Handbook of Cheese Technology

Basuni Hamzah

ASP
Empowering Creativity

ASP Publication

Handbook of Cheese Technology

Basuni Hamzah

ASP
Empowering Creativity

ASP Publication

Title: Handbook of Cheese Technology
Written by: Dr. Basuni Hamzah
Editing and Layout: A. Hamzah
ISBN: 978-602-72671-0-7

Printed by Agung Sriwijaya Peninsular (ASP), Palembang, Indonesia.

First Edition, 2015

Contents

Preface

The primary theme of this book is the efficient transformation of milk into high value cheese products. This needs a thorough understanding of the composition and properties of milk, and of the changes occurring in milk and its products during processing and storage. Moreover, knowledge of the factors that determine product quality, including health aspects and shelf life, is needed. Our emphasis is on the *principles* of physical, chemical, enzymatic, and microbial transformations, as well as the latest advances in the field.

Aimed at university food science and technology majors and practicioners, the book is written as a text, though it will also be useful as a work of *reference*. It is assumed that the reader is familiar with the rudiments of food chemistry, microbiology, and engineering.

The subject matter is made up of seven parts. Chapter 1, just as many books at the same category, serves as the introduction.. Chapter 2 describes classifications of cheese. Chapter 3 reviews the health benefits and nutritional aspects of cheese abrief. Chapter 4 is the most extensive, as it is the pedestal of the entire process of cheesemaking, which describes the biological and physical aspect of cheese. In Chapter 5, the steps taken in cheesemaking is discussed. Relatively detailed Chapter 6 describes factors that determine the quality of the cheese, especially during the processing. Finally, Chapter 7 put emphasis on latest trends and cutting-edge of cheese technology.

I thank Mr. A.Hamzah for an excellent performance in typing and editing the manuscript. Finally, I thank my students and colleague at Sriwijaya University, who, over the last 25 years, have suggested what they would like to see and have in the course. Those suggestions have been followed in writing this book.

Dr. Basuni Hamzah

Chapter 1

Introduction

Though shards of pottery pierced with holes found in pile-dwellings of the Urnfield culture on Lake Neuchatel – dated at 6,000 BCE – are hypothesized to be cheese-strainers (Simoons 1971), the earliest secure evidence of cheese making dates back to 5,500 BCE in Kujawy, Poland (Salque et al., 2012). Dairying seemingly existed around 4,000 BCE in the grasslands of the Sahara (Simoons, 1971). Hard salted cheese, the only form in which milk can be kept in a hot climate, is likely to have accompanied dairying from the outset. Since animal skins and inflated internal organs have provided storage vessels since ancient times for a range of foodstuffs, it is probable that the process of cheese making was discovered accidentally by storing milk in a container made from the stomach of a ruminant, resulting in the milk being turned to curd and whey by the rennet remaining in the stomach. Though an Arab legend attributes the discovery of cheese to an Arab trader who used this method of storing milk, cheese was already well-known among the Sumerians (Ridgwell and Ridgway, 1968).

Cheesemaking may have begun independently by the pressing and salting of curdled milk in order the better to preserve it. Observation that the effect of making milk in an animal stomach gave more solid and better-textured curds may have led to the deliberate addition of rennet. The evidence for cheese are the Sumerian texts of Third Dynasty of Ur, dated at the early second millennium BCE (Ridgwell and Ridgway, 1968). Visual evidence of Egyptian cheesemaking has been found in Egyptian tomb murals, dating to about 2000 BCE (Carmona and Ezzamel, 2007). The earliest cheeses were likely to have been quite sour and salty, similar in texture either to rustic cottage cheese or to present-day feta. In Late Bronze Age Minoan-Mycenaean Crete, Linear B tablets record the inventorying of cheese as well as flocks and shepherds (Ventris and Chadwick, 1973).

Cheese produced in Europe, where climates are cooler than in the Middle East, required less salt for preservation. With less salt and acidity, the cheese became a suitable environment for useful microbes and molds, giving aged cheeses their pronounced and interesting flavors. For people of the ancient times, and probably for those who lived during the following centuries, the most important incentive for cheese production was that cheese constituted a highly nutritious, high energy food with a much longer shelf life than liquid milk (Ridgwell and Ridgway, 1968). With the increasing knowledge of cheese production and the influence of acidification, salt dehydration, spices, and ripening on shelf life and taste, very different cheese varieties were developed. Whereas some of our present-day cheeses with international recognition were first described more than 1000 years ago, others are rather recent developments of the last three to four centuries.

Table 1 Top 10 cheese producers in 2011 (FAO, 2011)

Country/Region	**Production (metric tonnes)**
European Union	8,858,482
United States	5,162,730
Germany	2,046,250
France	1,941,750
Italy	1,132,010
Netherlands	745,984
Poland	650,055
Egypt	644,500
Russia	604,000
Argentina	580,300
Canada	408,520

ingredients are very prone of bacterial infesting and consist of long and large polymers and molecules that readily clog the passage of membrane layers.

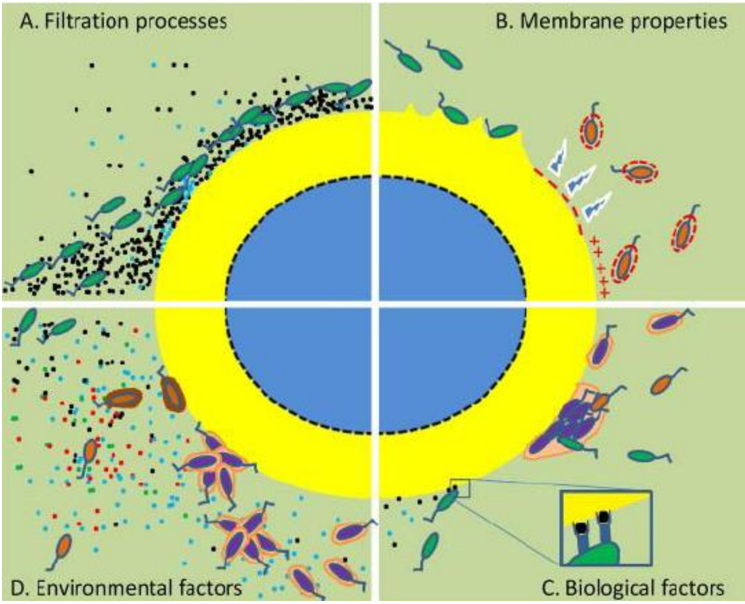

Figure 21 Mechanisms of initial adhesion between cells and membrane during NF/RO filtration processes (Habimana et al., 2014)

Recently, Habimana et al. (2014) hypothesized a mechanisms of initial adhesion between cells and membrane during NF/RO filtration processes (Figure 21). As feed water passes though the membrane, divalent cations, organic matter as well as microorganisms are concentrated onto the membrane surface during NF/RO filtration processes which involves permeation flux at high pressures (Figure 21a). During the early stages of filtration, salt concentration at the surface of the membrane is increased by concentration polarization, which in turn increases the osmotic pressure of the feed thereby reducing the water flux. As filtration is upheld, a rapid and gradual flux decline arises from the build-up of inorganic and organic elements and thriving microorganisms, covering the entire membrane surface coated in a thick fouled layer. Membrane material properties are relevant to the initial interaction between bacterial cell and the surface of the membrane. Membrane roughness enhances bacterial adhesion through its increased surface area by favouring the likelihood of initial contact but most importantly, by protecting adhered cells from detachment (Figure 21b).

The physicochemical properties of the membrane are known to influence bacterial initial adhesion. Properties such as low electronegative surface charge and high surface hydrophobicity have been shown to be correlated to high bacterial adhesion although this cannot be generalised, since the physicochemical properties of the microorganisms can also influence adhesion (Figure 21b). The bacterial cell wall properties can influence bacterial adhesion by the presence of an enveloping polysaccharide capsule, whose chemical attributes, may enhance irreversible adhesion (Figure 21c). Once attached the capsule producing bacteria may also recruit other "late-stage" colonizers onto the membrane surface. Specific adhesion between bacterial cells and the surface of the membrane through adhesins, cell-surface components of bacterial cell wall, can occur in the event of the recurrence of irreversibly bound organic or inorganic elements on the surface of the membrane (Figure 21c). Environmental factors such as temperature, pH, salt concentration, the presence of signal molecules are known to induce a number of different mechanisms at the cell level that might induce adhesion (Figure 21d). For example high salt concentration is known for reducing both cell and membrane electric double layer leading to cell-cell aggregation and increased adhesion with the inert surface. The presence of elements such as inorganic phosphates, are also known to trigger a cascade of intracellular molecular reactions, allowing the cell to adhere to inert surfaces (Figure 21d).

Turbulence promotor

Passive turbulence promotor is needed in future dairy processing processes, since it can trigger turbulence in feed passageways, eventually shaking off fouling materialls out of the membrane surfaces. In the past, vibrating systems were used, but relatively high energy requirement and intricate machinery parts of the system (which is difficult to maintain) made them fall in favor (Bran et al., 2004; Mistry and Maubois, 2004). Intensification of microfiltration has been accomplished using motionless mixers consisting of a series of pairs of semielliptical blades (Krstićś et al., 2004; Popovic et al., 2013) and twisted tapes (Popovic and Tekic, 2011); both reversible and irreversible fouling are reduced and the permeate fluxes are remarkably increased.

Popovic et al. (2013) reported that blade mixers of two aspect ratios 2.5 and 1.3 were tested in the microfiltration of milk (0.1 µm membrane) and achieved good result in this regard. The permeate fluxes are substantially increased by application of blade mixers due to a reduction of both reversible and irreversible fouling. The highest flux improvements of 500–650% for the same cross-flow rate (relative to the conventional operation) were obtained by application of the blade mixer of aspect ratio 1.3 (Popović et al., 2013).When compared for the same hydraulic dissipated power mixer of aspect ratio 2.5 proved to be slightly more efficient because it causes the lower pressure drop. Despite to the increased pressure drop, the energy savings obtained by application of blade mixers are considerable compared to the conventional operation and to the operation using some other mixers. In the membrane fitted with a blade mixer the flow field changes in a manner which afford the intensive disruption of boundary layer, scouring and removal of fouling forming material. The flow field is characterized by the high cross-flow velocities at membrane wall, alternation of stream line path and swirling motion (Popović et al., 2013).

1.1. New Source of Starters

Most, if not all, of the LAB found in starter cultures can be isolated from cheese made without the deliberate addition of a starter culture. Such strains are natural contaminants of milk which grow and produce acid during cheesemaking. The ultimate source of these bacteria remains to be determined. However, it is generally thought that plants and plant material are the natural habitat of *Lc. lactis* subsp, *lactis.* The habitat of *Lc. lactis* subsp, *crernoris* has not been determined but it can be isolated from dairy products. Many of the pure cultures of starter bacteria used in defined cultures are phage-related, implying that the number of different strains of starter bacteria is generally limited. Therefore, efforts have been made to isolate 'new' strains from raw milk, plants and other natural sources (Salama et al., 1995; Cogan et al., 1997; Wouters et al., 2002). Any potential new starter strain must produce acid rapidly, lack off-flavour development in milk and be resistant to a mixture of common phage. *Lc. lactis* subsp, *lactis* and *Lactococcus lactis subsp. tructae* but not *Lc. lactis* subsp, *cremoris* has been isolated from red nettles, common sow thistle, Himalayan blackberries, potato, cucumber, corn, sweet pea, beans, cantaloupe, corn and broccoli and many of them were good acid producers, coagulating milk in 18 h at 21^{o} C (Salama et al., 1995; Perez et al., 2011; Villegas et al., 2014). In contrast, very few strains of *Lc. lactis* (the sub-species was not determined) isolated from artisanal dairy products were good acid producers (Cogan et al., 1997). Some of them produce unusual flavours in milk. For example, the combination of a 'wild' starter, which had low protolytic activity and high amino acid decarboxylase activity, with a commercial strain, which had high proteolytic activity and low decarboxylase activity, resulted in the production of chocolate flavour in milk, due to several branched chain aldehydes and acids (Wouters et al., 2002; Parente and Cogan, 2004; Fernandez et al., 2011; Kirmaci et al., 2011; Bekkali et al., 2013).

Cheese is certainly known as one of the most biochemically complex food. Every aspect of cheese, be it microbiologically, chemically and physically, affects others in specific ways. In order to produce good cheese, which also an array of properties, one has to consider these factors.

The hallmark of this book is the efficient transformation of milk into high value cheese products. This needs a thorough understanding of the composition and properties of milk, and of the changes occurring in milk and its products during processing and storage. Moreover, knowledge of the factors that determine product quality, including health aspects and shelf life, is needed. The emphasis is on the *principles* of physical, chemical, enzymatic, and microbial transformations, as well as the latest advances in the field.

The Writer

Dr. Basuni Hamzah is a lecturer at Agriculture Product Technology Department, Faculty of Agriculture, Sriwijaya University. He was born on June 12th, 1953 in Palembang, Indonesia. He obtained B.Sc from Agriculture Product Technology, Bogor Agriculture University in 1978 and both M.Sc (1987) and Ph.D (1990) from Food Science Dpeartment, University of Kentucky, specializing on dairy technology. He served as Head of Tropical Food Research and Development Center, Palembang. He is active in the field of dairy, tropical agriculture products, and food fermentation technologies and publishes articles in several international journals.

ISBN: 978-602-72671-0-7

Agung Sriwijaya Peninsular (ASP Press)
Telp +62 (852) 67122394
e-mail driving.force.press@gmail.com.