore can be used in the formulation of 'kind to teeth' and 'tooth-friendly' products but without the laxative effects of other low-cariogenic bulk sweeteners and those products are especially beneficial for children. Recent study showed that trehalose is digested more slowly, and thus has a lower glycemic index, with a lower insulin release than sucrose (van Can et al., 2012). Also, trehalose inhibits lipid and protein misfolding and has become an attractive molecule for study in neurodegenerative diseases characterized by protein misfolding and aggregate pathology. Such diseases include Alzheimer's, Parkinson's and Huntington's disease, and occulopharyngeal muscular dystrophy (Patra et al., 2009). **Having in mind all the beneficial properties that are mentioned above, the application of trehalose in fruit products at the expense of other sugars is desirable.**