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ANTIOXIDANT ACTIVITY OF ORANGE AND GRAPEFRUIT PEELS

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Annotation
The article presents the results of studies conducted to evaluate the antioxidant activity of the peel of different orange varieties, in particular Iranian, African, Chinese and Turkish oranges, as well as yellow-green and red grapefruit varieties. The antioxidant activity of aqueous and alcoholic extracts of the peel of fruits, dried and ground at a temperature of 35 °C, was measured in vitro using a method based on the inhibition of the adrenaline autoxidation reaction. It was found that all the studied fruit peels exhibited high antioxidant activity, while the peel of Iranian orange and red grapefruit had high antioxidant activity.

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Introduction. Orange (*Citrus sinensis L. Osb*.) is one of the most popular citrus fruits in the world, belonging to the Rutaceae family, and several countries in northern and southern Ecuador are leaders in its cultivation. This fruit contains several compounds important for human health, such as vitamin C, folate, antioxidants, flavonoids, and catechins [1, 2].

Grapefruit (Citrus paradisi) is a plant of the Rutaceae family, which is a fruit obtained by crossing sweet orange (*Citrus sinensis L. Osb*.) and pomelo (*Citrus grandis L*.). Grapefruit is a rich source of nutrients, bioactive components and phytochemicals such as vitamin C, polyphenols, lycopene, fiber and pectin [3]. These components play an important role in providing potential health benefits due to their nutritional, antiallergic, antioxidant, anticarcinogenic and antimicrobial properties [4].

10-13 percent of these citrus fruits consists of peel, and in some countries, particularly in Uzbekistan, it is considered waste. However, a number of studies have shown that the peel of these fruits contains more components with antioxidant properties, including flavonoids and essential oils, than the edible part [5, 3, 6, 7]. Therefore, in many cases, citrus peel has higher antioxidant properties than their pulp. These natural organic substances not only prevent the formation of dangerous

microbes, but also protect the body from oxidative stress, which is the cause of a number of chronic diseases [4, 3].

Free radicals, being highly reactive particles due to their unpaired electrons, cause serious destructive damage to DNA, proteins and cells. Antioxidants are protective agents that neutralize free radicals and thus protect the body from oxidative stress [6, 7, 8].

This article presents the results of studies conducted to evaluate the antioxidant activity (AOA) of orange and grapefruit peels from Iran, Africa, China and Turkey.

Materials and methods. The objects of the study were orange peels from Iran, Africa, China and Turkey, as well as red and yellow-green grapefruit varieties. The antioxidant activity of the samples was assessed using a method based on the inhibition of the adrenaline autooxidation reaction in vitro [9] [10, 11, 5].

Sample preparation: The peel was separated from the fruit and dried in an oven at 35 °C in air until constant weight. The average weight loss was 75%. The dried bark was cut into small pieces and ground in a mill.

Sample extraction: 0.75 g of the ground plant bark sample was boiled in 50 ml of water for 10 minutes, the resulting extract was passed through a 0.45 μm syringe filter and used for AOA measurement.

Measurement of antioxidant activity of the extract. In a 10 mm thick cuvette, 3 ml of 0.2 M carbonate (Na_2CO_3-$NaHCO_3$, pH = 10.65) buffer solution and 0.15 ml of 0.18% adrenaline tartrate solution were mixed and the optical density of the resulting solution D1 was measured every 30 seconds at a wavelength of 347 nm using a K7000 spectrophotometer (YOKE, China) for 10 minutes. Then, in the same 10 mm thick cuvette, 3 ml of 0.2 M carbonate (Na_2CO_3-$NaHCO_3$, pH = 10.65) buffer solution and 0.15 ml of 0.18% adrenaline tartrate solution were added, mixed immediately and the optical density D_2 (Table 1) was measured every 30 seconds (Tables 1 and 2).

Table 1. Optical density values measured at a wavelength of 347 nm at different times of a solution of adrenaline in carbonate buffer and a solution obtained by adding the tested aqueous extracts to a solution of adrenaline in buffer.

Time, Sec.	Adrenalin, (D_1)	Turkish orange, (D_2)	African orange, (D_2)	Iranian orange, (D_2)	Chinese orange, (D_2)	Red greypfruit, (D_2)	Yellow-green greypfruit, (D_2)
0	0.085	0.043	0.047	0.053	0.054	0.041	0,019
30	0.111	0.066	0.071	0.069	0.077	0.06	0,056
60	0.135	0.089	0.094	0.089	0.103	0.081	0,086
90	0.164	0.113	0.117	0.111	0.128	0.103	0,118
120	0.188	0.137	0.141	0.133	0.154	0.126	0,146
150	0.214	0.161	0.167	0.154	0.18	0.149	0,175
180	0.238	0.186	0.187	0.176	0.211	0.173	0,2
210	0.261	0.207	0.21	0.196	0.23	0.195	0,224
240	0.284	0.231	0.233	0.217	0.253	0.217	0,247
270	0.307	0.25	0.254	0.238	0.275	0.238	0,270
300	0.328	0.271	0.274	0.257	0.299	0.258	0,291
330	0.35	0.291	0.293	0.276	0.319	0.278	0,313
360	0.369	0.309	0.311	0.295	0.338	0.297	0,332
390	0.389	0.327	0.331	0.313	0.357	0.317	0,353
420	0.407	0.346	0.35	0.331	0.38	0.334	0,369
450	0.425	0.361	0.364	0.348	0.395	0.351	0,387

480	0.441	0.376	0.379	0.364	0.414	0.366	0,402
510	0.455	0.391	0.393	0.378	0.427	0.382	0,417
540	0.468	0.405	0.407	0.393	0.44	0.396	0,427
570	0.481	0.418	0.419	0.407	0.455	0.41	0,44
600	0.494	0.43	0.432	0.42	0.468	0.422	0,452

Table 2. Optical density values measured at a wavelength of 347 nm at different times of a solution of adrenaline in carbonate buffer and a solution obtained by adding the tested alcoholic extracts to a solution of adrenaline in buffer.

Time, Sec.	Adrenalin, (D_1)	Turkish orange, (D_2)	African orange, (D_2)	Iranian orange, (D_2)	Chinese orange, (D_2)	Red greypfruit, (D_2)	Yellow-green greypfruit, (D_2)
0	0.085	0.035	0.034	0.034	0.026	0.019	0,023
30	0.111	0.058	0.054	0.055	0.049	0.029	0,058
60	0.135	0.079	0.084	0.076	0.067	0.041	0,088
90	0.164	0.104	0.115	0.096	0.088	0.058	0,120
120	0.188	0.129	0.144	0.115	0.108	0.073	0,148
150	0.214	0.15	0.174	0.135	0.129	0.091	0,176
180	0.238	0.171	0.203	0.155	0.148	0.11	0,200
210	0.261	0.191	0.232	0.176	0.168	0.13	0,225
240	0.284	0.212	0.26	0.194	0.187	0.149	0,247
270	0.307	0.233	0.286	0.212	0.206	0.168	0,271
300	0.328	0.252	0.313	0.231	0.224	0.187	0,293
330	0.35	0.271	0.338	0.249	0.242	0.206	0,316
360	0.369	0.289	0.362	0.267	0.26	0.225	0,336
390	0.389	0.306	0.383	0.284	0.277	0.243	0,356
420	0.407	0.322	0.405	0.3	0.295	0.26	0,374
450	0.425	0.338	0.426	0.316	0.31	0.277	0,391
480	0.441	0.352	0.447	0.331	0.325	0.294	0,406
510	0.455	0.367	0.464	0.347	0.339	0.311	0,419
540	0.468	0.38	0.48	0.36	0.354	0.328	0,430
570	0.481	0.393	0.496	0.374	0.368	0.342	0,441
600	0.494	0.408	0.512	0.386	0.381	0.356	0,452

The antioxidant activity of the studied samples is expressed as a percentage of inhibition of adrenaline autooxidation (AOA) and was calculated using the following formula:

$$AOA = \frac{(D_1 - D_2) \cdot 100}{D_1}$$

Here is the optical density of the adrenaline tartrate solution added to buffer D_1, the optical density of the sample extract and adrenaline tartrate added to buffer D_2. The values of the AOA indices of the studied samples over time, calculated using the above formula, are presented in Table 3.

Table 3. Antioxidant activity values of aqueous and alcoholic extracts of citrus peels studied at specific time points and their mean values

Time	AOA, %											
	Turkish orange		African orange		Iranian orange, (D_2)		Chinese orange, (D_2)		Red grapepfruit, (D_2)		Yellow-green grapefruit, (D_2)	
	watery	alcohol	watery	alcohol	watery	alcohol	Watery	alcohol	watery	alcohol	watery	Alcohol

1-min	34.07	41.48	30.37	37.78	34.074	43.704	23.7	50.37	40	69.63	36,0	34,32
3-min	21.85	28.15	21.43	14.71	26.05	34.874	11.34	37.82	27.31	53.78	16,0	15,73
5-min	17.38	23.17	16.46	4.573	21.646	29.573	8.841	31.71	21.34	42.99	11,3	10,63
10-min	12.96	17.41	12.55	-3.64	14.98	21.862	5.263	22.87	14.57	27.94	8,4	8.44
Total	**21.56**	**27.55**	**20.2**	**13.35**	**24.18**	**32.503**	**12.29**	**35.69**	**25.81**	**48.58**	**17,92**	**17,28**

Conclusion: Testing the antioxidant activity of aqueous and alcoholic extracts of Turkish, Iranian, Chinese and African oranges, as well as red and yellow-green grapefruit varieties in the adrenaline inhibition reaction model showed that all samples have positive antioxidant activity. It was found that alcoholic extracts of the studied samples exhibit higher antioxidant activity than aqueous extracts. The results show that among the orange samples, aqueous and alcoholic extracts of Iranian orange and red grapefruit peel have higher antioxidant activity than other suitable extracts. From this, it can be concluded that it is possible to develop new medicinal food supplements based on the composition of Iranian orange and red grapefruit peel.

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