Evaluation of the prospects of using kumquat in sauces technology

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Abstract
The purpose of the work is to study the antioxidant properties of water-alcohol infusions from citrus fruits and to determine the feasibility of their application in the technology of sauces. The theoretical expected value of redox potential (*RP*) Eh_{min} is obtained for monitoring and has a value of 198,0 mV, the maximum value of 450,0 mV (infusion of lemon pulp) is characteristic of plant water-alcohol infusions. The actual measured of $RPEh_{act}$ – from 114,0 mV (control) to 298,0 mV (infusion of pulp lemon). At the same time, the minimum value of the recovery energy (*RE*) is – 84,0 mV and is characteristic for control, and the greatest value of 205,0 mV is the water-alcohol infusion from the kumquat peel. The *pH* level for water-alcohol infusions ranges from 3,50 (lemon infusion pulp) to 5,90 (infusion of lemon peel), the extracts have an acidic medium. According to the results of research, water-alcohol infusions are grouped according to the antioxidant activity – according to *RE*: extracts with average activity (from 100 to 200 mV) – mandarin, lemon, orange, grapefruit infusion; extract with high activity (from 200 mV and above) – infusion of kumquat.

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Introduction

The main directions of creating a new generation of sauces are: increase of antioxidant action, by blocking oxidative reactions [1-4]; reduction of the pH [1] of sauces, due to the obstruction of reproduction of microorganisms increase in terms of storage; improvement organoleptic parameters [1]. All this can be done by adding water-alcohol infusions to plant raw materials.

One of the promising directions for creating sauces is to increase their antioxidant action [5, 6] by introducing natural or identical natural compounds, active chemical compounds that prevent the oxidation of human cells and reduce the risk of developing various diseases, including those related to the action of chemical, physical, radiation, bacteriological and other factors of the environment.

Antioxidant activity [7] is manifested in the ability of compounds to neutralize the activity of free radicals [8, 5]. Free radicals – products of oxidative processes in the body, occurring under the influence the environment [7, 9, 10] (ionization, smoke, environmental pollution, the presence of toxins in food products).

Antioxidants make it possible to prolong the shelf life of food raw materials [11-

14], semi-finished products and finished products, protecting them from damage caused by oxygenation of air, for example, scalding oils and fats or fatty components of food products, biologically valuable substances, and some natural dyes. Direct addition of antioxidants in the sauce leads to a slowdown in the oxidation of unsaturated fatty acids that are part of the lipids. In this case, the addition of antioxidants should not lead to the destruction of the structure and stratification of the sauce. It is very complex because of the fact that it involves a number of factors, stabilizing the effect of each of which manifests itself under certain conditions. Consequently, the technological process of production must be realized in such a way that the substances that are part of the sauce can be active and provide conditions for increasing the strength of the formation of complexes.

Methods of research

Redoxmetry – determination of antioxidant capacity of water-alcohol infusions of plant raw materials; pH-metry; methods of determination of organoleptic parameters.

Results and discussion

Kumquat (fortunel, kinkan) is a group of plant species, which belongs to the family of root, which belongs to the genus citrus [5, 6, 9, 11, 12]. Fruits – small, medium-sized plum, golden-yellow, orange or fiery-orange; peel – smooth, fragrant, sweet-spicy; the pulp is juicy, with sour taste, close to mandarin, and citrus smell [13, 14]. In kumquat there is a significant amount of flavonoids [8, 9], polyphenols [6, 10, 13], carotenoids [14], luteins and tannins, which are known antioxidants [6, 7, 8, 9, 10].

The comparative characteristic of the food and energy value of kumquat in relation to orange, mandarin is presented in the Table 1.

Kumquat is 33,8 % more caloric in relation to orange and 25,4 % in relation to mandarin. In relation to mandarin and orange, kumquat has a higher content of fats, carbohydrates, minerals that perform plastic and protective functions, and also affect the metabolism of humans. Significantly higher vitamin content in kumquat prevents the development of diseases and pathologies, as well as improves the general condition of a person. The exception is vitamins B_1, B_5, B_6, the content of which in kumquat is less than in oranges and mandarins, therefore the use of kumquat in recipes is possible with incomplete replacement for orange or mandarin.

Table 1

Comparative characteristics of the food and energy value of kumquat in relation to orange, mandarin

Nutrient	Quantity in 100 g of orange	Quantity in 100 g of mandarin	Quantity in 100 g of kumquat	Kumquat/ orange, +/–, %	Kumquat/ mandarin, +/–, %
Proteins, g	0,94	0,81	1,88	50,0	56,9
Fat, g	0,12	0,10	0,86	86,0	88,4
Carbohydrates, g: – food fibers; – monosaccharides	11,75 2,40 9,35	8,70 1,20 7,50	15,90 6,50 9,36	26,1 63,1 0,1	45,3 81,5 19,9
Potassium, mg	181,0	37,0	186,0	2,7	80,1
Calcium, mg	40,0	0,0	62,0	35,5	100,0
Magnesium, mg	10,0	12,0	20,0	50,0	40,0
Phosphorus, mg	14,0	20,0	19,0	26,3	–5,3
Sodium, mg	0,0	2,0	10,0	100,0	80,0
Copper, mg	0,045	0,000	0,095	52,6	100,0
Iron, mg	0,10	0,15	0,86	88,4	82,6
Zinc, mg	0,07	0,00	0,17	58,8	100,0
Vitamin C, mg	53,2	26,7	43,9	–21,2	39,2
Vitamin B_1, mg	0,087	0,058	0,037	–135,1	–56,8
Vitamin B_2, mg	0,040	0,036	0,090	55,6	60,0
Vitamin B_3, mg	0,282	0,376	0,429	34,3	12,4
Vitamin B_5, mg	0,250	0,216	0,208	–20,2	–3,8
Vitamin B_6, mg	0,060	0,078	0,036	–66,7	–116,7
Vitamin A, me	225,0	0,0	290,0	22,4	100,0
Vitamin E, mg	0,018	0,000	0,015	–20,0	100,0
Energy value, kcal	47,0	53,0	71,0	33,8	25,4

Water-alcohol infusions were obtained by extraction of a water-alcohol blend (in volume of 100 ml) with a volume fraction of ethyl alcohol rectified 40 % of plant material (size ≈ 3x3 mm, weighing 4 g) with double tension (maceration) at the usual temperature, which consists of the following operations: raw material acceptance and weighing; sorting of raw materials and waste disposal; weighing of waste; shredding of raw materials; preparation of a water-alcohol mixture of required strength; loading of raw material into an emergency capacity; gulf of raw materials with a water-alcohol mixture; insertion of raw materials with a water-alcohol mixture at daily stirring for 5 days depending on the type of raw material; the pumping and pumping of the first draft into the collections for storing and measuring the volume of the received infusion; second gulf of raw materials with a water-alcohol mixture; reintroduction of raw materials with a water-alcohol mixture at daily stirring for 5 days; discharge, pumping and measurement of the volume received by the infusion of the first and second drains; mixing of infusions of the first and second drains; unloading of consumed raw material from an emergency capacity; evaporating the alcohol that was left in the spent raw material. In the process of extraction, a diffusion phenomenon is used, based on the concentration alignment between the solvent (extractant) and the solution of substances contained in the plant cell.

The indicator of active acidity *pH* was measured on the *pH*-meter pH150MI with a combined glass electrode ESK-10603. *RP* was measured on the *pH*-meter pH150MI with combined redox metric platinum electrode ERP-105.

For not activated inorganic solutions in steady state, there is a right formula that relates the rate of active acidity of *pH* and *RP*[1]:

$$Eh_{min} = 660–60 \cdot pH, \text{ mV} \quad (1)$$

where Eh_{min} – minimal theoretically expected meaning of the *RP*;
pH – active acidity of tested solution.

Acquired meanings of Eh_{min} were compared with the actual measurements of Eh_{act} of solution. The shift of *RP* to the side of the recovered meanings – *RE* was determined by the formula:

$$RE = Eh_{min} – Eh_{act}, \text{ mV} \quad (2)$$

where *RE* – the shift of *RP* to the side of recovered meanings (resilence);
Eh_{min} – minimal theoretically expected meaning of *RP*;
Eh_{act} –actual measured *RP*.

For the study samples of citrus fruits were selected: kumquat, mandarin, orange, lemon, grapefruit, which were evaluated for organoleptic and physico-chemical parameters (table 2).

According to the results of research, water-alcohol infusions are grouped according to the antioxidant activity – according to *RE*: extracts with average activity (from 100 to 200 mV) – mandarin, lemon, orange, grapefruit infusion; extract with high activity (from 200 mV and above) – infusion of kumquat.

In fig. 1-2 graphic dependence of physicochemical and organoleptic parameters of water-alcohol infusions from citrus is presented.

Table 2

Indicators of *RP* of water-alcohol infusions from citrus at *t*=20° C

Raw	*Org,* points	*pH*	Eh_{min}, mV	Eh_{act}, mV	*RE*, mV
Water-alcohol mixture 40% v.	9,680	7,70	198,0	114,0	84,0
Infusion of grapefruit (peel)	9,651	5,53	328,2	202,0	126,2
Infusion of lemon (peel)	9,659	5,90	306,0	169,0	137,0
Infusion of mandarin (peel)	9,590	5,49	330,6	190,0	140,6
Infusion of grapefruit (pulp)	9,573	4,58	385,2	234,0	151,2
Infusion of lemon (pulp)	9,620	3,50	450,0	298,0	152,0
Infusion of orange (peel)	9,597	4,90	366,0	199,0	167,0
Infusion of orange (pulp)	9,583	4,72	376,8	203,0	173,8
Infusion of mandarin (pulp)	9,540	4,63	382,2	196,0	186,2
Infusion of kumquat (pulp)	9,645	3,87	427,8	224,0	203,8
Infusion kumquat (peel)	9,656	5,00	360,0	155,0	205,0
min	9,540	3,50	198,0	114,0	84,0
max	9,680	7,70	450,0	298,0	205,0

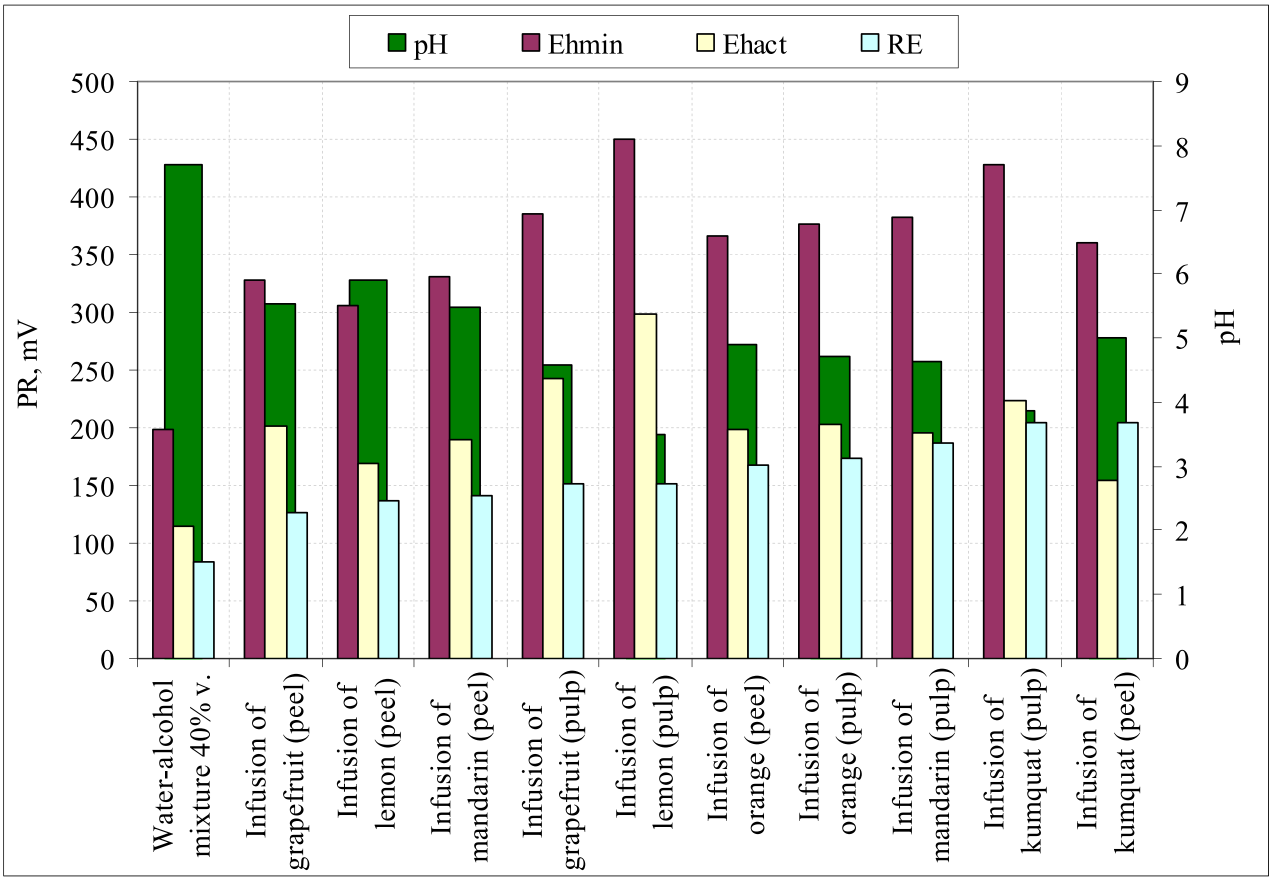

Figure 1. Graphic dependence of physicochemical indices of water-alcohol infusions from citrus

Adding vegetable alcoholic and alcoholic infusions from citrus to sauces regulates their acidity by reducing the pH that prevents the reproduction of microorganisms and enrich them with vitamins and trace elements.

It has been experimentally established that the largest *RP* are infusions from a kumquat. It is expedient to use them in the technology of production of red sauces, for example, red orange sauce, in order to increase antioxidant properties.

The recipe composition of the improved red orange sauce is shown in Table. 3

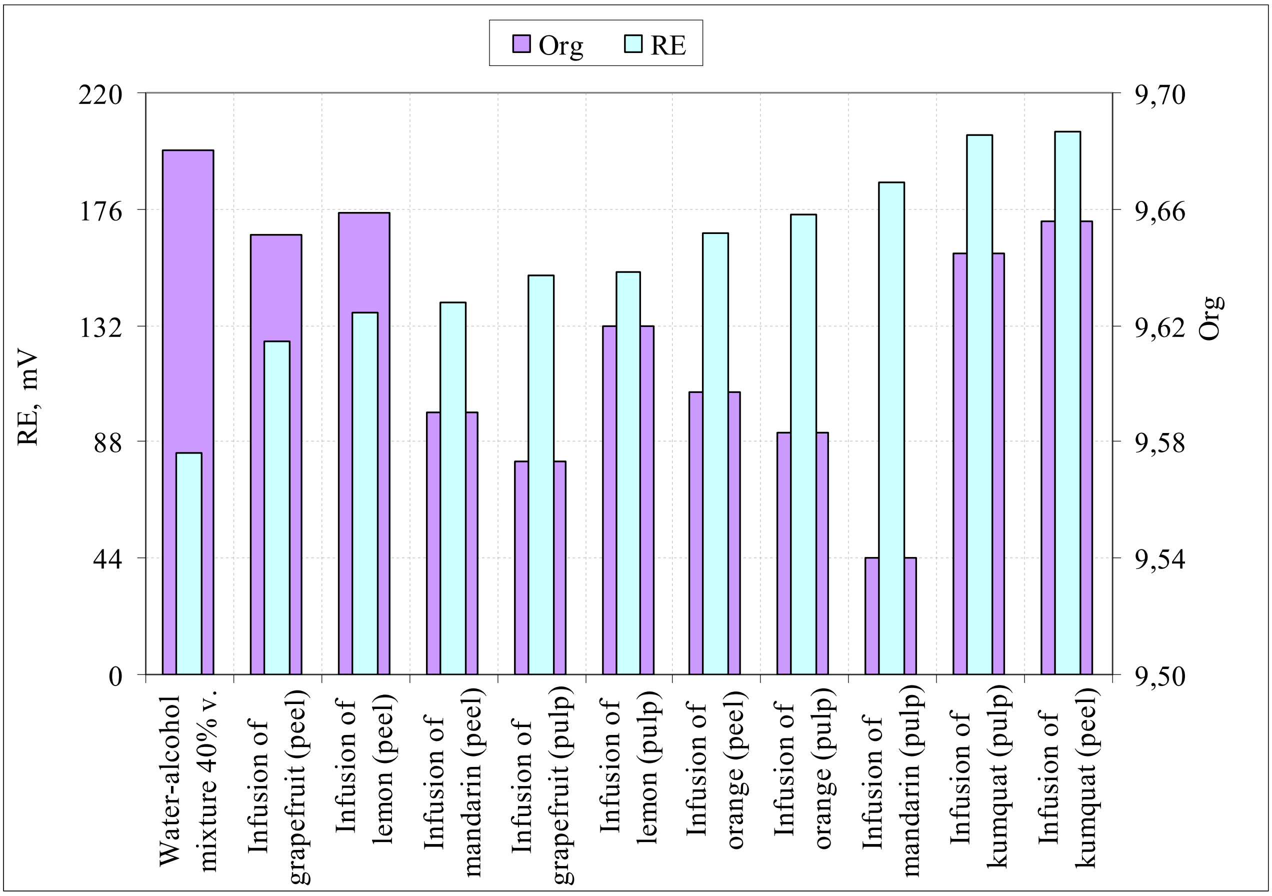

Figure 2. Graphic dependence of organoleptic parameters and energy of restoration of water-alcohol infusions from citrus

Table 3

Composition of the recipes of the red main sauce of oranges

Raw	Content, %
Red turnip sauce №824 or №825	64,1–64,5
Orange (pulp)	8,01–8,05
Oranges (peel)	2,95–2,85
Kumquat (pulp)	8,01–8,05
Kumquat (peel)	2,91–2,85
Wine red	4,37–4,05
Infusion of kumquat	4,45–4,05
Butter	5,2–5,6

Conclusions

The feasibility of using kumquat in sauces is scientifically substantiated. The antioxidant activity of citrus-water alcoholic infusions has been investigated and the rational ratios of the recipe composition of red sauce have been developed.

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