Research Article

The Rehydration Ability of Whey Ingredients

Arkady N.Ponomarev, Elena I.Melnikova, Ekaterina V.Bogdanova, and Daria A. Paveleva

FSBEI HE Voronezh State University of Engineering Technologies, 19, Revolyutsii Av., Voronezh, 394036 Russian Federation

ORCID

Bogdanova Ekaterina V.; 0000-0001-5053-2273

Abstract. The purpose of this research was to studythe ability of whey protein concentrates (WPC) and whey permeate produced with ultrafiltration of cheese whey to rehydrate. The products studied were cheese whey concentrate witha PDM percentage of 80% (WPC-80), and cheese whey permeate, both produced under the conditions of the PJSC Dairy "Voronezhsky".WPC-80 and the whey permeate dissolution processes were studied using microscopy. Water-impermeable hydrophobic layers were formed at the boundary, preventing water penetration into dry particles. The result was a higher dissolution timeforWPC-80 compared with whey permeate. When WPC-80 came into contact with water,it initially formed an obtuse wetting angle with a slow change over time. Whey permeate reached the equilibrium wetting angle more quickly. Quickreconditioning of WPC moisture content required avoiding capillary penetration of water, which created a turbulent liquid flow. The application of these ingredients in different food industry areas can reduce the costs for finished products, contribute to cost-effectiveness, increase the total production, and reduce environmental risks.

Keywords: whey protein concentrate, whey permeate powder, water-wetting, dissolution

Corresponding Author:
Bogdanova Ekaterina V.; email:
ek-v-b@yandex.ru

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1. Introduction

Current market trends demonstrate an increase in the production of milk-intensive protein products, which technology associates with creating large volumes of a by-product –milk whey [1]. It contains about 50% of solidsand more than 80% of whey proteins from milk, which determine its high biological value [2, 3]. Analysis of protein, carbohydrate and lipid complexes indicates significant advantages for using milk whey as a raw materialforfood production, making its processing highly relevant and economically feasible.

Among the most promising methods for milk whey processingthereare membrane methods [4]. They are based on itspropertiesas a heterogeneous system with a clearly defined selectivity of components by molecular weight, size and ionic strength (micro-, ultra- and nanofiltration). Drying of whey fractionation ingredients allows obtaining products with a long shelf life and high nutritional and biological value. These ingredients

are widely used ininfant food, gerodietetic and sports nutrition, in confectionery for taste enrichment and as stabilizers in the production of meat and dairy products [5]. Such technological approachhelpstocompensate the deficit of essential substances, correct immune system functioning and increase non-specific resistance of a human body to adverse environmental conditions.

Taking into account that development of the functional products industry encourages production growth of such ingredients and the constant expansion of their application field, researchhas been conducted to study the ability of whey protein concentrates (WPC) and whey permeate produced with ultrafiltration of cheese wheyto rehydrate. Complete and rapid rehydration of powder products is the most important characteristic of their quality. It determines the ability of whey ingredients to perform certain technological functions in food systems.

2. Materials and methods

Objects of research were cheese whey concentrate with PDM percentage of 80% (WPC-80), cheese whey permeate, produced under conditions of PJSC Dairy “Voronezhsky”.

Research methods includedstandardcommon methods accepted in research practice for assessing the recombination ability for powdereddairy products.

The process of wetting and dissolving was studied using immersion microscopy (Altami Bio 1 microscope, Canon camera adapter) with200x magnification of the “squash” preparation. The specimenwas placed on a slide, covered with a coverslipand fixed on the stage. An electronic image of the preparation was obtainedwiththecamera adapter and AltamiBio software.

Since the main factor determining wetting ability is surface tension at the border between a dry particle and water, the limiting wetting angle for whey ingredients was measured. This indicator characterizes wetting of powder with a dropofwater, overcoming the boundary tension between solid and gas phases.

The test sample was distributed over a hard surface in a uniform layer. The liquid was surfacedinsuch a way to neglect the effect of gravity on the drop spreading. For this purpose, a 0.1 ml water drop was placed on the prepared surface using a microsyringe. A pipette instrumentwas installed very close to the surfaceso that the drop could spread and come into equilibrium with the surface. The limiting wetting anglewas measured using a goniometer.

The experiment results wereprocessedwithmathematical statistics after analyzing the data in triplicate. Graphic interpretation and data processing were carried out

using Microsoft Office 16.0 application software package. The obtained results are characterized by high reproducibility, interoperability of the experimental data, and accurate statistical processing.

3. Results and discussion

Each particle of a powder product has a complex surface with a significant branched system of capillaries of various sizes and geometrical shapes. Therefore,it is characterized by different capillary attraction. For this reason, an important quality indicator of a dairy powder product is its ability to rehydrate. The first stage of this processiswetting.Particles in contact with liquidgo to the critical state during dispersion and dissolution and then begin to detach fromthepowder surface and flow into the liquid. Simultaneously a concentrated solution of the dissolved product is forming around the particles. When a dissolved particle reaches a greater density than that of water, it sinks to the bottom. In this case, moisture absorption of the powder depends on the ratio on the surface of each particle and the thickness of the hydrophobic layer of milk fat and the hydrophilic layer of whey proteins, lactose and mineral salts [6, 7, 8, 9].

WPC-80 and whey permeate dissolution processes were studied using microscopy (Figure 1). It was found that water-impermeable hydrophobic layers were formed at the boundary ”WPCparticle-water”, preventing water penetration into dry particles (Figure 1b). The result of this phenomenon was an increase in the dissolution timeforWPC-80 against whey permeate.

WPC-80 in contact with water initially forms an obtuse wetting angle (Figure 2) with a slow change over time. Whey permeate reaches the equilibrium wetting angle faster over time. Thus, WPC-80 is characterized by worse wettability in comparison with the permeate.

Since wetting occurs not only on the surface of the water: the particles lying above the water surface are also wetted due to the capillary flow of the liquid. The replacement of pore air with water under the capillary forces for WPC-80 is insufficient, and air bubbles can remain between the wetted particles. This contributes to lumps formation in a dry product, wetted and swollen on the outside and dry on theinside. Complete rehydration of this sample will be difficult even withintensivemixing.Therefore, quick reconditioning of WPC moisture content requires avoiding capillary penetration of water that creates a turbulent liquid flow.

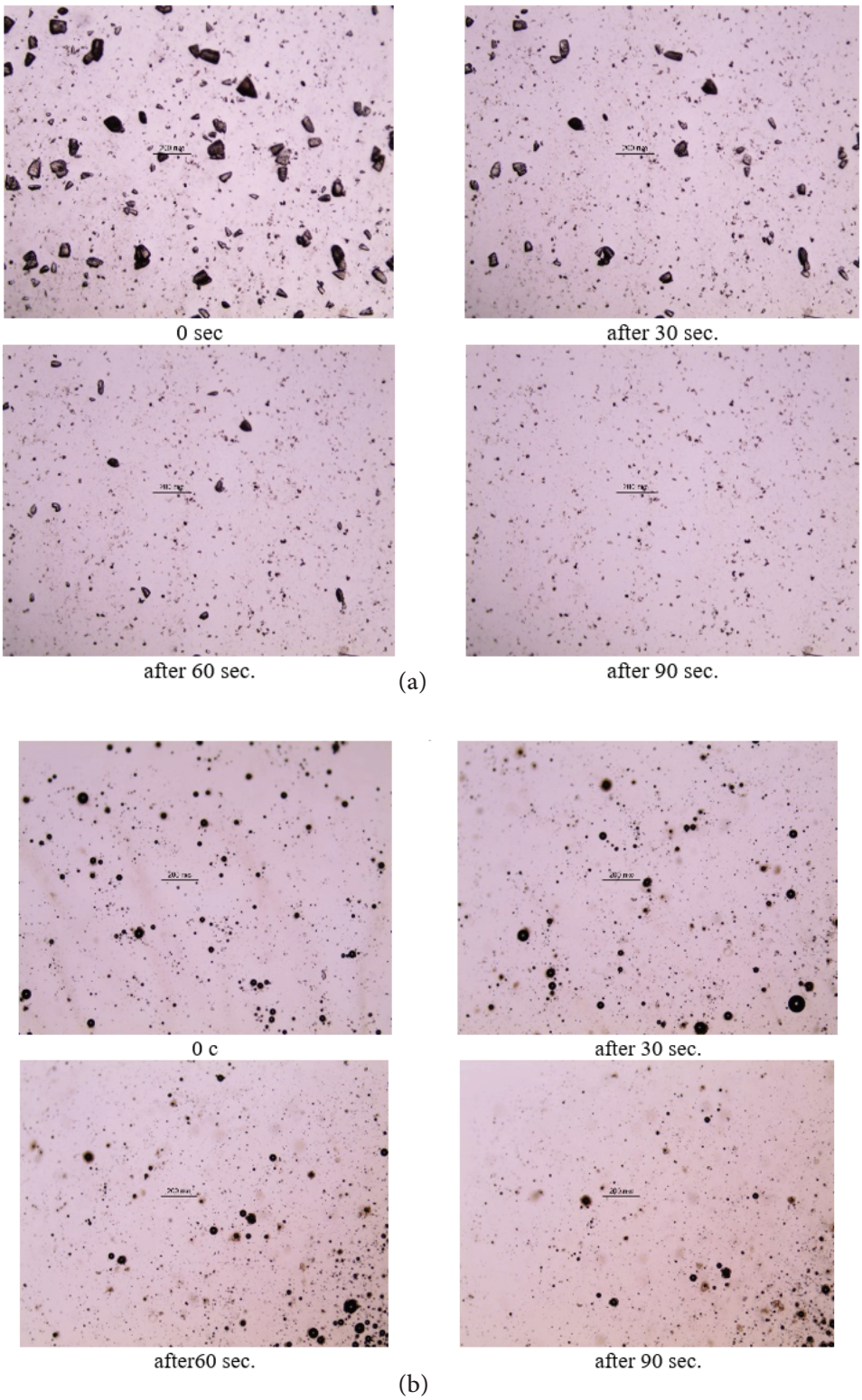

Figure 1: Microscopy of the dissolution process of whey powder ingredients: a) cheese wheypermeate; b) WPC-80.

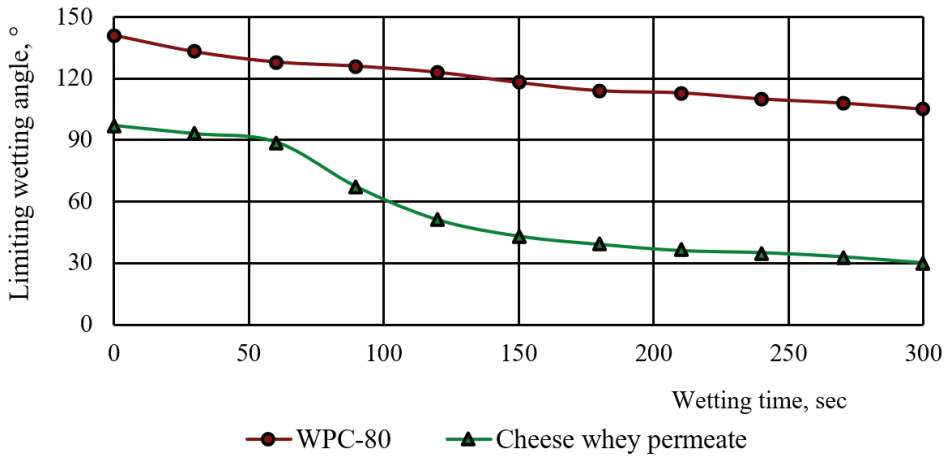

Figure 2: Dependence of changes in the limiting wetting angle of a powder product on the duration of contact with water.

4. Conclusion

When powder contacts with water its particles begin being wetted, dispersed and dissolved. Therefore, the study of whey ingredients rehydration process nature is essential for their application in different food industry areas.This will allow for finished product cost reduction, contribute to cost-effectivenessincreaseattheproduction and reduce environmental risks.

5. Ethics Policy

The authors declare no conflict of interest.

6. Funding

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