INFLUENCE OF DIFFERENT INCUBATION TEMPERATURES ON GRAININESS AND ROUGHNESS OF STIRRED YOGHURT

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ABSTRACT

The aim of this work was to study how the incubation temperature and the storage time can affect the physicochemical characteristics, including graininess and roughness, of stirred yoghurt. Yoghurts were incubated at 37, 42 or 45°C. Physicochemical properties of stirred yoghurt were determined during storage at 4°C for 15 days. Visual roughness, number of grains, perimeter of grains, syneresis, storage modulus, and yield stress decreased, when the incubation temperature was decreased. The storage time did not affect any of the physicochemical properties of yoghurt, except for the pH. For practical applications, incubation temperature can be optimized to improve quality or modified to create fermented milk products with different physical properties.

INTRODUCTION

Yoghurt represents a very significant dairy product around the world (Chandan, 2006). Although there is great interest in the healthy-promoting properties of yoghurt, texture of stirred yoghurt plays an important quality and consumer acceptance (Lee & Lucey, 2004; Lucey, 2004). Texture, one of the most essential components of the stirred yoghurt quality, represents all the rheological and structural attributes perceptible by means of mechanical, tactile and visual receptors (Sodini et al., 2004).

Textural defects of stirred yoghurt like graininess and roughness are objectionable as consumers expect smooth, uniform and fine-bodied products (Lucey et al., 1998). Graininess which sometimes occurs during the manufacture of stirred yoghurt is the appearance of non-dispersible particles (Tamime & Robinson, 1999). Roughness, irregular conformation of the surface structure of food, is an important physical property of solid food influencing sensory attributes (Pedreschi & Aguilera, 2000). The use of a high incubation temperature is often associated with these types of defects (Lucey & Singh, 1998; Lucey, 2004). Sodini et al. (2004) reported that the graininess of stirred yoghurt decreased, when yoghurt milk was incubated at 38°C instead of at 42°C.

The objective of this research was to study the effect of incubation temperature on the physicochemical properties, including graininess and roughness, of stirred yoghurt.

MATERIAL AND METHODS

1. Milk processing and yoghurt preparation

Skim milk [13% (w/w) total solids] was prepared with low-heat skim milk powder [36.1% (w/w) total protein, BY 409 EG, Bayerische Milchindustrie eG, Landshut, Germany] dissolved in distilled water. The milk was left to hydrate for 2 h at ambient temperature while being continuously stirred. The standardized milk was heated at 95°C for 5 min and, then, subsequently cooled to 37, 42 or 45°C in the tubular heating equipment (200 L h^{-1}) of the Dairy for Research and Training Department at the University of Hohenheim (ASEPTO-Therm UHT-Pilotanlage, Asepto GmbH, Dinkelscherben, Germany). After cooling, 0.1 g L^{-1} of frozen pellets (starter culture Yo-Mix 621, Danisco A/S, Denmark) was added, and the yoghurt milk was incubated at 37, 42 or 45°C until the pH had decreased to 4.60. Fermentation was stopped by rapidly cooling to 4°C in an ice-water bath. At the beginning of the cooling in an ice-water bath the yoghurt was manually stirred with a stainless-steel bored disk by up and down movements for almost 60 s. After setting the stirred product into 100 mL cups, the stirred yoghurt samples were stored at 4°C for 15 days. The physicochemical characteristics of the samples were analysed at days 1, and 15 of storage.

2. Physicochemical property measurements

2.1. pH and syneresis

The pH was determined by a Knick 765 pH meter (Knick Elektronische Messgeräte GmbH & Co., Germany), and syneresis of the yoghurt samples was measured using centrifugation method (Bhullar, Uddin & Shah, 2002).

2.2. Graininess and visual roughness

Graininess was measured by image analysis using the protocol described by Kücükcetin (2008). Image analysis was performed to determine the number of grains and boundary length (perimeter) of the grains as a measure for graininess. The number of grains indicating a perimeter greater than 1.0 mm per 3 ml of yoghurt and the mean perimeter of grains (PG) were evaluated. The mean absolute intensity deviation of each pixel from a median smoothed intensity of the picture was defined as visual roughness (R_{vis}) of the yoghurt sample. The measurement of R_{vis} was based on that described by Kücükcetin (2008).

2.3. Texture measurement

The textural properties of the samples were analyzed after 1-day and 14-day storage. Storage modulus (G') and yield stress were determined according to Baravian et al. (2002) and Steffe (1996), respectively.

3. Statistical evaluation

All statistical calculations were performed using SAS Statistical Software (release for Windows, SAS Institute Inc., USA).

RESULTS AND DISCUSSION

The pH at the end of the incubation period was similar for the different yoghurts with an average pH of 4.6, regardless of the incubation temperature. The pH values had decreased significantly ($p<0.05$) in each of the yoghurt samples after having been stored at 4°C for 15 days.

. At day 1, average syneresis of the yoghurt samples incubated at 45, 42 and 37°C was measured to be 76.2±0.9, 73.9±0.8 and 71.0±225%, respectively. Syneresis in yoghurt samples decreased as the incubation temperature decreased, which is in agreement with previous studies. Lucey, Munro, and Singh (1998) and Lee and Lucey (2004) reported that yoghurt produced at a lower incubation temperature showed lower syneresis.

The number of grains and the mean perimeter of grains of the day 1 yoghurt varied from 21 to 183 per 3 mL of the sample and from 2.1 to 3.4 mm, respectively, according to the incubation temperature. The number of grains in the yoghurt incubated at 45°C was higher than that of the yoghurt incubated at 37 or 42°C. The use of high incubation temperatures in cultured products promotes the formation of grains (Lucey, 2004). At a low fermentation temperature, the aggregation of proteins occurs more slowly, and a large number of protein-protein interactions between the casein particles takes place. Thereby, less rearrangement of the particles during gel formation occurs. This forces the formation of a more continuous network and contributes to an increase in the rigidity of the network. This may also explain why products obtained at low temperatures are smoother, as a lower extent of particle rearrangement would imply less graininess (Sodini et al., 2004). The visual roughness was influenced by the incubation temperature. The effect of storage was not significant ($P>0.05$). The visual roughness decreased significantly ($p<0.05$) as the incubation temperature was decreased.

The G' and the yield stress of the yoghurt varied from about 225 to 406 Pa and from 32 to about 69 Pa, respectively, according to the technological conditions. The G' values of the samples increased significantly ($p<0.05$) with incubation temperature; a similar trend was reported by Lankes, Ozer, and Robinson (1998), who showed that the number and distribution of the strong bonds increased with incubation temperature. These authors assumed that the stronger protein bonds contributed to the elastic character of viscoelastic gels. The yield stress of yoghurt samples incubated at 37°C was lower than those incubated at 42 or 45°C. The yield stress significantly ($p<0.05$) decreased as the incubation temperature decreased.

Conclusions

This study has shown that incubation temperature affects the physicochemical properties of stirred yoghurt. As the incubation temperature was decreased, the number of grains, perimeter of grains, visual roughness, syneresis, G' and yield stress decreased. For practical applications, incubation temperature can be optimized to improve quality or modified to create fermented milk products with different physicochemical properties.

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COMPARISON OF DIFFERENT SEA BUCKTHORN BERRY VARIETIES ON THE BASIS OF PHYSICAL PROPERTIES

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ABSTRACT

Sea buckthorn (*Hippophae rhamnoides* L., *Elaeagnaceae*) as an edible berry has a long history of application as a food both in Asia and in Europe.
To describe the berries for different kind of purposes (transportation, processing) some chemical and physical analyses (the moisture content, dimensions and size distribution of the berries and also puncture resistance) were carried out.

INTRODUCTION

Sea buckthorn is a bush with berries from yellow to red in colour which has been used for centuries. These berries contain a large variety of substances especially those that are biologically active and have antioxidant properties.
In ancient Greece, sea buckthorn leaves added to horse fodder were well reputed to result in weight gain and shiny hair; thus, the Latin name "*Hippophae*" meaning shining horse.
Sea buckthorn occurs as a native plant distributed widely throughout temperate zones between 27° and 69° N latitude and 7° W and 122° E longitude including China, Mongolia, Russia, Great Britain, France, Denmark, Netherlands, Germany, Poland, Finland, Sweden, and Norway (Li and Schroeder, 1996).
During the last 10 years the cultivation of sea buckthorn in Estonia is turned more popular – there is over 500 ha sea buckthorn plantations. There are two research institutions in Estonia – the Experimental Station at Rõhu (experiments with sea buckthorn since 1998) and Polli Horticultural Research