Properties of Salt Coagulated Cheese Produced by Calcium Chloride and Calcium Propionate

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Abstract

The project was carried out to clarify the physical, chemical and microbial properties of cheese coagulated by salt solutions. Salt coagulated cheese was produced by adding 4.2% by volume salt solution into boiled whole raw milk. Two salt solutions of calcium chloride and calcium propionate were studied at 3 different concentrations, including 5, 10 and 20% (w/v). The cheese curds were then pressed for 1 h at room temperature, cut into small cubes and kept at refrigerated temperature for physical, chemical and microbial analysis. In general, the yield of calcium propionate cheese was slightly higher than that of the calcium chloride cheese. The calcium propionate cheese had higher moisture content and pH value together with lower salt content and hardness compared to those of the calcium chloride cheese. The highest salt content of 1.27 ± 0.13% was found in the calcium chloride cheese added with 20% salt solution, whereas the highest hardness (4.03 ± 0.12 N) was discovered in the calcium chloride cheese supplemented with 5% salt solution. Different types and concentrations of salt solutions did not significantly affect the whiteness of the cheese sample ($p>0.05$). The number of psychrotroph bacteria in different cheese samples was in the range of 3.48 – 5.48 log cfu/g, while the presence of yeast and mould in all the cheese samples was lower than 1.49 log cfu/g.

Keywords: calcium chloride, calcium propionate, salt coagulated cheese, salt concentrations

Introduction

Cheese is one group of fermented milk based food products that are produced in wide range of flavours and forms throughout the world (Fox and McSweeney, 2004). The production of cheese involves 3 basic principles, including coagulation of milk, reduction in moisture content and ripening (Nielsen, 2004). Coagulation of milk can be carried out by the action of rennet enzyme and/or acidification (Fox and McSweeney, 2004; Nielsen, 2004).

Milk coagulation was a complex process, which was affected by calcium addition, phosphate addition, pH, ionic strength and temperature (McMahon *et al*., 1984). Coagulation of milk during cheese production is influenced by concentration of casein and milk fat. When acid was used to coagulate the milk, the acid dissolved the colloidal calcium phosphate of the casein micelles and neutralized the electric charge of the particles, which caused the micelles to be aggregated (Walstra *et al*., 2006). The addition of salt solution would also destabilize the casein micelle. Pastorino *et al*. (2003) mentioned that adding salt to milk or casein systems promoted dissociation of calcium and phosphate from casein micelles into the solution.

Calcium chloride was occasionally added during cheese making to reduce the lag time between enzyme addition and coagulation. The addition of the salt solution could also reduce the requirement of rennet by 50% (McMahon *et al*., 1984). McMahon *et al*. (2005) found that an increase in the calcium content of non fat Mozzarella cheese caused the protein bundles became larger and denser with a corresponding increased in serum pockets as water was excluded from the protein network matrix.

This study was concentrated on the production of cheese coagulated by salt solutions. Two calcium salts, including calcium chloride and calcium propionate, were investigated.

Materials and Methods

Production of Salt Coagulated Cheese

Raw milk from a local dairy cooperative in Chiang Mai was purchased and delivered to the laboratory within 30 min under refrigerated condition. An amount of 1,200 ml raw milk was boiled, added with 50 ml of calcium salt solution, either calcium chloride (Foodfill, Bangkok, Thailand) or calcium propionate (Kemira Chem Solutions b.v., Holland, Netherland), and continued to be heated for a further 5 min to ensure the coagulation was completely be carried out. Each of the calcium salt solution was studied at 3 concentration levels, which were 5, 10 and 20% (w/v). The separated liquid (cheese whey) was then separated using cleaned double layers cheese cloth. The cheese curds were collected and pressed in a small scale pressing equipment for 1 h at room temperature to promote more removal of the cheese whey. At the end of the pressing time, the cheese curd was cut into small pieces (approximately 2x2x2 cm^3) and kept in refrigerated temperatures until the time of analysis. Each treatment was prepared in triplicate.

Physicochemical and microbial analyses of salt coagulated cheese

Yield of salt coagulated cheese was calculated based on the amount of the final cheese curd (after pressing) divided by the amount of raw milk used and multiplied by 100. The amounts of salt, total titratable acidity and moisture content of salt coagulated cheese were determined using methods of AOAC (2000). The measurement of pH, colour and texture of salt coagulated cheese were carried out using a pH meter (Consort C830, Belgium), a colorimeter (Minolta CR-300, Japan) and a texture analyzer (Texture Analyser model TA.XTPlus, Stable Micro Systems, UK), respectively.

For microbial enumeration, total plate count, the count of yeast and mould and psychrotroph bacteria were carried out based on procedures published by Harrigan (1998).

Results and Discussion

The yield of salt coagulated cheeses was more affected by the type of calcium salt solution rather than the concentrations of salt solutions (Fig. 1a). The cheese curd coagulated with calcium propionate produced higher yields compared to those of the curd added with calcium chloride. A cheese yield between 10.1 and 10.4% had been reported by Heino *et al*. (2010) for Edam cheese milk, whereas Hydamaka *et al*. (2001) found a yield of 47.7 to 74.6% for heat and acid coagulated cheese from ultrafiltered milk retentates. Differences in the cheese yield were mainly affected by different pressing time and pressure.

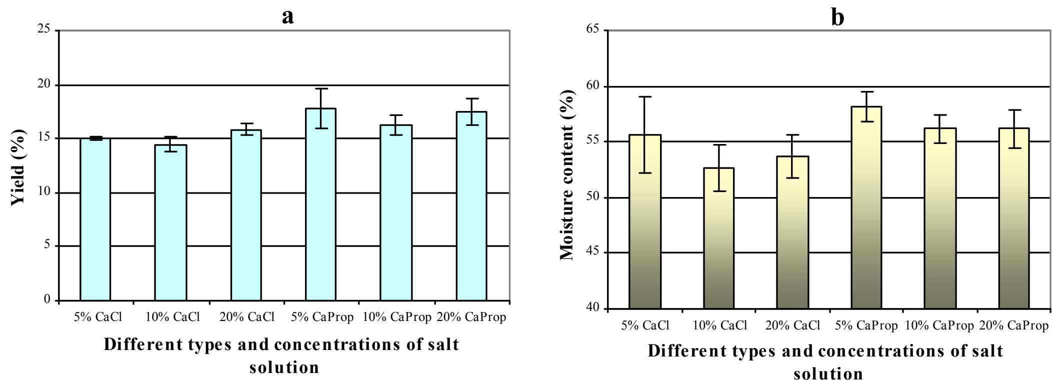

Figure 1. Yield (%) (a) and moisture content (%) (b) of salt coagulated cheese affected by different types and concentrations of calcium salt solutions

A higher cheese yield produced by calcium propionate was contributed to a higher moisture content found in the cheese samples (Fig. 1.b). The lowest moisture content of 52.67 $\pm$ 2.07% was found in the cheese coagulated with 10% calcium chloride. Okpala *et al*. (2010) reported a moisture content of 63.1 $\pm$ 0.8% for fresh cheese, whereas Dave *et al*. (2003) found moisture contents between 53.2 and 57.8% for direct acidification of Mozzarella cheese. Discrepancy in the moisture content of different cheeses was affected by the pressing condition, raw milk composition, type and strength of coagulant and processing parameters (Hydamaka *et al*., 2001; Dave *et al*., 2003).

Cheese samples coagulated with calcium propionate significantly had higher pH values compared to those produced with calcium chloride (Fig. 2a). The pH of calcium chloride cheese samples was similar to the report of Singh *et al*. (2007), who found that the addition of calcium salts (50 mg/100ml) in milk reduced the pH of milk to be about 6.3 that led to destabilization of the milk. The high pH found in this study might also be affected by the absence of microorganisms and acid addition during its production.

The amount of salt measured as sodium chloride showed that the cheeses made from calcium chloride contained higher amounts of salt compared to those produced by calcium propionate (Fig. 2b). The highest amount of salt (1.27 ± 0.13%) was significantly found in the cheese coagulated with 20% calcium chloride. This value was similar to the salt content in the Mozzarella cheese produced by direct acidification (Dave *et al*., 2003).

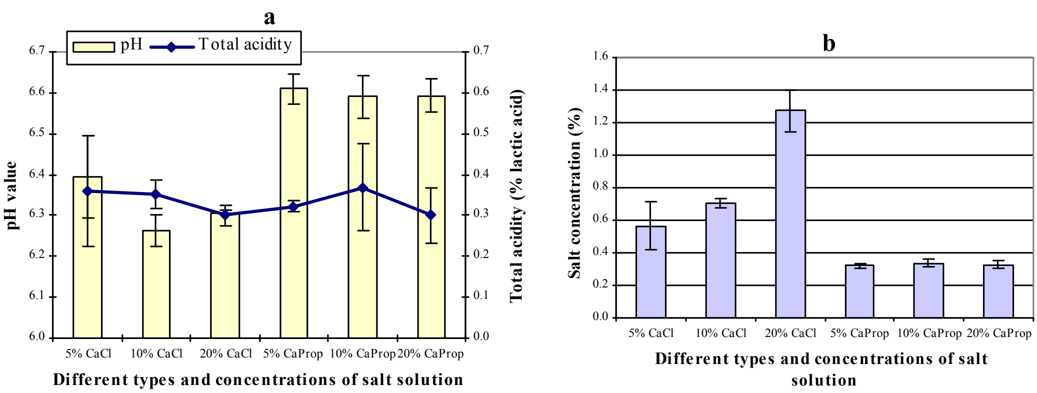

Figure 2. pH, total acidity (% lactic acid) (a) and salt concentration (%) (b) of salt coagulated cheese affected by different types and concentrations of calcium salt solutions

The colour of different salt coagulated cheeses was not affected by different types and concentrations of salt solutions (Fig. 3a). The cheeses had a light, almost pure white colour with slightly green and yellow colour directions. This finding was almost similar to the fresh cheese produced by rennet coagulation (Okpala *et al*., 2010).

The hardness of salt coagulated cheeses was affected by different types of salt solutions. Cheeses coagulated with calcium chloride had higher hardness values than those made from calcium propionate (Fig. 3b). The highest hardness value was found in the cheese produced by 5% calcium chloride. A fresh cheese produced by rennet coagulation was reported to have a hardness value of 2.54 ± 0.09 N (Okpala *et al*., 2010).

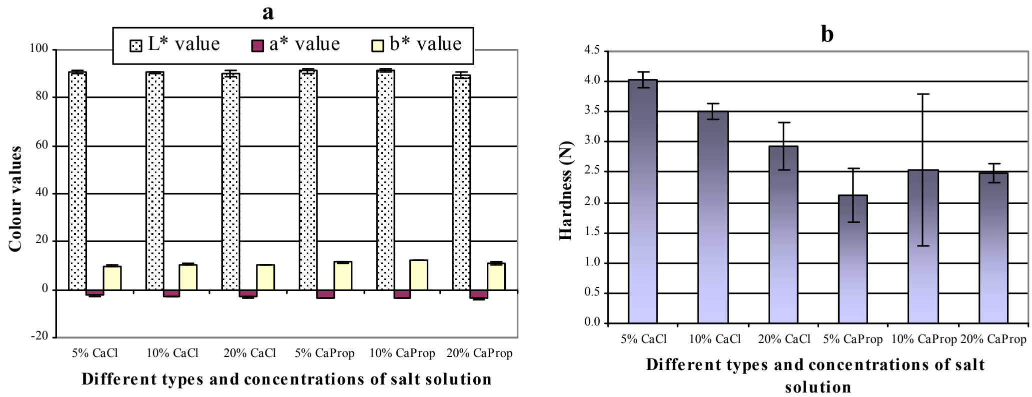

Figure 3. Colour values (a) and hardness (N) (b) of salt coagulated cheese affected by different types and concentrations of calcium salt solutions

Different salt coagulated cheeses contained a total microbial count between 5.00 $\pm$ 0.42 and 7.48 $\pm$ 0.00 log cfu/g, a total number of yeast and mould of less than 1.49 $\pm$ 1.42 log cfu/g and a total psychrotroph bacterium in the range of 3.48 $\pm$ 0.00 to 5.48 $\pm$ 0.00 log cfu/g. The high number of total microorganisms in the cheese could be contributed from the concentration factor of the raw milk during the boiling process. High pH values and moisture contents of the salt coagulated cheeses would be other factors that might support the survival of microorganisms during the pressing period for 1 h at room temperature. The majority of microorganisms in salt coagulated cheeses were represented by psychrotroph microorganisms.

Conclusions

From the collected data, it could be concluded that coagulation of raw milk could be produced by a combination of heat treatment and calcium salt solutions. The addition of calcium chloride created better cheese characteristics, indicating a better effect of the salt solution to destabilize the casein micelles. With a lower pH value of the calcium chloride cheese, the cheese had higher salt content and hardness value than those of the cheese produced with calcium propionate.

Acknowledgement

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