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EFFICIENCY OF THE USE OF TEA ANTIOXIDANTS IN THE PRODUCTION OF SAUCES OF FUNCTIONAL PURPOSE

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Abstract

New recipes of sauces based on plant materials of functional prescription were developed. To rise antioxidant activity of the new composition sauces, the tea additive was introduced. It was prepared through the mechanochemical treatment of the green tea leaves. Pectin was used as a natural gelling and structure-forming agent. To rise food value of sauces was used cream and mixture of valuable unrefined oil kinds: mustard, pumpkin, and corn oil. The ready samples of sauces were examined for the organoleptic and physicochemical characteristics. The efficiency of the introduction of the tea additive was evaluated by determining the peroxide number of the sauces.

Key words: *sauces, antioxidant activity, antioxidants, tea additive, peroxide number*

1. INTRODUCTION

At present, one of the most promising and urgent research directions in the area of healthy nutrition is the development of the products with functionality possessing high antioxidant activity. Antioxidants (phenolic compounds, some vitamins - E, C, β-carotene, aromatic amines, naphthols etc.) are biologically active compounds that, on the one hand, inhibit the process of lipid oxidation in foodstuff, and on the other hand, decrease the risk of many diseases in humans.

Two main groups of antioxidants may be distinguished: those of synthetic and natural origin. It was demonstrated that the use of synthetic antioxidants in prophylactic and dietary nutrition is unreasonable because they may be toxic or may cause allergic reaction. Quite contrary, natural antioxidants are ecologically safe and, as a rule, much cheaper.

The major source of natural antioxidants is the plant raw material, including the green tea (*Camellia sinensis* L.) leaves. Polyphenols in tea include catechines (flavan-3-ols). In addition to catechins, tea contains flavanol glycosides – quercetin, kaempferol, myricetin, as well as nerolidol, β-ionone, δ-cadenin and β-caryophyllen. Tea plants also contain small amounts of flavandiols and phenolic acids (Price 1998, Webb 2000).

The sum of tea catechins possesses the highest antioxidant activity (Vinsor, 1995). Similarly to other phenolic compounds, catechins interact with free radicals and neutralize them transforming into stable long-living radicals and thus interrupting the oxidation chain (Bors, 1990).

They act through the following mechanisms: anti-radical (against OH' and O^{2-}), anti-lipoperoxide (against R' – alkyl radical, ROO' – peroxy radical, and RO' – alkoxy radical), anti-oxygen (against O^2 and $^1O^2$); metal chelating (Bombardelli, 1993). Catechins act also as interceptors of the nitrogen oxide radical thus protecting from peroxynitrite-mediated nitration and oxidation (Van Acker, 1995).

The antioxidant activity of tea catechins is an important factor of moderation, limitation of free radical oxidation processes and lipid peroxidation in an organism, the factor preventing and slowing down vascular atherosclerosis, cardiac ischemia, hypertension, and other forms of free radical pathologies (diabetes, cataract, etc.) (Loest, 2002). The antioxidant activity of catechins is also exhibited as the protection of low-density lipoproteins (LDL) from oxidation, the protection of cells from preliminarily oxidized LDL (Hatta, 1995, Luo, 1997). This protective activity is exhibited by catechins in relatively low doses and concentrations (0,1 – 3 μM cause a 50% decrease in the toxicity of oxidized LDL). The complex of catechins of a tea plant possesses clearly pronounced radioprotective action due to their high antioxidant activity and high solubility in the fluids of an organism (Negre-Salvagre, 1992).

The object of investigation in the present work is the sauces prepared on the basis of the plant raw material with the addition of the tea additive possessing high antioxidant activity (AOA).

The importance of sauces in human nutrition cannot be overemphasized. Sauces render attractive appearance to the meals, improve the taste, odour, consistence and diversify the assortment.

Pectin-containing plant raw material used as the major ingredients for new sauce formulas included cranberries, beet, apples and horse-radish roots. The chosen plant raw material contains a broad range of biologically active substances: vitamins, mineral substances, dietary fibres, antioxidants etc.

To enhance the functional properties of the sauces, the tea additive was also introduced. It was prepared through the mechanochemical treatment of the green tea leaves. At present, there are two technologies of isolating antioxidants from the plant raw material: extraction and mechanochemical treatment (Fig. 1).

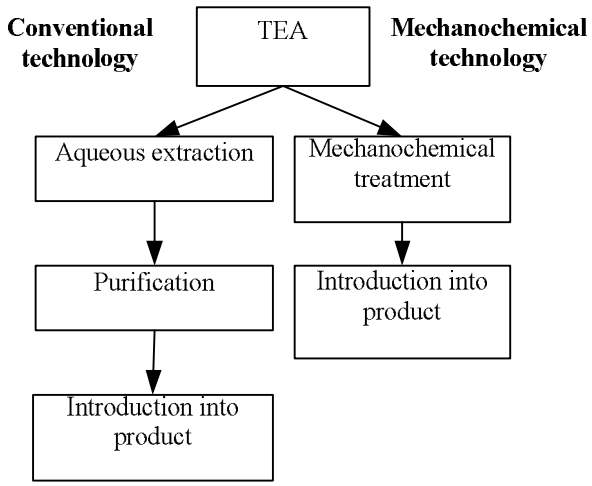

Fig. 1. Methods of antioxidant isolation.

Extraction is widely used at present, but it does not give the most complete isolation of the phenolic compounds from tea leaves in comparison with the mechanochemical treatment. This is connected with the fact that the mechanochemical treatment of the plant raw material results in the destruction of its biomass at the cell level, which increases the biological availability of phenolic compounds present in the cells. The treatment is carried out in the solid phase, so the concentration of antioxidants remains table in time, which is not characteristic of aqueous extraction. In addition, another

disadvantage of extracts is the presence of additional liquid phase; it is not always desirable to introduce additional liquid phase into the product because this may have a negative effect on the organoleptic and microbiological indices of the final product

Pectin was used as a gelling and structure-forming agent. Pectin improves the flow characteristics of the final product, serves as an efficient emulsifying agent for sauces containing vegetable oil providing the stability of emulsion during the entire shelf life. From the physiological point of view, it possesses radioprotective properties, decreases the level of glucose, insulin and cholesterol in the organism, improves the peripheral blood circulation and accelerates the satiety feeli8ng due to binding water in stomach (Ovodov, 2009).

The fat-containing component for new sauces was a mixture of valuable unrefined oil kinds: mustard, pumpkin, and corn oil. Mustard oil provokes appetite, stimulates digestion processes, exhibits bactericidal and antihelminthic activity. Pumpkin oil enhances the motor function of intestines and bile-excreting tract, and also acts as an antiparasitic agent. Corn oil stimulates bile secretion, decreases its viscosity, has antispasmodic and anti-inflammatory action. All these kinds of oil are rich in valuable polyunsaturated fatty acids (PUFA), antioxidants, contain vitamins E, B1, B2, B6, P, PP, provitamin A, mineral substances: potassium, calcium, magnesium, iron, manganese, copper, zinc, selenium and molybdenum (Korneeva, 2007).

2. MATERIALS AND METHODS

A broad assortment of sauces was developed. On the basis of the results of the organoleptic evaluation, 4 better samples were chosen for further investigation:

Sample No. 1 – Beet sauce prepared on the basis of beet mash;

Sample No. 2 – Cream sauce prepared on the basis of apple puree with the addition of 10% cream;

Sample No. 3 – Apple sauce prepared on the basis of apple puree with the addition of corn oil;

Sample No. 4 – Beet-apple sauce prepared on the basis of beet and apple puree with the addition of a mixture of corn, pumpkin and mustard oil.

It was established experimentally that optimal concentration of the tea additive in the solid phase is 0,7%.

The ready samples of sauces were examined for the physicochemical characteristics.

The antioxidant activity of the samples under investigation was determined using the amperometric method (Pakhomov, 2003). The total antioxidant activity is represented in arbitrary units corresponding to the concentration of the reference compound quercetin, in mg per 1 g of the product under investigation), providing a similar effect during the amperometric examination.

The efficiency of the introduction of the tea additive was evaluated by determining the peroxide number (GOST 26593-85).

3. RESULTS AND DISCUSSION

The results of the determination of antioxidant activity in the ready samples with tea additive and without it are presented as a diagram in Fig. 2. It was established that the tea additive is the efficient means to enhance the antioxidant activity of the initial samples.

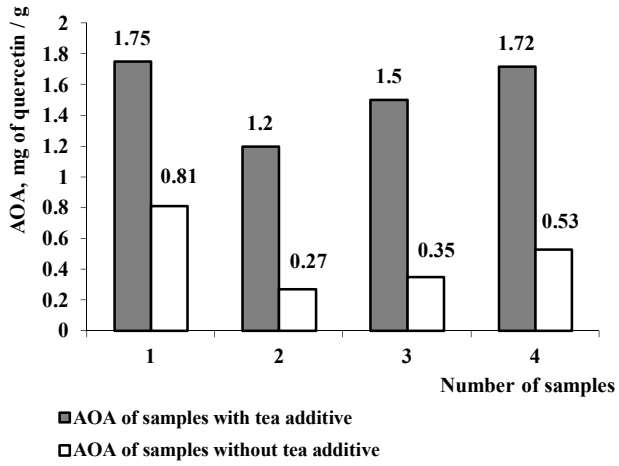

Fig. 2. Antioxidant activity of the samples under investigation.

We studied the changes in the physicochemical and organoleptic characteristics of the developed sauce samples during their storage at a temperature of +2 ÷ +4 °C It was established by means of organoleptic examination that the sauces can be stored without any changes for 15 days, then a foreign odour and extraneous taste appear, which is an evidence of the termination of their storage life.

The plot illustrating the changes of the antioxidant activity of the experimental samples with the tea additive is shown in Fig. 3.

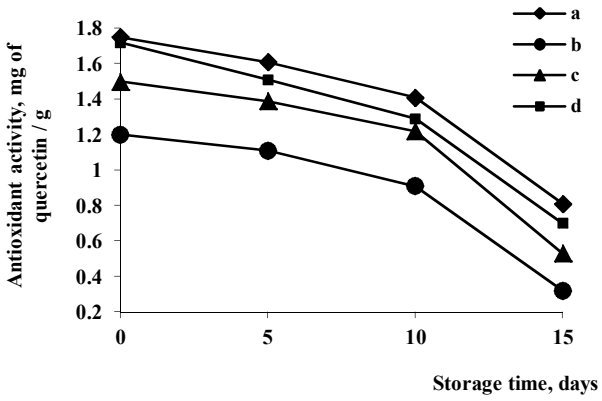

Fig. 3. Changes of the antioxidant activity of the samples with tea additive during storage.

Due to the high stability of the antioxidant tea additive in the samples under investigation, the AOA value decreases only slightly during the first 7 days of storage (as an average, by 3% of the initial value). Then a sharp decrease in AOA is observed, which is an evidence of a more intense consumption of antioxidants due to the accumulation of oxidation products.

Changes of the antioxidant activity of the experimental samples without the tea additive are plotted in Fig. 4.

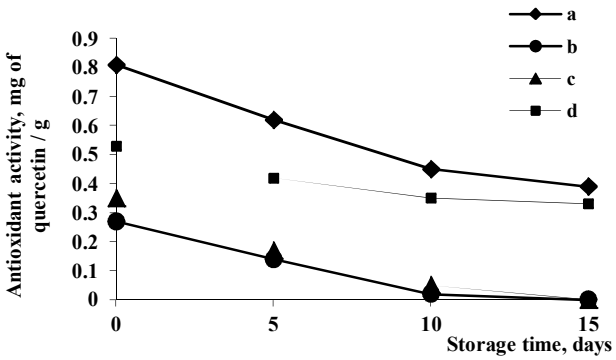

Fig. 4. Changes of the antioxidant activity of the samples without the tea additive during storage.

One can see in this plot that the AOA value of the samples under investigation steadily decreases and after storage for 7 days becomes smaller by 30% than the initial value. The AOA of samples No. 2 and 3 is close to zero by the end of their storage life.

One of the goals of the introduction of the tea additive into the developed samples was to slow down lipid oxidation in the final product during storage. It was established that the peroxide number changes only insignificantly in the samples with vegetable oil and the tea additive, while in the samples without the additive the amount of peroxide compounds increases noticeably (Fig. 5, 6).

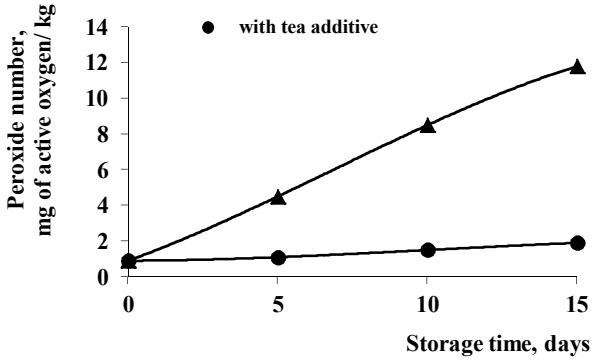

Fig. 5. Changes of the peroxide number for the Apple sauce, sample No. 3, during storage.

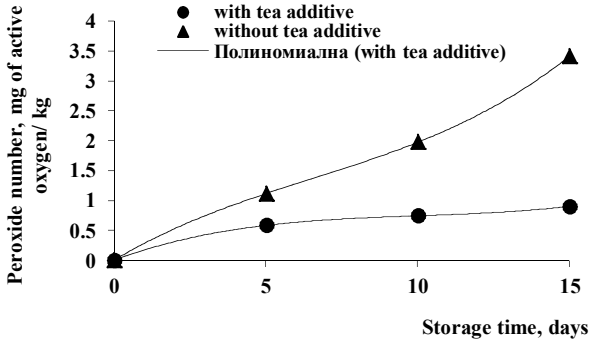

Fig. 6. Changes of the peroxide number for the Beat-apple sauce, sample No. 4, during storage.

4. CONCLUSIONS

The investigation results provide evidence of the high efficiency of the powdered antioxidant tea additive prepared through the solid-phase mechanochemical method for use in dietary sauces and dressings. The powder tea additive not only enhances the functional properties of sauces by increasing their antioxidant activity but also slows down peroxide oxidation of lipids during the entire storage life.

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