J Food Sci Technol (May–June 2010) 47(3):355–357
DOI: 10.1007/s13197-010-0059-4

ORIGINAL ARTICLE

Textural profile analysis of paneer dried with low pressure superheated steam

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Revised: 3 August 2009 / Accepted: 8 August 2009

Abstract Paneer is highly perishable at ambient conditions and its shelf-life is very low. At high temperature, it develops a sour smell, and bitter taste. Drying can be one of the methods to increase shelf-life. Drying experiments were conducted at 62, 72 and 82°C and 10, 14 and 18 kPa absolute pressures with superheated steam. The product quality was judged by instrumental texture profile. Hardness, adhesiveness, gumminess and chewiness increased with increase in temperature and decreased with increase in pressure. Springiness and cohesiveness, however, decreased with increase in temperature and pressure. Textural properties of fresh and rehydrated paneer indicated large variation on hardness, adhesiveness and resilience whereas springiness, cohesiveness and chewiness had marginal variation as compared to fresh paneer.

Keywords Paneer · Drying · Texture · Low pressure · Superheated steam

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Introduction

Paneer, a dairy product, is marble white in appearance with spongy body, close-knit texture possessing sweetish-acidic nutty flavour (Chandan 2007). Quick freezing extends the shelf life of paneer for long periods but surface drying of deep frozen paneer of 8 days and poor rehydration characteristics of air dried paneer are reported (Vishweshwaraiah 1987). Treatment with sorbic acid extended its shelf life up to 36 days (Singh et al. 1989). Microwave drying of paneer at 80% power level for 5 min had better sensory score due to no fat loss and no browning (Singh and Rai 2004).

Optimal combination of deformation and deformation rate can be used for maximizing the correlation between sensory and instrumental hardness for cheese products (Xiong et al. 2002). Sensory and instrumental measurements were quantified to assess hardness, cohesiveness and adhesiveness. They were good for hardness and adhesiveness but not cohesiveness (Halmos and Foo 2002). High quality dairy products require precise control over factors determining product appearance, flavour and texture (Foegedinga et al. 2003).

Research has seldom been carried out on drying of paneer using low pressure superheated steam. The objective was to determine the effect of low pressure superheated steam drying on the texture of dehydrated paneer after rehydration.

Materials and methods

Paneer with the brand name ‘Anchal’, prepared from standardized cow milk was procured from Anchal Dairy, Lalkuaon. To conduct single experiment, the quantity purchased was 500 g. It was kept at 4°C in a refrigerator for 48 h. The initial moisture content (AACC 1983) of paneer was about 50% (wb). Paneer was diced in a cube for drying. Drying experiments were conducted at 62, 72 and 82°C and 10, 14 and 18 kPa absolute pressures with superheated steam.

Experimental set up of low pressure superheated steam dryer was specially developed to conduct the drying experiments. The paneer was diced in to cubes of two different sizes (1 cm^3 and 1.5 cm^3) with stainless steel knife. It was pretreated with NaCl and potassium sorbate. A fixed volume of water (0.5 l) containing 2.5% NaCl and 0.5% potassium sorbate was heated to 50°C in water bath. About 50 g of paneer cubes were placed into the solution and temperature was maintained at 50°C for 10 min. Experimental setup of low pressure superheated steam dryer was developed. Experimental setup components were steam generator, drying chamber, vacuum pump and data acquisition system with computer. The drying chamber consisted of a box insulated properly with rock wool. Two electric heaters of 1.5 kW capacities each were provided on opposite side walls of the drying chamber. The temperature of drying chamber was controlled by a temperature controller. The drying chamber was connected by a pipe from bottom to a chamber in which digital balance was kept. An autoclave was used as a steam generator. A steam trap was provided to reduce accumulation of steam condensate in the reservoir. Steam was transported to the drying chamber through a pipe insulated with glass wool. A heating tape, rated 1 kW was mounted on steam pipeline to increase the steam temperature to desired level of superheating. The sample holder was made using thin stainless steel sheet. This was connected to a balance by a thin rod passing through a G I pipe. One side of the rod was attached to the sample holder and other side was rested on analytical digital balance. The balance was placed in a smaller chamber. The data recorded by this balance was transferred through the serial cable by software. Electronic balance attached with computer allowed continuous weighing of the sample. Thermocouples were installed to measure temperature of superheated steam at inlet of drying chamber, drying chamber and product chamber continuously. These thermocouples were attached to the data logger. Thermocouple signals multiplexed and transferred to the computer through terminal software installed in PC. A vacuum pump was used to create the desired vacuum in the drying chamber.

Textural profile analysis test was performed on rehydrated paneer cubes using texture analyzer (Model TA, HD plus, Exponent Stable Microsystems, UK). The specifications of the texture analyzer were: load cell capacity 5 kg, return to start option, displacement 0.1–524 mm, pretest speed 5 mm/sec, test speed 0.01 mm/sec and post test speed 2 mm/sec. To place the sample heavy duty platform (HDP/90) was used. The probe adapter was used to connect the probe to texture analyzer. In these experiments AD/100 probe adapter was used to connect the probe to machine. Cylindrical probe (P/5) made of stainless steel with 5 mm diameter, was used throughout the experiments.

Paneer cubes of 1 and 1.5 cm^3 sizes were rehydrated in boiling water for 15 and 20 min, respectively and then separated from water through 10 mesh stainless steel sieves.

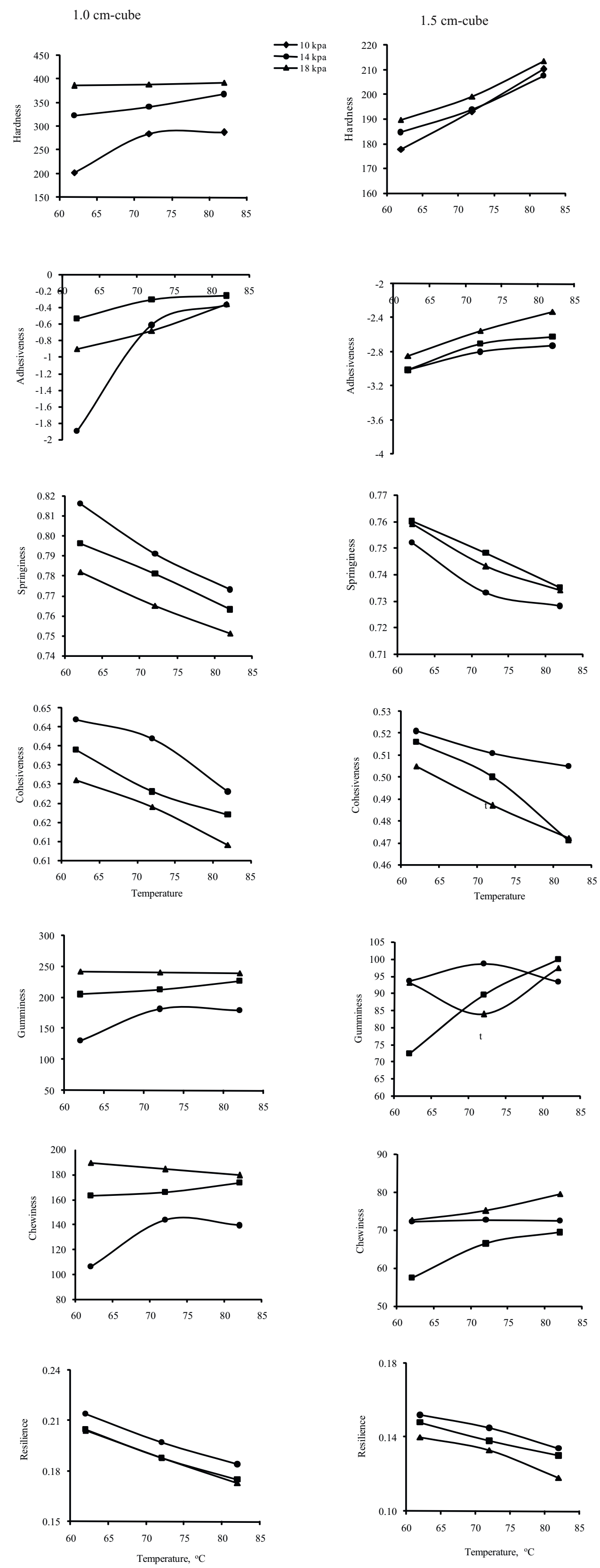

Fig. 1 Effect of temperature and pressure on textural properties of rehydrated paneer (n=3).

Table 1 Comparison of textural properties of fresh and rehydrated paneer

Properties	1 cm^3 paneer		1.5 cm^3 paneer	
	Fresh	Rehydrated	Fresh	Rehydrated
Hardness, g	168.2	203.0 to 392.5	157.9	177.9 to 213.5
Adhesiveness, g/sec	–2.919	–0.360 to –1.901	–4.405	–2.32 to –3.01
Springiness, mm	0.851	0.751 to 0.816	0.768	0.734 to 0.752
Cohesiveness	0.658	0.609 to 0.642	0.576	0.472 to 0.521
Gumminess	110.780	130.4 to 241.9	91.507	72.2 to 99.9
Chewiness	94.372	106.3 to 189.5	53.195	57.4 to 79.5
Resilience (n = 3)	0.248	0.73 to 0.214	0.194	0.118 to 0.152

Samples were subjected to texture profile test. The sample was positioned centrally on the heavy duty platform under the probe. Then compression test was commenced. When a 5 g surface trigger (force) attained, the probe proceeded to penetrate 5 mm (for 1 cm^3 paneer) and 8 mm (for 1.5 cm^3 paneer). After the end of penetration distance at which the force was maximum, the probe returned to its original position at constant speed (2 mm/sec). The texture profile curve was interpreted in terms of 7 textural parameters, 5 measured (hardness, adhesiveness, springiness, cohesiveness and resilience) and 2 calculated (gumminess and chewiness). All tests were replicated thrice.

Results and discussion

A large variation on the hardness, adhesiveness and resilience was found whereas springiness, cohesiveness and chewiness had marginal variation in rehydrated paneer as compared to fresh paneer in both the sizes (Table 1).

Hardness of paneer increased with increase in temperature and pressure for both the sizes (Fig. 1). Effect of pressure was more pronounced compared to temperature for 1.0 cm^3. Hardness of 1.5 cm^3 paneer was lower than that of 1.0 cm^3. This might be due to relatively less displacement kept during compression test. Adhesiveness increased with increase in temperature in both the sizes. In general, adhesiveness of paneer at 10 kPa was minimum in both the sizes. It was maximum at 14 kPa and 18 kPa for 1 and 1.5 cm^3, respectively. Springiness decreased with increase in temperature for both 1 and 1.5 cm^3. It decreased with increase in pressure for 1.0 cm^3 while minimum and maximum were at 14 and 10 kPa in case of 1.5 cm^3. Less springiness was observed in 1.5 cm^3 compared to 1.0 cm^3 paneer. Cohesiveness decreased with temperature and pressure. It was higher at 10 kPa and at all temperatures while lower at 18 kPa in both sizes of paneer. It could be due to moisture loss and change in proteins which significantly influnced various textural characteristics. Cohesiveness of 1 cm^3 paneer was higher than that of 1.5 cm^3 paneer. Gumminess was almost constant at different temperatures for the pressures 14 and 18 kPa. However, it increased with temperature at 10 kPa in case of 1 cm^3. For 1.5 cm^3, it increased with temperature at 14 kPa. Gumminess was less in 1.5 cm^3 than in 1 cm^3. Chewiness increased with increase in temperature. Higher chewiness was observed at 18 kPa and at all temperatures. Minimum chewiness was at 10 kPa and 14 kPa pressures for 1 and 1.5 cm^3, respectively. Chewiness was more in 1 cm^3 as compared to 1.5 cm^3 paneer. Resilience decreased with increase in temperature and pressure. Resilience was more for 1.0 cm^3 in comparison to 1.5 cm^3.

Conclusions

Paneer dried under low pressure superheated steam had similar textural properties of rehydrated paneer as fresh paneer.

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