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Determination of Physicochemical Properties of Different Citrus Fruit Wastes

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Abstract

Citrus is one of the most waste producing products in the world. For this reason, the overall utilization of wastes is important in terms of economy, nutrition, and environment. In this study, citrus by-product powders were prepared after bitterness removal, drying, and grinding processes. Moisture content, ash content, water holding capacity and oil holding capacity analyzes were performed in the final products. Moisture contents were calculated as 8.47, 5.20 and 5.62% in lemon, orange, and tangerines by-products powders, respectively. Ash values in dry matter were calculated as 5.17% in lemon, 4.53% in orange and 7.90% in tangerine by-products powder. Whereas, the water activity values were determined as 0.37, 0.30 and 0.32 in lemon, orange, and tangerines, by-products powders, respectively. The values of L*, a*, and b* were determined respectively as 80.18, 3.00 and 29.01 for lemon, 79.19, 5.17 and 43.85 for orange, and 72.62, 10.16 and 39.12 for tangerine by-products powders. Water holding and oil holding capacity values of the samples were in the range of 4.80-5.59 (g water/g dry powder) and 0.87-0.94 (g oil/g dry powder), respectively.

Keywords: Citrus, waste, physicochemical properties

Introduction

Citrus is a plant community which has high economic value with the inclusion of Citrus Aurantium, orange, tangerine, grapefruit and lemon and also citrus genus fruit tree species. Its nutritive value, taste, aroma and unique properties of texture and colors are effective in having a wide usage area of citrus fruits in the world. Citrus, native to China and India is grown in most regions with a temperate climate. With southern and southwestern Anatolia in Turkey is grown in the Mediterranean region [1] Citrus production is carried out in almost all countries. Citrus products, which contain vitamin C and which have important benefits for human health, are evaluated as fruit juice, jam and marmalade industrially besides directly consumption.

According to FAO data, as of 2014, 72.3 million tons of oranges, 30.4 million tons of mandarin, 16.3 million tons of lemons, 8.4 million tons of goldtop and more than 12.4 million tons of citrus were produced in the world [2].

Table 1. World Citrus Production by Species (Tons)

Products	2010	2011	2012	2013	2014
Orange	69.516.079	71.256.326	68.881.509	71.909.516	72.253.965
Mandarin	23.664.411	27.205.032	27.653.751	28.725.241	30.418.767
Lemons	14.853.090	15.070.980	15.013.862	15.231.292	16.254.214
Goldtop	7.573.842	7.940.623	8.263.010	8.358.007	8.397.156
Other Citrus	12.124.631	10.916.839	12.417.487	12.387.415	12.473.165
Total	127.732.05	132.389.800	132.229.61	136.611.471	139.796.997

General Structure of Citrus

Apart from the edible parts of citrus fruits, it largely creates waste from its peels and seeds. The general structure of citrus fruit from outside to inside is flavedo, albedo, segment, segment membrane, fruit juice sac, seed, and central axis [3]. The cross-sectional area of the fruit is as shown in Fig1.

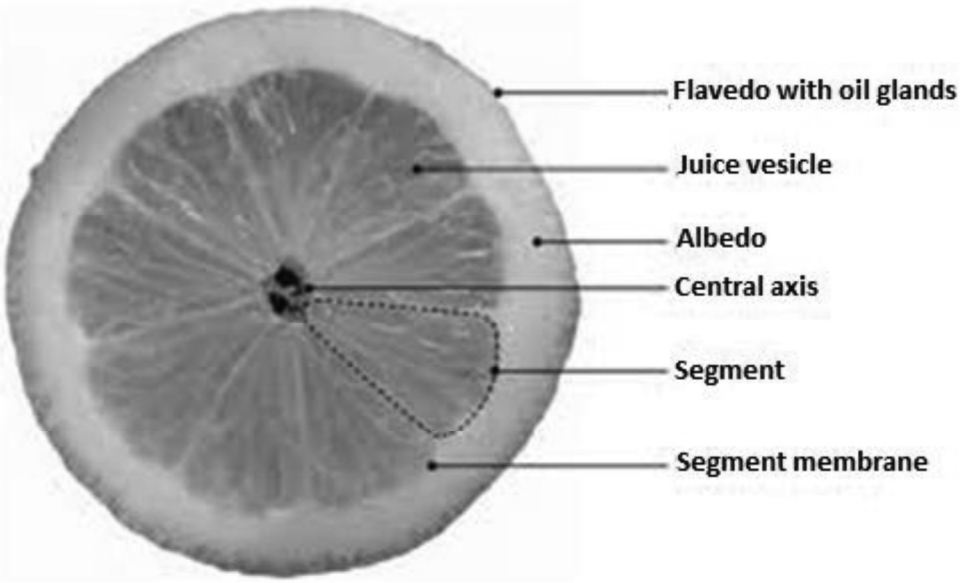

Fig. 1. Cross-sectional area of the citrus fruit [4]

Citrus peels consist of flavedo and albedo layers. Flavedo is the thin outermost layer which has differing color from yellow to red. This layer contains carotenoid pigments and fat cells. Below the flavedo, albedo layer which is white and similar to felt comes. The layer is rich in pectin. The albedo layer consists of larger cells. This layer has got veins that carry nutrients to the water.
In citrus fruits, the flavedo layer constitutes approximately 8-10% of the whole fruit and albedo constitutes 15-30%. So, 20-40% of the citrus fruits constitute the shell. 20-30% of the fruit is composed of slices and other pulp. As a result, about 40-50% fruit juice yield can be obtained from citrus fruits [5].

Wastes of Citrus

Fruit and vegetable shells are rich in bioactive components such as polyphenols, carotenoids, which are called phytochemicals and have various positive effects on health. Since peels have more biological activity than fractions of other fruit and vegetables, their research has been concentrated on their evaluation. Besides the edible part of citrus fruits, the waste part consisting mainly of peels and nuclei is used in the treatment of various diseases among the public. In studies, total phenolic matter, mineral, vitamin contents of peels were found to be higher than fruit and juice [6].

Material and Method

Material
In this study, orange, lemon, and tangerine peel flour prepared by grinding after dried in the oven were used.

Methods

Determination of moisture
Moisture values of orange, tangerine and lemon peel flour samples were measured as percentages by using Denver Instrument (IR-200).

Determination of Ash
Ash determination was carried out according to the AACC 08-01.01 method. Samples were placed on crucible which was brought to constant weighing and burned until white ash was formed at 550-590^{0}C temperature. The samples cooled in a desiccator were weighed with precision a balance [7].

Determination of Color

The color values of the flour samples obtained by drying from citrus wastes to be evaluated as a whole were measured using Hunter Lab Color Quest XE color determination device (Hunter Lab, Hunter Associates Laboratory, Reston, VA, USA). Color readings were made according to the L * a * b * color system. In the system, a* red-green color, b* yellow-blue color, L* gives the value of lightness and darkness [8].

Water Activity
Water activity was measured using the AW-SPRINT (TH-500) instrument.

Water Holding Capacity
The water holding capacity was determined by centrifugation. The samples (0.25 g x 3) were suspended in 2.5 ml of water and stirred at room temperature for 24 hours, and the suspension was centrifuged at 2500 g for 25 minutes. The supernatants were separated and the hydrated fibrous fraction was weighed [9].

Oil Holding Capacity
Oil holding capacity using sunflower oil (1.0054 g / ml density). It was determined under the same conditions as the water binding capacity described in 6.3.7 and expressed as ml oil / g fibrous residue [9].

Result and Discussion
At these stages of the study, moisture values were calculated as 8.47, 5.20 and 5.62% in lemon, orange, and tangerines, respectively. Ash values in dry matter were calculated as 5.17% in lemon, 4.53% in orange and 7.90% in tangerine. Water activity values were calculated as 0.37, 0.30 and 0.32 in lemon, orange, and tangerines, respectively. Color values were measured by using L*, a*, b* parameters. The values of L*, a* and b* were determined respectively as 80.18, 3.00 and 29.01 for lemon, 79.19, 5.17 and 43.85 for orange, and 72.62, 10.16 and 39.12 for tangerine. Water holding capacity and oil holding capacity values were determined as 5.21, 5.59, 4.80 (g water/g powder) and 0.87, 0.94, 0.91 (g oil/g powder) for orange, lemon and tangerine, respectively. According to the data obtained from the study, moisture content of lemon peel is higher than orange and tangerine. Ash, water activity, water holding capacity, and oil holding capacity values were founded similar in all 3 products. According to the results of the color values, the lemon peel is brighter while the tangerine peel is more red-green. When these data were compared with the literature, similar results were obtained. In the next stage of the study, it is aimed to test these samples in various food products and determine their effects on product properties.

Table 2. Moisture, ash, water activity, water holding (WHC), and oil holding capacity (OHC) results of powder samples

Sample	Moisture %	Ash %	Water Activity	WHC (g/g)	OHC (g/g)
Lemon	8,47	5,17	0,37	5,59	0,94
Orange	5,20	4,53	0,30	5,21	0,87
Mandarin	5,62	7,90	0,32	4,80	0,91

Table 3. Color value results of samples

Sample	Color		
	L*	a*	b*
Lemon	80,18	3,00	29,01
Orange	79,19	5,17	43,85
Mandarin	72,62	10,16	39,12

L: Lightness-darkness, a*: red-green color, b*: yellow-blue color

Conclusions

In the next stage of the study, it is aimed to examine the texture and sensory properties of these samples by adding them to various food products and to determine their physicochemical effects on the product properties. It is aimed to improving nutritional values besides improve the sensory physical properties of the products in which the samples are added. So, the nutrients lost in the waste can be recovered.

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