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EFFECT OF SOME TECHNOLOGICAL PARAMETERS DURING DRYING OF RIPENING CHEESE ON ITS PHYSICOCHEMICAL PROPERTIES AND MICROSTRUCTURE

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A study was carried out into the production of cheese powder with the spray drying method. The effect of different buffer salts (trisodium citrate or sodium polyphosphate) added in the technological process on the physicochemical and sensory properties as well as the microstructure of powdered cheese was analysed.

Two types of ripening cheeses were subjected to the drying process, *i.e.* Salami and Pas Helvetia Swiss/L with the declared fat content in dry mass of 43% and 45%, respectively. The experimental cheeses were deeply ripened and their pH values were 6.0 or close.

Cheese for drying was preliminary disintegrated and mixed with technological water and buffer salt. The resulting cheese suspension was heated up to 50°C prior to its introduction to the spray-drying tower in order to obtain lower viscosity.

Cheese powder with trisodium citrate exhibited more advantageous physicochemical properties, *i.e.* better solubility and more visible deformation of cheese powder particulate microstructure. The experimental cheese powders had high contents of free fat which increased after three months of storage. A high content of free fat can limit cheese powder shelf life.

INTRODUCTION

Long-term storage of ripening cheeses has a disadvantageous effect on their quality. To prevent such an effect, varied methods of extension of their shelf life are applied including cooling, freezing and adequate packaging [Jarmul *et al.*, 1986; Panfil-Kuncewicz & Kuncewicz, 1996]. Ripening cheese can also be preserved by pasteurization and melting. One of the more interesting methods of ripening cheese preservation is spray drying. Spray dried cheese powder is mainly used as a flavour-odour additive to crackers, chips, crisps and a relish for ready-to-eat products, salads and fresh vegetables.

The process of drying is mainly aimed at the reduction of water content in a final product. As a result, water activity is decreased, which is one of the basic factors in the development of microorganisms and in chemical and enzymatic transformations.

The available literature is deficient of research into cheese powder, therefore, the aim of the present study was a physicochemical evaluation of the resulting cheese powders.

The effect of trisodium citrate and sodium polyphosphate added to the cheese suspension prior to its spray drying on the physicochemical and sensory properties as well as on the microstructure of the final powdered cheese was determined.

MATERIAL AND METHODS

MATERIAL

Deeply ripened cheeses (pH approx. 6.0) were used in the experiment, *i.e.* Salami with 43% and Pas Helvetia Swiss/L with 45% fat content in dry mass. The experimental cheeses were initially disintegrated and mixed at 60°C with technological water. Trisodium citrate or sodium polyphosphate were added to the mix. The following amounts of trisodium citrate were added in the production of Salami cheese: product No. 1 – 3% and product No. 3 – 2.5%, while the following amounts of sodium polyphosphate were added in the production of Pas Helvetia cheese: product No. 2 – 2% and product No. 4 – 2.5%. After thorough mixing of the components, the resulting mix was introduced into a MINOR type NIRO ATOMIZER spray drying tower. During the drying process, the inlet air temperature ranged from 175 to 185°C, while the outlet air temperature ranged from 82 to 86°C. The cheese suspension was heated to approximately 50°C in order to maintain constant viscosity. Each experimental version resulted in three cheese powder products.

Following drying, cheese powder samples were cooled to 20°C and packed into polyethylene bags. The final products were stored in a dry room at 22°C and a relative air humidity of approx. 75%.

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METHODS

The experimental cheese powder samples were subjected to physicochemical and sensory analyses.

Raw material analysis. Raw material was subjected to: determination of dry mass in cheese and water-cheese mix, and measurement of pH of cheese, water-cheese mix after the addition of trisodium citrate or sodium polyphosphate.

Physicochemical analysis. The cheese powder samples were analysed for: water content, protein content, fat content, free fat content, ash content, and solubility index, according to the Polish Standard [PN-79A86004].

Sensory evaluation. Cheese powder samples were assessed for: appearance, colour, flavour and odour, as well as mechanical contamination, according to the Polish Standard [PN-79A86004].

Microstructure analysis. Cheese powder particulate microstructure was analysed using a JEOL JSM-5200 scanning microscope at an accelerating voltage of 10 kV. Cheese powder samples were spilled on a copper tape attached to metal discs and sprayed with a golden mist (JEOL JEE-400 vacuum spray). The cheese powder microstructure was also analysed using fluorescence microscopy. The cheese powder samples were dyed with Nile Blue A (Fluka 72480) on a cover glass by mixing a small amount of powder with a few drops of dye water solution (0.01 g/100 g H_2O). Thirty seconds later, the lipids exhibited fluorescence which was analysed under an Olympus BX60 optical microscope with a FCII/FCIII filter.

RESULTS AND DISCUSSION

Raw material analysis

The Salami cheese designated for drying contained 46.1% water and 24.3% fat. The pH value was 5.74. The Pas Helvetia Swiss/L cheese had 45.3% water and 24.6% fat. Its pH value reached 5.78.

The pH values of these cheeses confirm their deep ripeness. Cheeses designated for drying should be more ripened than those for direct consumption [Wangin, 1989].

The disintegrated cheeses were mixed with water in such a proportion as to obtain a 14-15% dry mass. Attempts at obtaining a higher content of dry mass caused an excessive increase in viscosity, which was inconvenient during cheese suspension introduction into the spray drying tower. The addition of trisodium citrate or sodium polyphosphate to the water-cheese mixes caused an increase in their pH values by approximately 0.1.

Physicochemical analysis of cheese powder

The water content of all cheese powder samples was below 3%. This proves that a drying process was correctly completed.

A low water content (only 2.5–3%), vacuum packaging and storage at approx. 20°C can strongly halt undesirable processes in cheese powder during its storage.

The fat content of the cheese powder samples was mainly determined by the fat content of cheese designated for drying and ranged from 43.1 to 45.4%.

A higher ash content was recorded in the particulate cheese powder samples compared to the cheese before drying. This increase in ash content was caused by the addition of citrate or polyphosphate to the water-cheese mix (Table 1).

TABLE 1. Proximate chemical composition of cheese powder.*

Product No.	Water content (%)	Fat content (%)	Ash content (%)
1	2.89	43.7	8.72
2	2.58	44.6	8.46
3	2.49	43.1	7.51
4	2.88	43.8	8.99

* Mean values from three experimental products

The content of free fat is a significant qualitative property of powdered products. The content of free fat in the experimental cheese powder samples was relatively high and ranged from 20.18 to 33.11%. However, after a 3-month storage, its content significantly increased and ranged from 26.86 to 40.24% (Table 2).

TABLE 2. Fat content of cheese powder.

Product No.	Fat content in d.m. (%)	Free fat content in a final product (%)	Free fat content after 3-month storage (%)
1	43.7	20.18	26.86
2	44.6	33.11	40.24
3	43.1	22.78	28.57
4	43.8	31.92	38.36

The high content of free fat in the stored cheese powder contributes to flavour and odour defects. A considerably lower content of free fat was found in cheese powder with an addition of trisodium citrate. According to Rutkowski *et al.* [1997], trisodium citrate can be used as an acidity regulator, buffer salt, antioxidant and stabiliser.

In order to decrease the content of free fat in cheese powder, cheese suspension in water should be homogenised prior to drying [Wangin, 1989].

The solubility of the experimental cheese powder samples was determined based on their solubility index. Based on the results, it could be concluded that larger additions of trisodium citrate or sodium polyphosphate to the water-cheese mix caused greater solubility of cheese powder. Cheese powder with a 3% addition of citrate (product No. 1) had the highest solubility, whereas cheese with a 2.5% addition of citrate (product No. 3) was characterised by the lowest solubility. Similar tendencies were recorded for cheese powder samples with an addition of sodium polyphosphate: product No. 4 (2.5% polyphosphate addition) and product No. 2 (2% addition), (Figure 1).

Based on the sensory evaluation, the cheese powder samples varied considerably in appearance. Cheese samples with an addition of trisodium citrate were much looser, whereas an addition of sodium polyphosphate caused visible clodding of cheese powder. Cheese powder samples

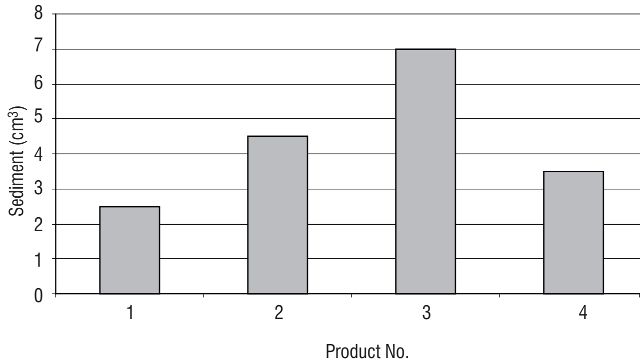

FIGURE 1. Cheese powder solubility index.

with an addition of citrate were light cream, while those with an addition of polyphosphate were yellow.

Cheese powder samples with an addition of trisodium citrate were milder in taste than those with an addition of polyphosphate. All the cheese powder samples were quite spicy and typical of ripened cheese.

Cheese powder particulate microstructure

Cheese powder particulate microstructure was analysed using a scanning electron microscope. The size and shape of powder particles as well as creases and cracks on their surface were analysed. The diameter of cheese powder particles (with a 3% addition of trisodium citrate) ranged from 2.9 to 50 μm. Powder particles were irregular in shape and had numerous creases. The pores could have an effect on high solubility of powdered cheese (Figure 2).

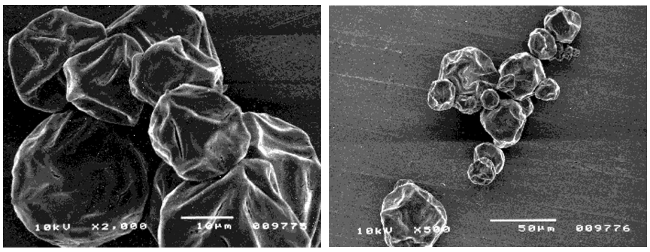

FIGURE 2. Microscopic picture of cheese powder with a 3% addition of trisodium citrate.

The particles of cheese powder with a lower addition of trisodium citrate (2%) reached diameters ranging from 5.8 to 42.3 μm. They were more spherical in shape and had pores all over their surface (Figure 3).

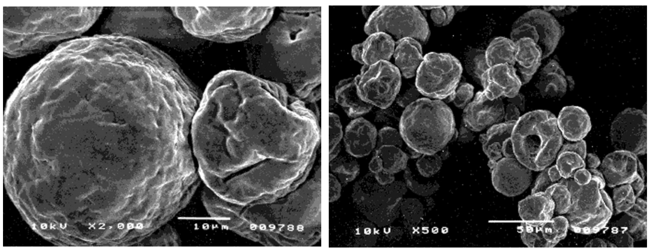

FIGURE 3. Microscopic picture of cheese powder with a 2.5% addition of trisodium citrate.

The particulate diameters of cheese powder with a 2% addition of sodium polyphosphate ranged from 3.8 to 43.3 μm (Figure 4).

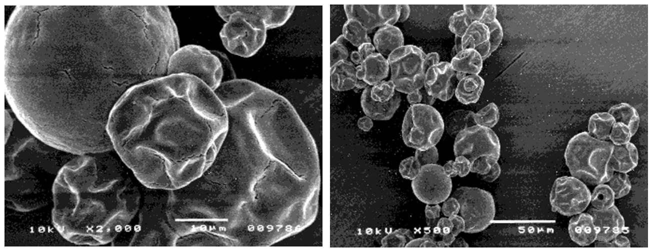

FIGURE 4. Microscopic picture of cheese powder with a 2% addition of sodium polyphosphate.

The particulate surface had a certain number of creases and numerous cracks. Slight aggregation capacity of cheese powder particles was observed. The particulate diameters of cheese powder with a 2.5% addition of sodium polyphosphate reached from 4.8 to 46.2 μm (Figure 5).

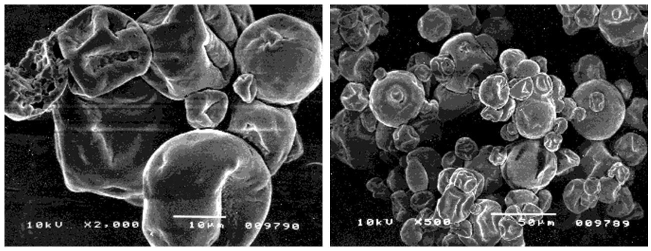

FIGURE 5. Microscopic picture of cheese powder with a 2.5% addition of sodium polyphosphate.

A higher dose of polyphosphate caused aggregation of powder particles into larger clusters. Sizes of powder particles are determined by the temperature of a drying medium, its concentration and viscosity. Creases on powder particle surface are formed when the temperature of the inlet air is too high and when the difference between the drying medium and the drying material is considerable [De Vilder *et al.*, 1976].

Based on the pictures of cheese powder (fluorescence LM) it was observed that the milk fat present in the experimental powders both forms the powder particulate surface structure and fills the capillary pores and fissures. Microstructures of cheese powder with an addition of trisodium citrate and sodium polyphosphate are presented in Figures 6 and 7, respectively.

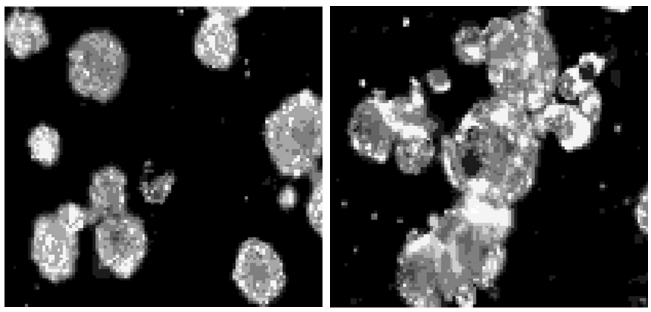

FIGURE 6. Optical microscopic picture (fluorescence LM) of cheese powder with an addition of trisodium citrate (left – 3 %, right – 2.5 %).

Fat can be enclosed in non-damaged powder particles, which constituted the majority in the microstructure of the examined powders. This kind of fat complexes in a protein

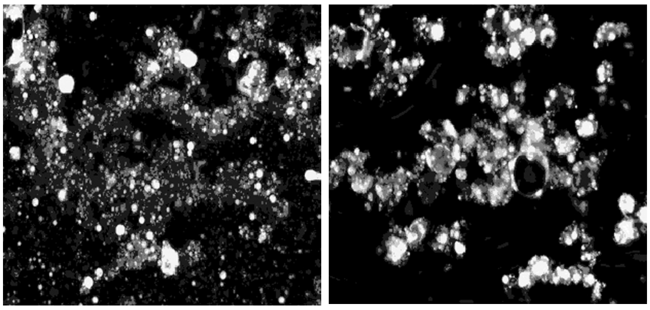

FIGURE 7. Optical microscopic picture (fluorescence LM) of cheese powder with an addition of sodium polyphosphate (left – 2.5 %, right – 2 %).

envelope can be more resistant to oxidation and can prevent its extraction [Buma, 1971; Caric & Kalab, 1987].

CONCLUSIONS

1. A high content of free fat and its increase after three months of storage can be a limiting factor in the long-term storage of cheese powders.
2. Smaller increases in free fat content during a 3-month storage of cheese powder were recorded for products with the addition of trisodium citrate.
3. Higher additions of trisodium citrate caused better solubility of cheese powder.
4. The addition of trisodium citrate caused more visible deformation of cheese powder particulate microstructure.
5. The addition of sodium polyphosphate caused the formation of greater clusters of powder particles.

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WPŁYW WYBRANYCH PARAMETRÓW TECHNOLOGICZNYCH PODCZAS SUSZENIA SERA DOJRZEWAJĄCEGO NA JEGO WŁAŚCIWOŚCI FIZYKOCHEMICZNE I MIKROSTRUKTURĘ

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Przeprowadzone doświadczenia polegały na wyprodukowaniu sera w proszku metodą suszenia rozpyłowego. W procesie technologicznym stosowano różny dodatek soli buforujących (cytrynian trójsodowy lub polifosforan sodu) i badano ich wpływ na właściwości fizykochemiczne, organoleptyczne oraz mikrostrukturę proszku serowego.

Do procesu suszenia użyto sery dojrzewające: Salami o zawartości 43% tłuszczu w suchej masie oraz Pas Helvetia Swiss/L o zawartości 45% tłuszczu w suchej masie. Sery te odznaczały się wysokim stopniem dojrzałości, ich wartość pH była równa lub bardzo zbliżona do 6,0.

Przygotowanie sera do suszenia polegało na jego wstępnym rozdrobnieniu a następnie zmiksowaniu z wodą technologiczną oraz solą buforującą. Otrzymaną zawiesinę sera przed wprowadzeniem do wieży suszarniczej podgrzewano do temperatury 50°C w celu utrzymania niższej lepkości.

Korzystniejsze właściwości fizykochemiczne wykazywał proszek serowy, w którego procesie technologicznym stosowano cytrynian trójsodowy. Tak uzyskany proszek serwoy charakteryzował się lepszą rozpuszczalnością i bardziej widoczną deformacją mikrostruktury cząstek proszku serowego. Uzyskane w doświadczeniach proszki serowe charakteryzowały się wysoką zawartością wolnego tłuszczu, a jego zawartość po trzech miesiącach przechowywania jeszcze bardziej wzrastała. Wysoka zawartość wolnego tłuszczu może ograniczać czas przechowywania proszku serowego.