KINETICS RESEARCH OF RICE FLOUR PASTE DRYING WITH BEET COLORANT COMBINED WITH ENERGY SUPPLY

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Summary: The aim of our research was to develop a method of stabilizing the natural pigment of betanine contained in beetroot juice, with its further use as a natural colorant in meat–containing products production. At the same time, to develop a comprehensive mix in dry form containing natural beet colorant with combination of rice flour, used as a cobuilder for mincemeat sausages.

Key words: paste, mushrooms, energy consumption, infrared drying, the combined method of exposure

At heating and drying processes of moist materials by radiant infrared light, the energy is converted into heat.

Water molecules, which are in the product, absorb infrared light, scilicet, the energy is supplied directly to the water of the product. Thus, a high efficiency is achieved. With this heat supply, there is no need to raise significantly temperature of the product during drying, and drying process can be carried out at a temperature of 40–60 ºC. This drying product has two advantages. Firstly, at these temperatures, the most quality product is provided: the cells do not break, vitamins preserved, sugar does not caramelize. Secondly, low temperature does not heat drying equipment, i.e., there is no heat loss through the walls and ventilation. At the same time, the infrared radiation at a temperature of 40–60 degrees allows us to destroy all floras on the surface of the product, making dried product virtually sterile.

The disadvantages of infrared drying includes the fact that the infrared radiation energy is absorbed mainly by the surface of the material, which is dried, and to prevent it from cracking and deformation, i.e., deterioration in the quality of the finished product, we have to reduce the amount of energy supplied, which reduces the intensity of drying and worsens the economic performance of the process. Continuous supply of infrared radiation energy deteriorates these indicators, which creates the temperature gradient directed into the sliced product. This prevents heat and mass transfer, that worsens the conditions of moisture moving from the inner to the outer layers. For food penetration depth of infrared energy is up to 6 – 12 mm. At this depth, a small part of the radiation energy penetrates, but the temperature of the layer, which lies at a distance of 6–7 mm from the surface of the material, grows much more intensively than in the convective heating method. Therefore, we propose to combine two methods of heat supply when drying foods, complex supplements and so on, which will improve the final product quality, reduce energy costs and speed up drying process.

As we know, while convective drying, the air is the carrier of heat from the heater to the product, which is more energy costly than at the thermo radiation drying, in which the air carrier does not perform the function of warmth but removes moisture. We suggest to combine the two methods of supplying heat drying, which will reduce the relative humidity, and thus increase the driving force of the process compared with drying only infrared rays, thereby reducing the loss of native properties of the product dried by this method.

In modern conditions, producers are very often obliged to use for meat products a significant quantity of uncolored ingredients of protein and carbohydrate nature (protein and fat emulsions, stabilizers of pork shutters, protein drugs of animal and vegetable provenance, different kind of flour and starch, hydrocolloids, cellulose). Herewith, color deterioration of the final product occurs at the expense of reduction of the natural colorants content present in the meat raw materials (myoglobin and hemoglobin). In addition, the use of light color meat (with a vice of PSE, of pigs and birds provenance) also lowers the color intensity of the finished product.

Additional colorants are required to compensate the meat product coloration [1].

To be noted that all alimentary colorants used in meat industry nowadays have some disadvantages.

Many drugs of natural origin are unstable when exposed at existing technological processing parameters (temperature, pH, oxygen, light and others) and at meat products storage.

Suchwise, the natural shade of the colorant in the form of beet juice varies depending on the pH of the environment. At a pH of 4 to 5 of its color is bright red, with a slightly bluish tint. At higher pH blue tint note amplified colorant and the color turns purple. In alkaline environment, betanine collapses and its color becomes yellowish–brown. The range of pH values, when betanine can be applied, is from 2 to 7, which enables its use in meat products.

The aim of our research was to develop a method of stabilizing the natural pigment of betanine contained in beetroot juice, with its further use as a natural colorant in meat–containing products production. At the same time, to develop a comprehensive mix in dry form containing natural beet colorant with combination of rice flour, used as a cobuilder for mincemeat sausages.

Dry mix was picked, which includes citric acid and sodium polyphosphate in the research process to stabilize the beet betanine natural pigment. Beet juice, containing 1,75% of this mixture, is thermally stable within 85 °C and resistant to changes in pH, due to good buffering capacity of the stabilized juice the need arose to develop the coloration in dry form in order to prolong storage and transportability of the stabilized beetroot juice. Pigments juice concentration does not exceed 8%, and the total amount of solids in the juice of sugar beet is 12%. Therefore, we investigated the possibility of increasing the concentration of pigments juice by its application to a rice flour with further drying the resulting paste.

Rice flour was hydrated by liquid colorant 1:1 and 0.75:1 to increase the concentration in the betanine paste, which gave the opportunity to get viscous paste of red–purple color. The beet juice has a stabilized pH 4,0 ± 0,2, unstabilized juice – 5,35 ± 0,2. The resulting paste was dried at a temperature of 70 ± 2 °C, to a moisture content of 7 – 10%. The paste colour before and after drying was determined with the help of color tones NCS – Tintorama Color 5. The paste technological parameters are shown in Table 1, where the WBA is water binding ability.

Table 1. The paste technological parameters before and after drying process

The degree of the paste hydration		pH	Moisture%	WBA, %	Plasticity, cm²/g	Color
1:1	before drying	4,5±0,2	51,64±0,05	69,56	8,73	S2070–R10B red–purple
	after drying	–	10,09±0,05	–	–	S1060–R10B pink–purple
0,75:1	before drying	5,3±0,2	52,90±0,05	57,9	5,9	S2070–R10B red–purple
	after drying	5,1±0,2	7,40±0,05	–	–	S1570–R10B pink–purple

We conducted a combined drying process of rice flour paste with beet colorant at a ratio of 1:1 and 0,75:1, at a coolant temperature of 70 C. Irradiation was carried out at the top and bottom of the product by means of tubular "dark" infrared generators with a wavelength of 2.0 ... 4.0 mm. An irradiation size of infrared heaters was E = 8 W/m^2. The distance from infrared heaters to the product was 15 cm. The convective supply of heat from the outside Ten of capacity 1 kW, with a velocity of coolant of 6 m, was simultaneously performed with the irradiation. Paste was applied on a 8 mm thick parchment and placed on a mesh tray, which was inserted into the drying chamber.

Results of experimental data are shown at the Figure 1 as moisture content of the material dependence on the time of drying. As shown at the picture 1, the duration of the drying process at a ratio of paste and beet of 0,75:1 was 85 minutes, while at a ratio of 1:1 was 58 minutes.

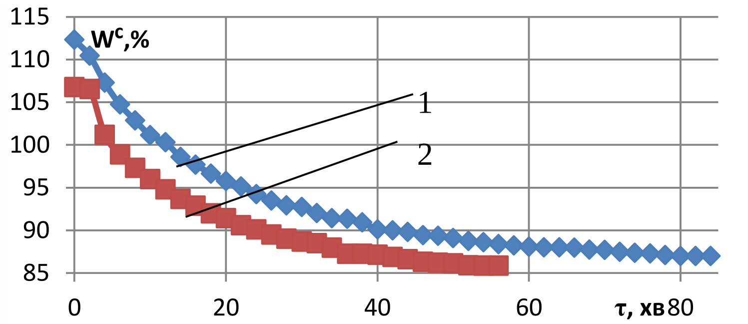


Fig. 1. The curves of the pasta rice flour combined drying with beet colorant at a ratio of 1 – 0,75:1 2 – 1:1.

The drying curves characterize the change in integral moisture W^C in function of time. This shows that with increasing rice flour concentration duration of the drying process decreases up to achievement off the final amount of moisture WC = 87%.

With filler concentration increasing for 25%, maximum speed drying time is respectively reduced from 10 minutes to 4 and corresponds to the first critical moisture Wskr = 101%.

Approximating the data of the first period of drying, the equation is derived that obeys to a linear law.

For the ratio of the rice flour with beet colorant:

1 – 0,75:1 – W^C = –1,16 τ – 112,3 when R^2 = 0,99;

2 – 1:1: – W^C = –2,68 τ + 112 with R^2 = 0,99.

where W^C – moisture content,%; τ – time, min; R^2 – coefficient of correlation.

Approximating the data of the second period of drying, there is an equation that obeys to power–law dependence derived:

1 – 0,75:1 – W^C = 119τ–0,073 at R^2 = 0,98;

2 – 1:1: – W^C = 111,65 τ–0, 067 with R^2 = 0,99;

In deriving the equation for determination of the rate of the experimental dependences drying dWs / dτ from W^C /, we found that the first stage of drying rate can be considered approximately constant. With increase of concentration of filler, it rises from 1.1 kg / (kg • min) (the ratio of the rice flour with beet colorant 0,75:1) to 2.68 kg / (kg • min) (for 1:1 ratio pastes).

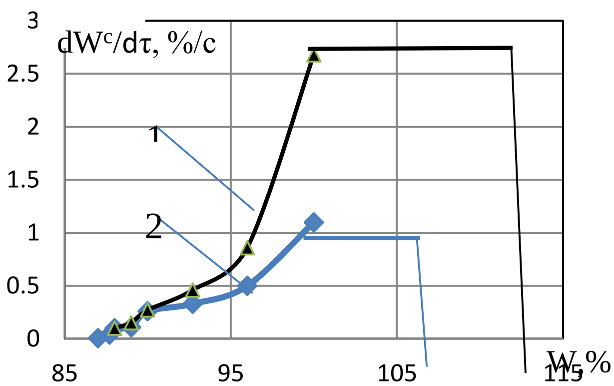


Fig. 2. The curves of the pasta rice flour combined drying with beet colorant at a ratio of 1 – 0,75:1 2 – 1:1.

After analyzing the second period of drying, we obtained approximate equation with ratio of:

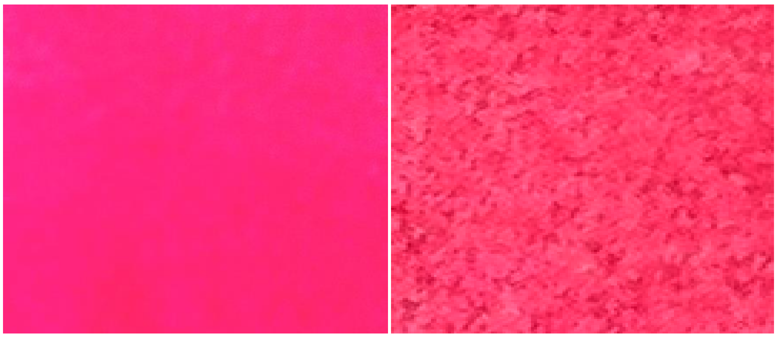
1 – 0,75:1 – $dW^c/d\tau$ = $2E–48W^{24,1}$ with R^2 = 0,98;

2 – 1:1: – $dW^c/d\tau$ = 7,026lnW–31,4 with R^2 = 0,93;

Natural color of the pastes before and after drying is shown at the Figures 3 and 4.

a b

Fig. 3. The color paste (0.75:1) before drying (a), after drying (b)



a b

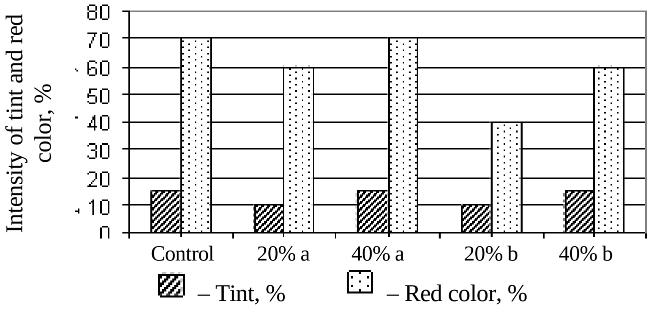
Fig. 4. Color paste (1:1) before drying (a), after drying (b)

As a result of paste drying (hydration 1:1), the loss of hue is within 20%, and coloring (R10B) remained unchanged. Upon hydration 0.75:1, loss hue is 15%.

After pulverizing colored powders, are to be used prospectively as additives in the production of complex meat containing products to maintain color of non–meat raw materials.

Dry pink and purple color powder were used for coloring sausage, in which the replacement of raw meat was no more than 40%. We used chicken from 35 to 70% as the main raw meat, fat – 10% and soy protein or protein stabilizer in 20 and 40%. Also, the amount of moisture varied: 20% and 40%. Colored dry powder was injected in an amount of 2% in the embodiments of formulations that contained soy protein, and the stabilized beet juice – 1% of the composition with a protein stabilizer. Comparative evaluation of the color intensity of sausages produced by classical technology, is shown in Pictures 5 and 6.

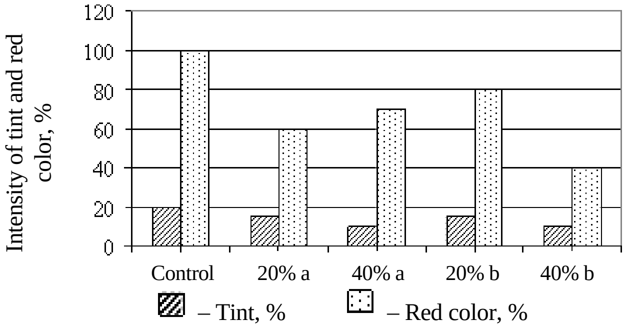
Samples with stabilized beet juice



An amount of albuminous stabilizator is in compounding, %

Fig. 5. Comparative evaluation of sausages color intensity with protein stabilizers
a – 20% moisture content in the composition, b – 40% moisture in a composition

Standards with dry beet dye



An amount of soy is in compounding, %

Fig. 6. Comparative evaluation of sausages color intensity with hydrated soy
a – 20% moisture content in the composition, b – 40% moisture in a composition

Conclusion

Stabilized beet juice can be used as a colorant in meat–containing products in an amount of 1 – 2% in order to give them the color characteristics of cooked sausages. The colorant is thermostable at the temperature range of 80 – 85 °C, at a pH range of 4 – 8.

Colored dry powder in an amount of 2% on the basic raw material has a better coloring capacity comparing with the stabilized liquid juice, due to a better stability in a dry betanine form.

When using the colored powder in a composition containing a white powder protein stabilizer, the concentration from 2% to 1% can be reduced.

Literature

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