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## A REVIEW ON APPLE AND APPLE JUICE

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### ABSTRACT

Apple is a cultivated fruit species from the *Rosaceae* family. Apples and apple juice have an important place in nutrition thanks to the phenolic compounds, minerals and vitamins they contain. In addition, apples and apple juice, which have antioxidant properties, protect our body against many diseases caused by oxidative stress. Apple juice content generally consists of 11.1 g carbohydrates, 1.4 mg vitamins, 134 mg minerals and 0.74 mg phenolic acids. Apple juice content varies depending on parameters such as the type of apple, the characteristics of the soil where it grows, and the climate. In this review, information about the composition of apple juice is presented.

### Introduction

Apple (*Malus domestica*) is a type of fruit belonging to the Rosaceae family. There are 460 apple varieties in Turkey. There are more than 6500 apple varieties worldwide. Starking, Golden, Starkrimson and Amasya apples are

the most produced apple varieties (Aşkın, Demirsoy, Demirsoy, Koyuncu, Koyuncu, Kankaya, et al., 2002; Cennet & KARAÇAYIR, 2009). Apple is one of the fruit varieties with the highest nutritional value. Apples and apple juices are rich in phenolic compounds (Boyer &

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Liu, 2004). Apples and apple juices also play an important role in nutrition in terms of minerals, vitamins and dietary fiber. The composition of apple and apple juices is similar to each other (Souci, Fachmann, & Kraut, 2000; Thielen, Will, Zacharlas, Dietrich, & Jacob, 2004) (Tablo 1). With these properties, both apples and apple juices can protect our body against many diseases caused by oxidative stress such as coronary diseases, asthma and diabetes (Obloh & Ademosun, 2012). Phenolic contents of apples; It may vary depending on parameters such as apple type, growing conditions, and harvest time. Apple contains polyphenol content such as hydroxycinnamic acids, dihydrochalcones, flavonols, catechins and anthocyanins. And this polyphenol content varies between 0.01-1% of the total weight of the apple (Vrhovsek, Rigo, Tonon, & Mattivi, 2004).

**Table 1.** Nutritional values of apples and apple juice (Souci, Fachmann, & Kraut, 2000)

	Apples	Apple juice
Water (g)	85.3	88.1
Energy (kcal/kJ)	54/227	48/203
Protein (g)	0.3	0.07
Fat (g)	0.6	
Carbohydrates (g)	11.4	11.1
Fibre (g)	2.0	0.77
Pectin (g)	0.5	0.032
Potassium (mg)	144	116
Calcium(mg)	7.0	4.2
Magnesium (mg)	6.0	6.9
Phosphorus (mg)	12.0	7.0
Vitamin C (mg)	12.0	1.4
Organic fruit acids (g)	0.5	0.74

The composition of apple juice varies depending on parameters such as apple type, growing conditions, apple quality, processing and storage. The composition of apple juice

generally consists of carbohydrates, organic acids, polyphenols, vitamins and minerals (Alvarez, Riera, Alvarez, Coca, Cuperus, Bouwer, et al., 2000; Lee & Mattick, 1989) (Table 2). Esters, alcohols, aldehydes, ethers, fatty acids, terpenes and ketones are at the level of 200 ppm in apple juice and form the aroma of apple juice (Alvarez, et al., 2000; Simpson, 1979).

**Table 2.** Main components of apple juice (Lee & Mattick, 1989)

Compound	Concentration (g/l)
Water	860±900
Sugars	100±120
Fructose	46±70
Sucrose	27
Glucose	20
Malic acid	3±7
Pectin	1±5
Starch	0.5±5
Polyphenols	1
Proteins	0.6
Vitamins (mainly ascorbic acid)	0.05
Ashes	2

### Apple Juice Composition

The composition of apple juice varies according to the fruit that depends on different characteristics such as climate, soil, and the region where it grows. Apple composition changes in organic acids, sugar, and pectin content during storage polyphenols and aroma components during processing. In addition, the color of apple juice also varies depending on the conditions of processing (Ashurst, 1994; A. C. Hulme, 1971).

### **Sugars and sorbitol**

Sugars are the soluble components (Karaogul & Alma, 2018) of fresh apples, comprising 7% to 14%. Accordingly, the Brix value of apple juice depends on its sugar content. The sugars in apple juice consist of fructose, glucose and sucrose. During the ripening of apples, the amount of fructose and sucrose increases while the amount of glucose decreases (Ashurst, 1994; A. Hulme, 1958).

The sugar profile of apple juices constitutes an important part of the composition and provides important information about the originality of apple juices. Most of the sugars in apples and pears are synthesized in the leaves. It then reaches the fruit in the form of sorbitol, called sugar alcohol. Although most of the sorbitol turns into sucrose, glucose and fructose, some sorbitol is still found in the juice of the fruit (Karadeniz & Ekşi, 2002).

### **Starch**

Starch is a carbohydrate generally found in nature and one of the main bases of food energy (Karaogul, 2019; Karaoğul & Alma, 2019). However, the presence of starch in apple juice poses significant processing problems such as slow filtration, membrane clogging, gelation and turbidity (Carrín, Ceci, & Lozano, 2004). Therefore, starch is a major problem in apple juice processing. Unripe apples contain 15% starch (Reed, 1975). The starch rate in apples varies depending on the type of apple and climate. The starch content is high, especially at the beginning of the season. As the apple ripens on the tree, starch turns into sugar. A few weeks before harvest, the amount of starch begins to decrease. However, the lower the temperatures during the apple growing process, the higher the

starch content of the apple (Carrín, Ceci, & Lozano, 2004).

### **Pectin**

Pectin appears in apple juice due to the effect of pressing step during processing. The amount of pectin is lower in apple juices harvested in the early period, and the amount of pectin is higher in apple juices harvested in later periods and kept in cold storage. Since apples contain pectin methyl esterase, freshly squeezed apple juice should be kept in the cold. Pectin can be broken down in large amounts by the action of enzymes added to apple juice (Ashurst, 1994).

### **Organic acids**

Malic acid, which is responsible for the sour taste of apple juice, constitutes 90% of the total organic acids. As the amount of malic acid decreases, the sweet taste becomes dominant in apple juice (Veberic, Jakopic, Stampar, & Schmitzer, 2009; Wu, Gao, Zhao, Liao, Chen, Wang, et al., 2007). The most abundant organic acid in apple juice is malic acid, with a rate of 0.18-1.4%, depending on the type and climate. Citric acid can be found in very small amounts, approximately 0.01%. Citramalic and shikimic acids were found to be present at levels of 0.05% and 0.015%, respectively (Beech & Carr, 1977). Galacturonic acid can be seen at a level of 0.2% in concentrated apple juice. Lactic acid can be found in apple juice as a result of bacterial spoilage (Ashurst, 1994).

### **Aminoacids**

The amino acids found in apple juice are divided into three groups: asparagine, aspartic acid and glutamine, which are found in the highest amounts; serine, alanine,  $\gamma$ -aminobutyric acid (GABA), valine, isoleucine and other amino acids, which are found in the

lowest amounts (Ma, Neilson, Lahne, Peck, O'Keefe, & Stewart, 2018).

### Polyphenols

Polyphenols are obviously taking place compounds originate basically in the fruits, vegetables, cereals and beverages (Akan, Bagatur, & Karaogul, 2023; Alwazeer, Elnasanelkasim, Çiçek, Engin, Çiğdem, & Karaoğul, 2023; Hamad, Alma, Gulcin, Yilmaz, & Karaogul, 2017; İkinci, Dursun, & Karaogul, 2021; Karaogul, Kirecci, & Alma, 2016; Karaogul, Parlar, Parlar, & Alma, 2016; Koyuncu, Gonel, Temiz, Karaogul, & Uyar, 2021; KURT & KARAOĞUL; Ugurtay & Karaogul, 2022; Verep, Ates, & Karaogul, 2023). In this case, polyphenols of apples are divided into six groups. Of these, anthocyanins and flavonol glycosides are found only in apple peel. The other four groups consists of phenolic acids, dihydrochalcones, catechins and procyanidins. The main phenolic acid in most apple varieties is chlorogenic acid. Procyanidins, also called tannins, are responsible for the desired mouthfeel and astringency in apple juice (Ashurst, 1994; Williams & Atkin, 1983).

### Minerals

Minerals are elements in foods that human bodies need to advance and utility typically

(H.Balaky, Karaogul, Altuntas, Hammadi, Galalae, & Alma, 2020). That's why it's in apple juice, potassium and calcium are the most abundant minerals in both natural and commercial apple juice. Then magnesium and sodium are the other two predominant minerals found in apple juice (Ashurst, 1994).

### Volatile Components

A large number of aroma compounds have been identified in apples and apple juice (Dimick ve Hoskin, 1981; Acree ve McLellan, 1989; Paillard, 1990). The aroma components of apple juice are divided into four main groups: esters, aldehydes, alcohols and volatile substances formed in the process. Esters, the amount of which increases during storage, are responsible for the aroma of apples. During the processing and storage of apples and apple juice, off-flavor composed mainly of aldehydes and ketones are formed by enzymatic pathways. During thermal processes such as pasteurization, aromas such as furfural and HMF resulting from sugar degradation are released. Therefore, the flavor of apple juice contains a great deal of complexity (Ashurst, 1994).

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