

**TÜRKİYE'DE YETİŞEN BAZI TROPİKAL MEYVELERİN BESLENME  
AÇISINDAN ÖNEMİ VE GASTRONOMİDE YENİ YAKLAŞIMLAR**  
**The Importance of the Nutritional Values of Some Tropical Fruits Grown in  
Turkey and New Approaches in Gastronomy**

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**Abstract**

There is an increasing demand in the production and consumption of tropical fruits because of the growing trend of consumer interest in new and different products in recent years. Although tropical fruits are consumed less frequently compared to local fruits with regard to their limited production possibilities due to special ecological conditions, going beyond our habits, and the fact that they are considered expensive. The variety of these fruits is associated with protection from noncommunicable diseases (NCD) such as cancer and cardiovascular diseases due to the nutritional compounds they contain and their high antioxidant activity. Widely known and grown tropical fruits in Turkey are banana, pineapple and kiwifruit and in recent years, pitaya (dragon fruit), guava, lychee, papaya, avocado, pomelo, mango, kumquat and passion fruit are cultivated in the regions which have suitable climate conditions. In the current study, the reviews about the nutritional value and bioactive compounds of some tropical fruits grown in Turkey have been investigated and their benefits for the human health have been evaluated. In this study, innovative products from the tropical fruits in the field of gastronomy by applying different cooking techniques and technologies in order to improve the flavor and texture properties besides the existing fields of use was revealed.

**Key words:** Gastronomy, Innovative Product, New Recipes, Nutrition, Tropical Fruit

## Öz

Son yıllarda tüketicilerin yeni ve farklı ürünlere olan ilgisinin artması nedeniyle tropikal meyvelerin üretimi ve tüketiminde artan bir talep yaşanmaktadır. Bu talep tropikal meyvelerin üretimleri için özel ekolojik koşullar gerektirmesi, alışkanlıklarımızın ötesine geçmesi ve pahalı sayılması nedeniyle sınırlı üretim olanaklarıyla yerel meyvelere göre daha az tüketilmesine rağmen oluşmuştur. Bu meyvelerin çeşitliliği, içerdikleri besin bileşikleri ve yüksek antioksidan aktiviteleri nedeniyle kanser ve kardiyovasküler hastalıklar gibi bulaşıcı olmayan hastalıklardan (NCD) korunması ile ilişkilendirilebilir. Türkiye’de yaygın olarak bilinen ve yetiştirilen tropik meyveler muz, ananas ve kivi olup, iklime uygun bölgelerde son yıllarda pitaya (ejderha meyvesi), guava, liçi, papaya, avokado, pomelo, mango, kumkat ve çarkıfelek meyvesi yetiştirilmektedir. Bu çalışmada, Türkiye’de yetiştirilen bazı tropikal meyvelerin besin değeri ve biyoaktif bileşikleri ile ilgili yapılan çalışmalar incelenmiş ve insan sağlığına faydaları değerlendirilmiştir. Bu çalışmada, mevcut kullanım alanlarının yanı sıra lezzet ve doku özelliklerini iyileştirmek için farklı pişirme teknikleri ve teknolojileri uygulanarak gastronomi alanında tropikal meyvelerden yenilikçi ürünler ortaya çıkarılmıştır.

**Key words:** Gastronomi, Yenilikçi Ürün, Yeni Reçete, Beslenme, Tropikal Meyve

## Introduction

Tropical fruits are grown in regions where the average temperature during the coldest month does not fall below 18°C and all seasons are hot and rainy (Klimatoloji Şube Müdürlüğü, 2017). Although these fruits have been involved in daily nutrition in the countries of their homeland for many years, their recognition and consumption around the world is based on a recent past. Lately, people's quest for new tastes, experience of different foods other than the foods they are used to and the tendency to benefit more from them in the fields of health and cosmetics have increased the import of tropical fruits and their production in suitable environments outside their homeland.

Banana, pineapple and kiwifruit are the most commonly produced and consumed tropical fruits in Turkey. The amount of banana production in Turkey in 2019 was 548.323 tons, while the kiwi production amount is reported that 63.798 tones in the same year, and no data have been found for pineapple (TÜİK, 2020). In addition, pitaya, guava, lychee, papaya, longan, avocado, pomelo, mango, kumquat, passion fruit, cherimoya and breadfruit have been grown in Turkey in recent years. In Turkey in 2019, 4.209 tons of avocados, in 2018 250.000 tons of grapefruit (pomelo incorporated into this data) has been reported that production takes place, and the production amounts of other tropical fruits produced in Turkey could not be reached. (TÜİK, 2020; FOASTAT, 2020). Some of these fruits which are grown in the warm regions of the Mediterranean and Aegean coasts, both in agricultural areas and in greenhouses, meet the consumer at the points of sale while others are not easily accessible if they are not supplied directly from the producer. With the increment in access to tropical fruits, interest in these fruits has increased. Tropical fruits, which have high nutritional value and several health benefits, are generally consumed as table fruits in Turkey. In this study, it was aimed to

(1) introduce the nutritional value and general usage areas of tropical fruits and (2) to increase the usage possibilities in gastronomic way by developing new recipes with these fruits, which are rich in nutrients and bioactive compounds.

### **Banana (*Musa spp.*)**

Banana, which is widely consumed in Turkey, is grown in more than 130 countries, and Southeast Asia is the homeland (Sing et al., 2016). 99% of banana production takes place in Mersin and Antalya in Turkey (Subaşı et al., 2016). It is an important source of nutrients as it contains vitamins, minerals and phenolic compounds and the inclusion of banana in the recipes increases the nutritional value of foods (Lim, Lim & Tee, 2007; Wall, 2006; Forster et al., 2003; Borges et al., 2014). It is a valuable nutritive fruit for healthy diets with its high potassium content and resistant starch in its structure (Lassoudière, 2007; Singh et al., 2016).

Banana, commonly found in Turkey, is usually consumed raw as a fruit. After processing, it is also consumed by adding certain amounts to various foods or as a new food product completely different from its original form. In addition to being consumed as deep fried, boiled and/or baked, it is aimed to store the fruit puree and flour produced by technological processes in this structure for long shelf life and to offer variety of products to consumers. Unripe bananas can be finely sliced, deep fried and consumed as chips and ripe bananas can be consumed as a snack by increasing the shelf life through drying while banana puree can be used as an alternative food component with its thickening property (Singh et al., 2016).

### **Kiwifruit (*Actinidia deliciosa*)**

It is a fruit that grows in the eastern parts of Asia, especially in China, and its commercial production began in the late 1930s in New Zealand. The regions of production in Turkey are Black Sea and Marmara, and the first registered domestic kiwifruit variety is called “ilkaltın (first gold)” (Şahin, 2019; Uzundumlu et al., 2018). Kiwifruit, which is easily accessible all over the world, is rich in vitamin C, E, K, potassium, carotenoid, flavonoids and total dietary fiber (Jung et al., 2005; Stonehouse, 2012). Today, the most common type of kiwifruit consumption is fresh, dried, frozen, and it is also consumed as liquor and tea (Şahin, 2019); in addition to decorating different pastry products such as pavlova, cakes and tarts, ice cream and sorbets, drinks, salads, sauces are also used. According to Soquetta et al. (2016), in order to create value from kiwifruit, which is an agricultural waste shell and pulp, it is suggested to reduce the amount of agricultural industry waste by adding dietary fiber to bioactive compounds and antioxidant enrichment.

### **Pineapple (*Ananas comosus*)**

Pineapple, which has an important place in the cuisine of Southeast Asian countries, is used in meat dishes together with curry in Malaysia while in Mexico, a fermented pineapple drink is consumed as tepache and fruit is consumed as a kind of confectionery

in Philippines (Hossain et al., 2015). In addition to the food and health sectors, there are studies on the production of paper from the leaves of pineapple by investigating the possibilities of usage in different branches of industry and thus, it is aimed to contribute to the nature by reducing the lumbering (Sibaly & Jeetah, 2017). Pineapple, which has a juicy and fibrous structure, has been reported to be consumed in the right portions since it contains 14% sugar in its full mature state (Almeida et al., 2011; Hossain et al., 2015). While pineapple's calcium, potassium, vitamin C, carbohydrate and raw fiber content enable to regulate the digestive system by helping to maintain a balanced diet, bromelain, a proteolytic enzyme in its content, helps to hydrolyze proteins by consuming fruit with food (Hossain et al., 2015). A mature pineapple is regarded as the body's primary antioxidant against free radicals and supports iron absorption (Debnath et al., 2012; Hossain et al., 2015).

### **Avocado (*Persea americana*)**

Avocado, which has become popular in recent years, is widely cultivated in Mexico and South America while it is produced in the Mediterranean coastline and South Aegean area in Turkey and is known as “American pear” (Yurt & Büyüktuncer Demirel, 2017). In Turkey, 75-80% of the avocado production is in Antalya, 15-20% in Mersin and 2-5% in other cities (Muğla & Hatay) (Tarhan, 2019). The nutritional value of avocado is rich in oil-soluble phytochemicals and potassium, and it is reported to contain low amounts of sodium (Alvarez et al., 2012). With this feature, avocado is suitable for low sodium diet by means of the high potassium and low amount of sodium it contains, and it has protective properties against cardiovascular diseases (Cowan & Wolstenholme, 2016; Zafar & Sidhu, 2011). Vitamin E, retinol, ascorbic acid, thiamine, riboflavin, niacin, pyridoxine and folic acid are other compounds that make avocado valuable (Duarte et al., 2016).

Sauces, soups, salads and also vinegar, wine, oil are produced from the flesh of avocado, and tea is obtained from the seed. It is reported that 30% of starch in avocado seed can be extracted and used in bioplastic production (Lubis et al., 2016).

### **Passion fruit (*Passiflora edulis*)**

Passion fruit is widely grown in countries such as Australia, Caribbean, California, Brazil and Ecuador where frost is not observed. Cultivation in Turkey is especially prevalent in southern provinces (Biriken, 2018). It is grown between May and October, the height is between 6-12 cm; according to the species of purple-brown, green-brown with various shell colors, the inner part is a juicy, yellow-orange fruit. It is used in pastry products such as pudding, mousse, cheesecake and cakes and it is also consumed as cocktail, fruit juice and jam. It has been reported that the aroma and flavor of passion fruit wine are enriched depending on the maturity of the fruit, mainly used in wine making (Nzabuheraheza & Nyiramugwera, 2014).

### **Guava (*Psidium guajava*)**

The first harvest and merchandising of guava fruit, whose homeland is South America and West India, was started in Mersin in 2018 (Adak et al., 2019). It is defined as “super fruit” due to its high antioxidant activity (da Silva Lima et al., 2019). All parts of guava are consumable and especially the shell is rich in vitamin C. It is reported that the fruit has a lowering effect on blood sugar, blood pressure, triglyceride and cholesterol levels, and it is also effective in pain relief and anti-inflammatory activity (Gutiérrez et al., 2008). The fact that the fruit itself, as well as the peels and seeds, is rich in phenolic compounds indicates that it can be used as a constituent in the development of functional foods. Guava is processed into fruit juice, ice cream and jams (da Silva Lima et al., 2019) In addition, the freeze-dried guava is pulverized and used as a natural food source used in baby food, soup and beverages. Guava powder is also available in tablet form and is considered a beneficent alternative due to its packaging, storage and easy accessibility (Zea et al., 2013).

### **Kumquat (*Fortunella margarita*)**

Kumquat, known as the “small jewel of the citrus family”, is also called “golden orange”. It is most common in China, Japan and the USA, but it is also cultivated in the Mediterranean Region in Turkey (Gölükcü et al., 2017). It is stated as a good source of antioxidants with high polyphenol content and it has antimicrobial, anticancer and metabolism regulating effect (Lou et al., 2017; Sadek et al., 2009). Although the flavor of kumquat, whose shape is similar to lemon and color is similar to orange, is like other citrus fruits, it is used in making liquor, marmalade, jam, sorbet, sauce, pickles or confectionery, including its shells, and its paste is evaluated in many food applications (Çakmakçı et al., 2016; Sadek et al., 2009; Love et al., 2007).

### **Lychee (*Litchi chinensis*)**

The origin of the lychee fruit is China and it is also widely cultivated in India (Zheng et al., 2014). The fleshy part of the lychee is known as fruit, and it contains lipids, protein, carbohydrate, C and B-complex vitamins, and minerals such as manganese, magnesium, iron and copper; the seed, which is separated as waste, is known as a natural antioxidant source (Prakash et al., 2017; Prasad et al., 2009). In the studies that have investigated to make the fruit accessible throughout the year and to be consumed in different ways, lychee fruit is generally preferred as fresh, dried, frozen, canned and juice while honey, wine and paste produced from lychee also exist (Singh, 2012; Vural & Karaman, 2009; Vijayanand et al., 2010; Zhao et al., 2014; Reyes et al., 2016).

### **Mango (*Mangifera indica*)**

The spread of mango throughout the world began with the trade between Europe and Asia like other fruits and spices. It is reported that the homeland of mango is India and the regions where it is grown in Turkey are especially in Antalya (Gübbük et al., 2017). Mango is regarded as a good source of antioxidant due to its ascorbic acid, carotenoids

and phenolic substances and it is rich in vitamin C and A (Shieber et al., 2000; Ribeiro et al., 2007). Mangiferin, a specific polyphenol present in mango leaf, is a natural source of antioxidants that helps to prevent various cancers, atherosclerosis, diabetes and obesity; the peel of the fruit is considered a good source of dietary fiber (Masibo & He, 2008; Larrauri et al., 1996).

While the ripe mango fruit is used in desserts like many tropical fruits, the powder form called “amchur” which is obtained by drying the immature mango is used as spice. The fruit is also processed into pickles, vinegar, wine, jam, marmalade, and juice (Campbell et al., 2006; Mukherjee, 1953).

### **Papaya (*Carica papaya*)**

Papaya, which attracts attention with its melon-like appearance, is widespread in countries such as Brazil, Nigeria, India, Mexico and Indonesia and is grown in the Mediterranean Region in Turkey (Demiral & Gübbük, 2004). It is accepted as a good source of vitamin C and A, riboflavin, folate, calcium, thiamine, iron, niacin, potassium and fiber. Papaya is consumed by being cooked like the other vegetables in its raw state while mature ones are generally consumed as beverages (Elgadir et al., 2014; Boshra & Tajul) (2013).

### **Pitaya (*Hylocereus undatus*)**

In recent years, pitaya (known as dragon fruit-strawberry pear-cactus fruit) has become popular in Turkey. While the homeland of the fruit is United States and Mexico, in Turkey, it is mainly cultivated in the Mediterranean region including Antalya and Mersin (Soydal et al., 2019). It is an important source of phytoalbumin that has antioxidative activity and vitamin C and accepted as a high nutritive fruit (Jaafar et al., 2009). Pitaya is an important source for betalaines, a water-soluble natural pigment substance and therefore, it is used as natural food colorant. It is stated that the natural colorant obtained from pitaya can be used in cosmetic and food industry, however, it has been pointed out that it has high cost (Tze et al., 2012). This fruit is widely preferred in pastry applications due to its visuality and it is also processed into juice, confectionery, jam, ice cream, yogurt, salad, marmalade and jelly products. In Malaysia, pitaya is used in wine making and its buds are suitable for soups, salads and tea (Gunasena et al., 2007).

### **Pomelo (*Citrus maxima*)**

Pomelo, known as the biggest and the juiciest fruit among all the citrus family, is also called “Chinese grapefruit”. The fruit is generally grown in Southeast Asia and other Asian countries (Wu et al., 2019; Tuan et al., 2019). Pomelo, which consists of 50% peel, is a source of vitamin C and physiologically active substances such as pectin, flavonoids, essential oils, natural pigments, limonoids, dietary fiber which are beneficial to the human organism; it is also considered functional food with high antioxidant content (Gamopilas et al., 2015; Liu et al., 2018). It is consumed as juice, marmalade and canned,

and is suitable for use as a thickener in the food industry due to its high pectin content (Tuan et al., 2019; Gamonpilas et al., 2015).

## **Material and Methods**

The fruits to be used in the trials were determined by the opinions of 5 experts which are; a chef instructor with 20 years of experience, a chairman of a Food Platform and also an academican in Nutrition and Dietetics, an academican who has been active in the food sector for over 25 years, a tropical fruit producer in Turkey and a member of marketing team of a market which is a market chain in Turkey supplies tropical fruits. The experts have concluded that in addition to bananas, kiwi, pineapple that have grown for many years in Turkey, the tropical fruits such as avocado, passion fruit, guava, kumquat, lychee, mango, papaya, pitaya, and pomelo were selected for the reasons as follows; being cultivated in recent years, having high nutritional values, having different presentation options and having the opportunity of utilizing the unused parts.

In the first part of the study the general characteristics of tropical fruits used in the experiments was given, in the second part information about the techniques and applications applied in developing new recipes that performed in the practice kitchen of Istinye University Gastronomy Department were included and in the third part nutritional values and costs were calculated and discussed.

The tropical fruit varieties used in this study, papaya, guava, avocado, pitaya (dragon fruit), mango, passion fruit were obtained from S.S Tropical Fruit Production and Marketing Cooperative which is located in Antalya/Gazipaşa, and lychee, banana, kiwifruit, pineapple, kumquat and pomelo were supplied from a local market in Istanbul and kept at +4°C during the trials (2 days).

While the experimental plan was being prepared, papaya, avocado, mango and lychee fruits were peeled and the seeds were separated; banana, dragon fruit, kiwi, passion fruit, guava, pineapple and pomelo were only peeled, and the kumquat was used directly. New product recipes for all fruits, the calculations of nutritional contents were obtained by using the software Nutrition Information Systems (BeBIS) 7.0 full version (Schmid, 2011) and these are given in Table 1 and Table 2, respectively.

For sensory analyses, a panel group of 10 panelists consist of chefs and academicians was formed to observe the developed recipes according to appearance, taste, and overall impression in a 5-point scale; 1: "very poor", 2: "poor", 3: "average", 4: "good", 5: "excellent".

## **Developing New Recipes**

In this study, recipes were created using cutting, mixing, drying, milling, fermenting, deep-frying, roasting, searing, poaching, emulsification, brewing, caramelizing, making confit, pureeing, and gelatin thickening techniques. The usage of fruit and developing new recipes was primarily depend on the state of the fruits we received and in this context applications were planned as follows: Banana has been used to obtain an ideal

consistency in cake making due to its good binding properties; avocado, as it was unripe, was coated and fried, so the outside has become crispy and inside stayed soft that makes it edible; pineapple with its fibrous structure like meat, the roasting process was applied; the acidity of passion fruit was used in Hollandaise sauce and crispness was created with its seeds; vibrant colors of kumquat and guava, it is aimed to be used as a decoration material in the field of pastry and dried to increase their shelf lives; inspired by apricot and peach kernels, a tea was made from lychee kernels and the waste part was utilized; mango was caramelized like the apple in the original recipe of tarte tatin and it became soft, retained its shape; papaya was treated like vegetables in Gazpacho; pitaya was turned into shaved ice to create a garnish option on plates; the spongy and bitter part of the pomelo fruit, which is not generally used, has become edible by absorbing the syrup due to its structure; kiwi was fermented to make it edible as its unripe.

Gluten-free cake: Banana was peeled and sliced in 3mm thickness and then dried in the dehydrator (Sedona Combo Dryer, SD-P9150-F, UK) at 60°C for 24 hours, ground in Delonghi KG49 coffee and spice grinder in "fine" mode at 12 speed until a smooth banana flour (about 3 minutes) was obtained. Cake was made by using the mixing method in which the flour in the recipe was replaced with banana flour, and egg and sugar were added by gently folding.

Marinated kiwifruit: The peeled kiwifruits (5 piece) were sliced in quarter and left in the marinating fluid (6 star anise, 1 cinnamon stick, 10 coriander, 5 cardanomon, 3% NaCl salt solution) for 2 hours at room temperature.

Roasted pineapple: After being cut to a size of about 10x4 cm, pineapple sticks were first caramelized with butter and sugar in the pan and the sticks were baked in oven at 180°C for 10 minutes with vanilla, star anise and stick cinnamon. Pineapple bark and petals were used as decoration on the plate and prepared by sprinkling powdered cinnamon with the ingredients cooked with it.

Crispy avocado: Hard avocado was sliced lengthwise, dipped in prepared coating batter and deep-fried at 170°C. After this process, the application was made in two ways; as a salty product, sprinkled with salt, served with grilled kiwifruit cooked in a cast pan, and as a sweet product, sprinkled with sugar and caramelized with blowtorch.

Poached egg with Hollandaise sauce: The seeds, meant to be added into the sauce later, were separated from the passion fruit with the help of a strainer before whipping the sauce to keep the seed undamaged. Instead of lemon juice, which was used in the original recipe, passion fruit fresh was whipped with the egg yolks until doubled in volume in bain marie, and clarified butter was added in triple steps while the mixture was whipped in the bain marie. Passion fruit seeds, salt, powdered white pepper and trace amount of lemon juice were added to the sauce. After the sauce was cooked, the pouched eggs in the classic eggs benedict were prepared (Gisslen et al., 2007). Water was boiled in a saucepan and vinegar was added into it. Eggs were broken one by one, cooked for 2-3 minutes and then placed with the help of a colander on a flat plate with paper towel. Eggs were carefully placed on a deep plate, Hollandaise sauce with passion fruit was added and they were adorned with couple of leaves of parsley and pomelo fruit pieces.



Guava and kumquat sweets: Guava and kumquat were sliced into 3 mm and dried at 60°C for 3 hours, then dipped in powdered sugar.

Lychee seed tea: The seeds were dried in the dehydrator at 60°C for 5 hours, then crushed in a food processor and brewed in a hot water together with dry rose buds.

Crispy upside down mango: The butter was added in the middle of the earthenware casserole bowl, the caramelized sugar was prepared in a separate pan, and the half mango flesh was placed on inside part above. The baklava dough, which was cut in accordance with the size of the bowl, was shaped by applying melted butter on each layer and pushing it into the cavities at the edge of the mango. After baking at 160°C for 15 minutes, it was turned quickly without hardening the sugar and removed from the casserole, served with cinnamon powder and dried kiwifruit and guava pieces, which had been dried for about 3 hours at 60°C in the dryer.

Cold papaya soup: Papaya fruit was mashed and served with pomelo juice and olive oil. In the presentation plate, pomelo pulp particles were added, and the alternative usability of pomelo fruit was diversified.

Pitaya dessert: The inside part of the pitaya was pureed and mixed with the softened gelatin leaf, which had been soaked in cold water beforehand. Trace amount of pomelo and guava juice were added to this mixture and it was kept at -18°C for 1 night. The cold pitaya dessert, which was turned into balls with a parisien spoon (30 mm), was replaced in the peel of the fruit. In this way, a decorative presentation was made in its own peel.

Pomelo confit: The white spongy parts of the pomelo fruit were cooked for 2 hours with star anise and cinnamon sticks in low heat. A transparent syrup was obtained.

## **Results and Discussion**

Tropical fruits, which have begun to take place in the Turkish market recently, are also used in the sectors of cosmetics and health, and in some industries as well, apart from being consumed as food in the world. Alternative usage of tropical fruits, whose consumption has increased in recent years although their production is limited in Turkey, were revealed by developing new recipes. Therefore, it will be possible to increase the consumption of tropical fruits, which are rich in nutrients and bioactive compounds, not only as a fresh fruit but also as dessert, soup, confit, tea, confectionery, sauce, cake and fried forms.

The gluten-free diet has recently become a preferred diet for not only individuals suffering from celiac disease but also people who want to have a more fit body. Therefore, the interest in gluten-free products is increasing day by day. The purpose of the development of gluten-free cake recipe (Figure-1) was to use banana flour as a flour substitute in gluten-free products.



**Figure 1.** Gluten-free cake

Lee et al. (2015) have reported that antioxidant activity of immature kiwifruits was generally higher than mature ones. Thus, more antioxidant activity can be provided for consumers with the consumption of immature kiwifruits. Therefore, the immature hard kiwifruit was thought to be more suitable for making a marinated product (Figure-2).



**Figure 2.** Marinated Kiwifruit

Pineapple, which is generally consumed as fresh fruit, was first seared in a pan according to the recipe developed and roasting was applied as the further technique (Figure-3). The aim of this process was to determine the compatibility of a fruit to roasting, which is known as the meat cooking technique, and the change in the final product quality according to the raw state of the fruit. It has been observed that this cooking technique may be an alternative to the consumption of pineapple.



**Figure 3.** Roasted Pineapple



**Figure 4.** Fried salty avocado

Tempura is a technique of Japanese cuisine which was developed to make the outside of the vegetable and seafood products crispy (Horigane et al., 2003). Tempura coating batter is prepared by mixing low protein flour and iced water (2:1 ratio). In this study, the recipe of the coating batter, which gives the coating a more homogeneous, swelling texture and is used in the tempura to leave the product moist, was rearranged with flour, yeast and beer and left for a while to activate the yeast. Therefore, avocado dishes which are crispy outside and moist inside were obtained as a new approach of avocado consumption (Figure-4, Figure-5).



**Figure 5.** Fried sweet avocado

The Hollandaise sauce, one of the 5 basic sauces on Escoffier's (1846-1935) main sauces list, consists mainly of a liquid phase containing egg yolk, butter and acid (Rognsa et al., 2014). According to Escoffier *Le Guide Culinaire* (Cracknell & Kaufmann, 2011), the Hollandaise sauce recipe was specified as butter, egg yolk, vinegar, salt, pepper and lemon juice. This sauce was adopted as a necessity in Eggs Benedict, a classic American breakfast that was first prescribed in 1894. In addition, as a different approach to the sauce, which is commonly used with asparagus, seafood, meat and fish dishes. A new version of Hollandaise sauce was tried with flesh of passion fruit instead of lemon juice, which exists in the original recipe (Figure-6). Thus, it has been observed that passion fruit, which is consumed only as fruit or juice and has high antioxidant activity, can also be used in a different way.



**Figure 6.** Poached egg with passion fruit Hollandaise sauce

Guava and kumquat fruits were prepared as a delicious candy and snack option for longer and easier consumption (Figure-7). It was considered that these sweets can be consumed as healthy snacks due to its low sugar content.



**Figure 7.** Guava and kumquat sweets

As a different approach, seeds of lychee fruits, which are generally waste, were used in recipe instead of flesh part. Thus, seeds were grounded and served as an alternative hot beverage (Figure-8).



**Figure 8.** Lychee seed tea

Tarte Tatin is a dessert of French cuisine, which was started to be made in the early 1900s. It contains caramelized apple slices and cake dough and is served after being baked in the oven and turned upside down. In our study; tarte tatin making technique was used and the dessert was prepared with mango and baklava dough (Figure-9). Thus, this recipe is thought to be an alternative to both the Tarte Tatin recipe and the consumption of the mango.



**Figure 9.** Crispy upside down mango

Gazpacho, which belongs to the Andalusian Region of Spanish cuisine and is under the title of “cold soups” in the soup categories, basically consists of minor ingredients such as olive oil, wine vinegar/lemon juice, salt and tomato juice/water with the main ingredients of tomatoes, cucumbers, red and green peppers, and onions (Pinilla et al., 2005). Papaya soup was made as an alternative to cold soups with the proper technique of making gazpacho soup where all vegetables are used raw (Figure-10).



**Figure 10.** Cold papaya soup

Pitaya usually consumed as a table fruit or soft drink was used for dessert making by different way. It can be regarded as an alternative to healthy desserts since it is a flour-free, sugar-free and oil-free dessert (Figure-11).



**Figure 11.** Pitaya dessert

While the flesh part of the pomelo was used visually fresh in other dishes, the white part between the peel and fruit was treated differently. Traditionally, confit technique is the process of cooking foods, especially fruits, in syrup for a long time at low temperatures (Ripoll et al., 2018). With the confit technique, also known as canning, the transparent and a kind of low-calorie dessert was obtained. The syrup which has a thick consistency due to the pectin in the composition of pomelo, can be considered as an alternative in sherbet desserts (Figure-12).



**Figure 12.** Pomelo confit

Additionally, portion costs of the recipes developed within the scope of the study were calculated and it was seen that the cost values ranged between 0,15-3,3 €. It is advised to take into account the harvest seasons of each fruit in terms of cost. The suggested harvest season in Turkey is winter for banana, kiwi, guava, and kumquat, spring for pomelo and pineapple, and summer for avocado, mango, passion fruit, lychee and pitaya.

Kiwi, banana, mango, papaya, avocado, pineapple, which can also be produced outside their native Asia Pacific countries (23°27' north-23°27' south), are known as major tropical fruits, and minor tropical fruits have also appeared in the world market in recent years. Their high quality as well as their efficient and low-cost production will enable them to be sold through a more favorable price policy. In this case, it is thought that the habit of consuming tropical fruits will increase as they contain components that are beneficial to health and their exotic appearances attract the consumer.

## Conclusion

Banana has become widespread with the cultivation that started in the 1950s. The first cultivation of kiwifruit came into being in 1988, and pineapple, lychee, guava, papaya, pitaya, pomelo, kumquat, mango and passion fruit have also begun to be produced in recent years. In the studies, it has been emphasized that these fruits are rich in vitamins and antioxidants, and they are valuable in terms of nutrition with the bioactive compounds they contain.

With the becoming widespread of production and sales, tropical fruits have become more accessible. However, their consumption is still very limited, as many are less recognizable and are considered more expensive than other fruits. Due to their nutritional value and health benefits, consumption of tropical fruits is recommended and different recipes have been developed to increase the consumption of these fruits.

People who pursue new flavors, are prone to experiencing new foods, and have improved taste physiology are described as “neophilic” by Pliner ve Hobden (1992). It may be concluded that new prescriptions from this study may be preferable to neophilic consumer groups with high income and educational level, equipped with nutritional knowledge and giving importance to a healthy lifestyle. Although the market share of these products is limited, it will be possible to increase their consumption with the use of novel recipes and label recommendations with different recipes. Considering the sensory test results, it was accepted by the panelists that the new forms of tropical fruits were appreciated by the applied techniques according to the criteria evaluated in the newly developed recipes, and that the visuality and general impression of the fruits increased with the new presentation techniques. And it was stated that with the processes applied to the tropical fruits used in the recipes, these flavors also appeal to the Turkish palate taste; It was stated by panelists that this effect was achieved with familiar Turkish cuisine items and techniques such as pickles, baklava dough, tea; roasting and deep frying techniques.

As it is seen in Table 2, innovative recipes are rich in some certain nutrients such as iron, phosphorus, zinc, potassium, vitamin A, vitamin C, vitamin D, vitamin B3, folate. Roasted pineapple, poached egg with Hollandaise sauce, pitaya dessert, guava sweets, fermented kiwifruit, crispy upside-down mango, crispy avocado and pomelo confit are the richest ones in micronutrients, fiber and bioactive compounds. According to WHO and FAO, micronutrient deficiencies are widely seen all around the world. It is estimated that there are more than 1,5 billion people who are suffering from micronutrient deficiencies, mostly seen as iron, zinc, iodine, vitamin A and folate deficiencies (WHO, 2018). These innovative recipes can help for preventing these deficiencies, also with the help of antioxidants and bioactive compounds, giving a place for these recipes may improve health of consumers.

Roasted pineapple, poached egg with Hollandaise sauce and pitaya dessert are good source of iron; roasted pineapple, poached egg with Hollandaise sauce, guava sweets and pomelo confit are good source of zinc; guava sweets, crispy upside-down mango and crispy avocado are good source of potassium; fermented kiwifruit, pitaya dessert, pomelo confit, kumquat sweets and cold papaya soup are good source of vitamin C; roasted pineapple, crispy upside-down mango and poached egg with Hollandaise sauce

are good source of vitamin A; roasted pineapple and poached egg with Hollandaise sauce are good source of folate.

In order to have healthy nutritional behavior; adequate, various and balanced diet should be provided and sustained. Innovative recipes may be good examples to get antioxidants and bioactive compounds as well as macro and micronutrients in consumers’ diet. For example, 1 portion of fermented kiwifruit provides 100% requirement of vitamin C of one healthy adult; 1 portion of poached egg with Hollandaise sauce provides 25% requirement of zinc of one healthy adult; 1 portion of roasted pineapple provides 20% requirement of folate of one healthy adult.

**Table 1.** Innovative recipes and portion nutritional values prepared with tropical fruits

<b>Fruit Name</b>	<b>Recipe Name</b>	<b>Recipe</b>
<b>Banana</b>	Gluten-free cake	120 g banana (~1 piece) 200 g eggs (~4 pieces) 250 g sugar 250 g banana flour 10 g baking powder 5 g vanilla Baking temperature: 180°C Time: 45 minutes Number of servings: 6 Cost: 0,76 €/portion
<b>Kiwi</b>	Marinated kiwifruit	300 g kiwifruit (~5 pieces) 1 L water 30 g salt 6 star anise, 1 cinnamon stick, coriander, 5 cardamom Waiting time: 2 hours Number of servings: 10 Cost: 0,15 €/portion
<b>Pineapple</b>	Roasted pineapple	600 g pineapple (~1 piece) 50 g sugar 50 g butter 7 star anises 3 cinnamon sticks 1 vanilla bean Baking temperature: 180°C Time: 12 minutes Number of servings: 4 Cost: 1,81 €/portion
<b>Avocado</b>	Crispy avocado	400 g avocado (~4 pieces) 120 g flour 250 ml beer 5 g yeast



		For frying: 1 L sunflower oil Topping: salt/sugar Number of servings: 5 Cost: 1,23 €/portion
<b>Passion fruit</b>	Poached egg with Hollandaise sauce	350 g passion fruit (~5 pieces) 60 g egg yolks (~3 pieces) 500 g butter 5 ml lemon juice Salt, white pepper 250 g eggs (~5 pieces) For cooking: 1 L water and 100 ml vinegar Number of servings: 5 Cost: 1,55 €/portion
<b>Guava</b>	Guava sweets	500 g guavas (~10 pieces) 200 g powder sugar Number of servings: 5 Cost: 0,58 €/portion
<b>Kumquat</b>	Kumquat sweets	200 g kumquats (~20 pieces) 200 g powder sugar Number of servings: 5 Cost: 0,21 €/portion
<b>Lychee</b>	Lychee seed tea	50 g lychee seeds (~4 pieces) 250 ml water 4 pcs dried pink roses 15 ml pomelo juice 15 ml guava juice Number of servings: 2 Cost: 1,20 €/portion
<b>Mango</b>	Crispy upside-down mango	120 g mango (~1 piece) 8 pcs baklava phyllo dough, ready to use 40 gr sugar 200 gr butter Baking temperature: 160°C Time: 20 minutes Number of servings: 2 Cost: 1,52 €/portion
<b>Papaya</b>	Cold papaya soup	500 g papaya 100 ml pomelo juice 30 ml olive oil Number of servings: 4 Cost: 0,94 €/portion
<b>Pitaya</b>	Pitaya dessert	300 g pitaya (~2 pieces)

		1 pcs gelatin leaf 15 ml pomelo juice 15 ml guava juice Number of servings: 2 Cost: 3,29 €/portion
<b>Pomelo</b>	Pomelo confit	White parts of 1 pomelo 2 L water 100 g sugar 5 star anises 3 cinnamon sticks Number of servings: 4 Cost: 0,81 €/portion

**Table 2.** Nutrition Information Systems (BeBIS) results

	Gluten-free cake	Fermented kiwifruit	Roasted pineapple	Crispy avocado	Poached egg with	Guava sweets	Kumquat sweets	Lychee seed tea	Crispy upside-	Cold papaya	Pitaya dessert	Pomelo confit
<b>Energy (kcal)</b>	424,6	35,4	124,5	300,0	693,7	132,6	248,0	38,8	440,2	54,2	289,1	265,1
<b>Protein (g)</b>	6,8	1,1	1,0	5,1	15,7	2,4	5,4	0,3	3,1	0,5	5,32	1,2
<b>Fat (g)</b>	48,6	0,4	0,8	36,0	9,7	0,7	2,5	0,01	0,8	4,1	0,15	0,6
<b>Carbohydrate (g)</b>	94,8	9,1	31,75	29,1	140,0	31,6	60,0	5,1	114,6	4,7	88,14	41,0
<b>Fiber (g)</b>	1,5	0,8	5	6,3	0,1	5,0	5,0	0,32	3,4	1,0	9,0	2,0
<b>Potassium (mg)</b>	188,0	13,2	72,0	462,2	70,0	700	141,2	56,1	235,0	125,0	17,0	148,0
<b>Calcium (mg)</b>	44,9	3,3	200,0	13,0	200,0	200,2	47,2	14,28	45,0	9,0	30,0	76,0
<b>Magnesium (mg)</b>	15,8	14,9	32,0	32,0	70,2	70,1	14,44	2,25	32,3	17,0	0,55	10,0
<b>Iron (mg)</b>	1,1	0,1	5	0,68	7,03	3,0	0,98	0,18	4,0	0,2	6,0	2,00
<b>Sodium (mg)</b>	254,1	60,0	400,0	8,2	50,0	250,0	7,2	14,0	675	48,8	132,0	49,0
<b>Phosphorus (mg)</b>	0,3	75,6	156,0	0,4	25,6	134,7	14,4	9,3	54	0	0,36	110,0
<b>Zinc (mg)</b>	0,8	0,4	1,2	0,712	2,3	1,2	0,12	0,014	0,4	0,8	0,12	1,2
<b>Selenium (µg)</b>	0,3	0,3	0	0,0	0	1,2	0	0,9	1,1	0,1	0,16	1,0
<b>Vitamin A (µg)</b>	64,8	13,4	230,0	116,8	210,3	130,1	12,0	0,15	760,0	12,0	0,6	130,0
<b>Vitamin B1 (mg)</b>	0,1	0	0,2	0,05	0,2	0,2	0,001	0,01	0,34	0,01	0,01	0,1
<b>Vitamin B2 (mg)</b>	0,2	0,3	0,3	0,104	0,3	0,3	0,01	0,026	0,21	0,01	0,002	0,12
<b>Vitamin B3 (mg)</b>	0,4	0,9	2,4	1,4	1,2	0,4	0,01	0,15	2,56	0,01	0,015	1,0

Vitamin B6 (mg)	0,1	0,1	0,2	0,205	0,3	0,3	0,002	0,004	0,002	0,002	0,005	0,21
Folate (µg)	25,3	37,6	80,0	73,1	80,0	46,7	10,4	0,42	12,0	1,2	0,9	2,5
Vitamin B12 (µg)	0	0	0,6	0	0	0,6	0	0	0,12	0	0,09	0
Vitamin C (mg)	1,8	82,3	20,0	8,0	20	20,1	33,2	10,53	28,0	45,0	68,0	39,0
Vitamin D (mg)	0,8	0	1	0	1,0	1,0	0	0	0	0	0	0
Vitamin E (mg)	0,5	0,9	0	0	0	0	0	0,21	1,3	1,1	0,13	1,1
Vitamin K (µg)	14,5	46,9	12,0	0,3	12,0	12,0	0	0,15	6,7	0,5	0,18	0,1

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