Handbook of Yoghurt Science and Technology

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Preface

The primary theme of this book is the efficient transformation of milk into high quality and high value yoghurt 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.Manufacturing prescriptions and product specifications are given at glance, as they are widely variable and not the emphasis of this book.

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 book is made up of eight parts. Chapter 1, discusses characteristics that distinguish yoghurt from other cultured milk beverages. It is important at the first place to set the limits of the discussion in this book through the traits that hallmark the change of milk into yoghurt and not others. Chapter 2 provides knowledge of the properties of milk itself, it forms the basis for understanding what happens during fermentation process. Chapter 3 reviews the health benefits of yoghurt, while brief understanding of probiotic yoghurt is covered in Chapter 4. In Chapter 5, manufacture process of yoghurt is described. Relatively detailed Chapter 6 describes factors that determine the quality of the yoghurt, especially during the processing. Chapter 7 ("plant design") refers and rounds up the principle discussed in two previous chapters. It starts with generic aspects and then discusses more specific groups of yoghurt. Finally, Chapter 8 put emphasis on latest trends and cutting-edge of yoghurt technology.

It goes without saying that the best teacher is experience, but if this book can offer some preliminary guidance on the intricacies of handling yoghurt, then its compilation will have been worthwhile.

Dr. Basuni Hamzah

Chapter 1
What is Yoghurt? What distinguishes it from other cultured milk beverages?

Nobody knows the exact period when yoghurt and other cultured milk products were discovered, its origins have been lost in the mists of time. What we do know for sure is that fermented milk was already being invented in prehistoric times. The legend tells that yoghurt (and kefir) were born on the slopes of Mount Elbrus in the Caucasus (Present-day Armenia and Azerbaijan) range by a miracle. The ancient Turk tribes who were nomadic shepherds stored their milk, from cows, sheep, goats, horses and camels, in pouches made from these animals' stomachs. It was widely known that yoghurt was discovered because a shepherd, forgetting some milk in one of these skins during a long journey for a while, found it under scorcingly hot climate of the desert turned into something denser, more acidic but tastier. Reason tends to prove this theory, germs, which are virtually everywhere, can spoil the milk wherever it is stored, as long as the vicinity can support them. As far as yoghurt is concerned, it is easy to isolate the main cause of fermentation in the organisms present in the animal skins used as containers. Micro-organisms preferring relatively high temperatures, 40 – 45°C, came together and the result was what the Turks called "Yogurut". Some sources say that this name was introduced in the 8th century and that it was evolved in the 11th century to its present form,*yoghurt*. It is further claimed, however much truth there may be in the story, that yoghurt adds longetivity to human age, that it was happened Cossacks living in Caucasian valley, whose fermented milk had become integral part of their diet, can easily reach the age of 130 to 140 years. The continuous migrations of the Turk tribes

from the East European steppes brought about the spreading of yoghurt in the Mediterranean area.

Due to the taste and health benefits, yoghurt soon became popular in the Western world. In the early 1500s, King Francis I of France was reportedly cured of a debilitating illness after eating yoghurt made from goats' milk. Scientific interest in the health benefits of yoghurt was initiated by Élie Metchnikoff in the early 1900s (Metchnikoff, 1908). Metchnikoff proposed that the lactic acid microbes of fermentation must be antagonistic to the putrefying microbes of the gut, and once introduced into the intestine, they would prevent the breeding of the noxious microbes that required an alkaline environment. His hypothesis was stimulated by the fact that populations such as those living in the Balkans regularly ate yoghurt and were noted for their longevity.

Aside of its discovery in the Turk world, cultured milk was also invented inadvertently by various civilizations around the globe. Cultured milk is the collective name for products such as *yoghurt*, *ymer*,*kefir*, *cultured buttermilk, filmjölk* (Scandinavian sour milk), *cultured cream* and *koumiss* (a product based on mares' milk). Even some communities which were less-familiar with milk like the Africans and South East Asians have their own varieties of cultured milk. The generic name of cultured milk is derived from the fact that the milk for the product is inoculated with a starter culture which converts part of the lactose to lactic acid, creating sour taste. Carbon dioxide, acetic acid, diacetyl, acetaldehyde and several other substances are formed in the conversion process, and these give the products their characteristic fresher, lighter taste and aroma. The biochemical aspects of yoghurt will be discussed further in the next chapter.
Yoghurt is produced using active cultures of bacteria to ferment cream or milk. Yoghurt that is produced in the United States is made with two specific live and active cultures of lactic acid bacteria (LAB)—*Lactobacillus bulgaricus (Lb. bulgaricus*) and *Streptococcus thermophilus (S. Thermophilus)*, which

wettability and bulk density but was low in fat, salt, ash content and pH (Shaker et al., 1999). Yoshimi et al. (1979) and Cajigas (1981) described a method for production of an instant soluble powdered yoghurt. Instant, agglomerated powders from temperaturesensitive milk products such as yoghurt may be produced continuously by spraying the product to be dried into a drying chamber and introducing a countercurrent pre-heated gas, e.g. air or N2, having a dew point of _25 to 0^{o}C (preferably 10 to 20^{o}C) to achieve two drying stages. Instantization is done by mixing freshly prepared curd, yoghurt etc. with a 1–25% (by weight of milk solids) hot or cold solution of gelling agents, like gelatin, agar-agar, galacturonic acids, carrageenates, carob bean flour, galactomannans or sodium alginate, singly or in combination, all of which form irreversible gels in milk. The mixture is homogenized,spray-dried to about 5% final moisture content and then subjected to fluidized-bed drying. Additives, e.g. sugar, fruit pulp, flavourings, may be added immediately before or after drying.

Yoghurt powder can be used as ingredients in instant yoghurt (Cajigas, 1981), labneh and starter culture (Tamime and Robinson, 1999). It can be used as a dry dessert mix and in frozen desserts like Yoo Whip, Yoo Fruit (USA and Great Britain), soup bases and instant drink mixes like lassi and oil emulsion products. It seems to be advantageous to handle dry ingredients, i.e. yoghurt powder for bakers in comparison to liquid yoghurt, and so can be easily used to advantage in bakery foods

However, the texture, gel structure and flavour of reconstituted yoghurt are reported to be poor in comparison to fresh yoghurt. A concerted effort, therefore, is required for improvement of texture, structure and flavour of reconstituted yoghurt (Kumar and Mishra, 2004). The texture and flavour of reconstituted yoghurt can be improved by adding stabilizers before drying (Tamime and Robinson, 1999). Today, consumers like yoghurt in variety of flavours, e.g. plain or fruit-flavoured yoghurt. Research on fruitfortified yoghurt powder should be undertaken. Development of bio-yoghurt powder is another

promising area requiring attention. Efforts are also needed to standardize drying processes and optimize parameters for maximum retention of live bacteria and other beneficial constituents in the dehydrated product.

Table 6 Physico-chemical and microbiogical characteristics of different types and yoghurt powder (Kumar and Mishra, 2004)

Characteristics	**Skim milk yoghurt powder**	**Skim milk yoghurt powder (natural sour taste)**	**Spray-dried *jameed* (Shaker et al., 1999)**	**Spray-dried instant yoghurt powder**
Physico-chemical				
Moisture (%)	5.0 max	4.0 max	4.0	4
Protein (%)	35-37	35.5	38	33
Milk fat (%)	1.5	1.0 max	1.2	4
Lactose (%)	45-50	50-54	50	37
Minerals (%)	7.5-8.5	7-9	6.8	7
pH	-	4.3-4.7	5.3	4.2
Bulk density (g/ml)	0.60-0.68	0.45-0.70	0.75	0.60
Bacteriological counts				
S. thermophilus	-	-	10^6 g^{-1}	1000 g^{-1}
L. bulgaricus	-	-	10^6 g^{-1}	-
E. coli	-	Absent in 1 g	absent	-
Non-spore bacteria	-	10000 g^{-1} max	-	-
Yeast and mould	-	10 g^{-1} max	10 g^{-1} max	-

Reconstitution and flavour is better in freeze-dried than in spray dried yoghurt, but the cost of production is greater. Thus, methods need to be developed which could produce yoghurt powder with good reconstitutional properties giving a properly set yoghurt and with better acetaldehyde retention at comparatively low cost. Development of such a technology for production of yoghurt powder, including its packaging and storage, will help in its commercial exploitation.

Fermentation-based food niche is one of the most biochemically complex food group. Among them is yoghurt, which gains huge attention since it has a lot of health benefits. Production of good, high added value yoghurt needs understandings of inter-correlations among numerous microbiological, chemical and physical factors.

The emphasis of this book is on the *principles* of physical, chemical, enzymatic, and microbial transformations, in order to achieve efficient transformation of milk into high quality and high value yoghurt 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.Manufacturing prescriptions and product specifications are given at glance, as they are widely variable and not the emphasis of this book.

The Writer

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