Determination of functional, textural and colour properties of market Mozzarella cheese

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Abstract: Mozzarella cheese is one of the most popular members of pasta-filata family cheeses that originated in Italy. There is increasing demand of Mozzarella cheese for preparation of varieties of food products. The various properties such as functional, textural and colour properties of Mozzarella cheese play a vital role in its marketing and consumer acceptance. In the present study, these properties of four brands of market Mozzarella cheese were determined. The stretchability, flowability and meltability of market Mozzarella cheese samples were found statistically significantly different ($p < 0.01$). The average values for stretchability, flowability and meltability ranged (minimum to maximum) between 14.67 ± 4.16 to 76.67 ± 2.06 cm, 20.47 ± 6.39 to 40.67 ± 1.01 % and 1.67 ± 0.23 to 10.2 ± 1.35 cm, respectively. All the textural and colour properties of market Mozzarella cheese were found statistically highly significantly different between the brands ($p < 0.001$). The values of the hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness of market Mozzarella cheese (minimum to maximum) varied from 29.51 ± 4.48 to 35.64 ± 0.16 N, -0.02 ± 0.02 to -0.67 ± 0.32 Ns, 0.32 ± 0.06 to 0.89 ± 0.05 , 0.28 ± 0.03 to 0.56 ± 0.05 , 10.11 ± 1.56 to 28.91 ± 4.16 and 3.29 ± 1.06 to 25.80 ± 4.52 , respectively. The L^* , a^* , b^* , chroma value, hue angle and whiteness index values of Market Mozzarella cheese varied from 70.30 ± 0.10 to 73.77 ± 0.15 , -1.14 ± 0.19 to 1.60 ± 0.12 , 19.88 ± 0.27

to 25.55 ± 0.34 , 19.91 ± 0.28 to 25.60 ± 0.33 , -1.51 ± 0.00 to 1.51 ± 0.01 radian and 60.79 ± 0.27 to 66.22 ± 0.33 , respectively. Colour and functional characteristics of Mozzarella cheese play a vital role for market acceptance along with textural characteristics for development of process equipments for Mozzarella cheese making.

Keywords: Mozzarella cheese, stretchability, springiness, whiteness index

Introduction

Mozzarella cheese is a prominent member of the pasta filata or stretched curd cheeses that originated in Italy. Pasta filata cheese is a high volume production cheese used in pizza and other Italian foods. Pasta filata cheeses are distinguished by a unique plasticizing and kneading treatment of the fresh curd in hot water, which imparts the finished cheese, with characteristic fibrous structure, melting and stretching properties (Kindstedt and Fox, 1993).

Traditionally Mozzarella cheese was mainly produced from milk of water buffaloes in Italy. In other European countries and U.S.A, Mozzarella cheese is produced by using cow's milk with some required modifications (Ghosh et al. 1990). Mozzarella cheese has soft texture, white colour with glossy appearance and it is mainly valued for its stretchable property which helps in preparation of lasagna, veal cutlet and pizza (Kosikowski, 1982; Jana, 2001). An increase in pizza consumption by people specially youngsters, resulted into increase in the demand for Mozzarella cheese. In general, Mozzarella cheese is used as pizza topping due to its stretchability (Kindstedt et al. 1989).

Although there is widespread popularity and acceptability of Mozzarella cheese in the Indian market, the consumption of the cheese is limited to major cities only. Mozzarella cheese production is mostly confined to large-scale industry. In rural or semi urban area, its usage is very limited. There are many reasons for this such as lack of importance of Mozzarella cheese and its application, limited production and availability at rural and semi urban area, etc. The various properties of some market dairy products are available in published literature e.g. Kradi cheese

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(Punoo et al. 2018), Indian cottage cheese i.e. Paneer (Wangdare et al. 2017), cheese and cheese products (Jayadevan, 2013), KheerMohan (Meena et al. 2014), Rasogolla (Srinivasa et al. 2017). Therefore, considering above-mentioned information, attempts were made to determine the functional, textural and colour properties of four brands of market Mozzarella cheese in present study.

Materials and Methods

Collection of Mozzarella cheese samples

There are different brands of Cheese manufacturers producing good quality Mozzarella cheese and also available throughout the country. Due to high demand of Mozzarella cheese in pizza making, some local cheese manufacturers are also producing good quality Mozzarella cheese to fulfill the local demand. For the present study, four brands of Mozzarella cheeses (two national, one regional and one local brand) were collected from Delhi and local market of Karnal. The collected different brands of Mozzarella cheese were designated as M1, M2, M3 and M4.

Functional properties of Mozzarella cheese

Meltability

Meltability was determined by the method described by (Oberger et al. 1993). Fifteen gram (15 g) shredded cheese was filled into a Pyrex glass tube (30 mm diameter × 250 mm length) and gently tapped with a spatula until each of the samples occupied a length of about 35 mm. The one end of the tubes was sealed with stoppers (Silicon rubber) and the other with aluminum foil having a small hole to allow gases to escape. The tubes were tempered at 4°C (in Refrigerator) for 30 min in a vertical position and then placed horizontally in an oven at 100°C for 60 min. After cooling to room temperature, the length of melted cheese was measured.

Stretchability

Stretchability of Mozzarella cheese was measured on pizza by following the standard procedure (Catherine et al. 1998). Shredded cheese (0.25g/cm²) was evenly distributed on the pizza base that was pre-cut in half and it was placed in the oven at 280°C for 4 minute and then evaluated for Stretchability. One half of the pizza was clamped and the unclamped section was manually pulled until the extended string that joining the both section of pizza base completely broke. The stretch was recorded by measuring the distance between the pizza halves.

Flowability

Flowability of cheese on cooking was assessed by the 'Schreiber test'. A disk of cheese (44.5 mm diameter; 4.0 mm thick) from the freshly cut surface of the cheese block was taken and placed on a glass disc, which was marked with four intersecting diagonals.

The glass disc was placed in an electrostatically controlled hot air oven at 280°C for four minutes. Glass disc with cheese was removed from the oven and placed on a steel surface at 0°C and allowed to cool for 3 minutes. The diameter of the molten cheese disk was measured at four locations (i.e. along the four diagonals). The flowability is the change in dimension, expressed as a percentage of dimension in the unheated sample (Fox et al. 2017). Therefore, flowability was calculated by following equation (Fox et al. 2017):

$$\% \text{ Flowability} = \frac{(D_1 - D_0)}{D_0} \times 100$$

Where, D_1 = diameter of cheese disk after heating

D_0 = diameter of cheese disk before heating

Texture profile analysis of Mozzarella cheese

Market Mozzarella cheese samples were analysed by using texture analyser (Model TAXT2i, Stable Micro Systems U.K., double cycle compression) installed with texture expert exceed (version 2.55; English) software. The product was subjected to a typical two bite compression test using compression probe (P-75) attached to the texture analyser. The texture analyser was calibrated for probe and then for force of 5 kg, before starting the analysis. Mozzarella cheese was evaluated for various textural properties like hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience at 2mm/s probe speed and 80 % compression. Initially the product samples were cut into a cylinder of height and diameter of 1 cm each. Product sample was kept on the Texture Analyser platform under the load cell of 25 kg. Five samples of the product for selected parameters were analysed.

Colour properties

Colour values (L^* , a^* , b^*) of the Mozzarella cheese samples were determined by using a colour flex colorimeter (Hunter Associated Laboratory, Inc., Reston, VA USA). Before colour measurement, the instrument was calibrated with a standard black glass and white glass tiles as specified by the manufacturer. Mozzarella cheese samples were shredded using stainless steel grater, the shredded samples were transferred to sample plate and then colour was measured. Data were received from software in terms of L^* {lightness; range: 0 (black) to 100 (white)}; a^* {redness; range: +60 (red) to -60 (green)} and b^* {yellowness, range: +60 (yellow) to -60 (blue)}. The chroma, hue angle and browning index (BI) were calculated from the L^* , a^* and b^* values (Barnwal et al. 2015; Gupta et al. 2011) and used to describe the colour:

$$\text{Chroma} = \sqrt{(a^*)^2 + (b^*)^2}$$

$$\text{Hue angle} = \tan^{-1} \left(\frac{b^*}{a^*} \right)$$

Whiteness index (WI) of the Mozzarella cheese samples was calculated using the following standard relation (Siriwongwilaichat et al. 2014; Srinivasa et al. 2017):

$$WI = 100 - \sqrt{(100 - L^*)^2 + a^{*2} + b^{*2}}$$

Statistical analysis

Analysis of variance (ANOVA) for different characteristics of market Mozzarella cheese was carried out by PROC ANOVA procedure (SAS software, version 9.3).

Results and Discussion

Functional properties of market Mozzarella cheese

The stretchability, meltability and flowability of market Mozzarella cheese samples were statistically significant ($p < 0.01$) as represented in Table 1. The stretchability of M2 and M4 were observed to be statistically similar. The functional properties values of market Mozzarella cheese as obtained were in the range of stretchability 14.67 ± 4.16 to 76.67 ± 2.06 cm, flowability 20.47 ± 6.39 to 40.67 ± 1.01 % and meltability 1.67 ± 0.23 to 10.2 ± 1.35 cm. The highest value of stretchability and meltability was observed in M3 sample and the highest flowability observed in sample M4. The lowest value of stretchability and meltability was observed in sample M4 and the lowest value of flowability was observed in M2 sample (Fig. 1).

Textural properties of market Mozzarella cheese

The hardness, springiness, gumminess, adhesiveness, chewiness, cohesiveness of market Mozzarella cheese samples were found highly significant ($p < 0.0001$) as shown in Table 2. The hardness of M1 and M4 were observed to be statistically similar. The adhesiveness of M1 and M2 were observed to be statistically similar whereas M3 and M4 were statistically at par with each other. The cohesiveness of M1 and M3 were observed to be statistically similar. The values of the hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness of market Mozzarella cheese were ranges in between the values of 29.51 ± 4.48 to 35.64 ± 0.16 N, -0.02 ± 0.02 to -0.67 ± 0.32 Ns, 0.32 ± 0.06 to 0.89 ± 0.05 , 0.28 ± 0.03 to 0.56 ± 0.05 , 10.11 ± 1.56 to 28.91 ± 4.16 and 3.29 ± 1.06 to 25.80 ± 4.52 , respectively. The value of the hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness of market Mozzarella cheese were found maximum in sample M2 among other samples (Figs.2-4).

Colour properties of market Mozzarella cheese

Colour properties like L^* , a^* , b^* , chroma value, hue angle and whiteness index of Market Mozzarella cheese were studied and found statically highly significant ($p < 0.0001$) with each other (Table 3). The a^* of M1 and M2 were observed to be statistically similar whereas M2 and M4 were statistically at par with each other. The b^* of M2 and M4 were observed to be statistically similar. Chroma value of M2 and M4 were observed to be statistically similar. Hue angle (in radian) of M1, M2 and M4 were observed to be statistically similar. The b^* stands for yellow-blue value, thus $+b^*$ stands for the increase of yellow and $-b^*$ for the increase of blue (Li et al. 2014). Whiteness index of M2 and M4 were observed to be at par with each other. The values of

Table 1 ANOVA table for functional properties of market Mozzarella cheese

Market Mozzarella cheese	Strechability (cm)	Flowablity (%)	Meltability (cm)
DF	3	3	3
SS	6950.33	3222.853	121.64
MS	2316.78	1074.284	40.55
F-Value	80.35	15.073	80.02
Prob	<.0001***	<.001***	<.0001***

*** $p < 0.001$; n=3

Table 2 ANOVA for textural properties of market Mozzarella cheese

Market Mozzarella cheese	Hardness, N	Adhesiveness, Ns	Springiness	Cohesiveness	Gumminess	Chewiness
DF	3	3	3	3	3	3
SS	1360.961	1.550	0.981	0.190	1083.447	1459.527
MS	453.654	0.517	0.327	0.063	361.149	486.509
F-Value	30.63	16.98	94.69	73.14	55.91	74.54
P	<.0001***	<.0001***	<.0001***	<.0001***	<.0001***	<.0001***

*** $p < 0.001$; n=3

Fig. 1: Variation in stretchability, flowability and meltability of market Mozzarella cheese

Fig. 2 Variation of hardness (N), gumminess and chewiness of Mozzarella cheese

Fig. 3: Variation in adhesiveness (Ns) of market Mozzarella cheese

Fig. 4: Variation in springiness and cohesiveness of market Mozzarella cheese

Table 3 ANOVA for colour characteristics of market Mozzarella cheese

Market Mozzarella cheese	L^*	a^*	b^*	Chroma	Hue angle	WI
DF	3	3	3	3	3	3
SS	22.20	18.31	48.25	48.53	20.55	51.88
MS	7.40	6.10	16.08	16.18	6.85	17.29
F-Value	310.67	329.75	324.37	324.13	184276.00	314.49
P	<.0001***	<.0001***	<.0001***	<.0001***	<.0001***	<.0001***

***p<0.001; n=3

L^* , a^* , b^* , chroma value, hue angle and whiteness index of Market Mozzarella cheese were ranged between 70.30 ± 0.10 to 73.77 ± 0.15 , -1.14 ± 0.19 to 1.60 ± 0.12 , 19.88 ± 0.27 to 25.55 ± 0.34 , 19.91 ± 0.28 to 25.60 ± 0.33 , -1.51 ± 0.00 to 1.51 ± 0.01 radians and 60.79 ± 0.27 to 66.22 ± 0.33 respectively. Imm et al. (2003) has observed L^* , a^* and b^* values for bovine mozzarella cheese ranging from

79.6 ± 1.74 (0 week) to 74.7 ± 1.84 (8 week), -4.3 ± 0.09 (0 week) to -5.9 ± 0.21 (8 week) and 17.4 ± 0.29 (0 week) to 22.1 ± 2.40 (8 week), respectively. The maximum L^* value observed in M2 sample. The M3 sample shows maximum value of a^* , b^* , chroma value and hue angle. The highest value of whiteness index observed in sample M1 (Fig. 5-6).

Fig.5 Variation of L^* , b^* , chroma and whiteness index of market Mozzarella cheese

Conclusions

The functional, textural and colour properties of four brands of market Mozzarella cheese (M1, M2, M3 and M4) were determined and found statistically significant among each other. The highest value of stretchability and meltability was observed in M3 sample, highest flowability observed in sample M4, lowest value of stretchability and meltability was observed in sample M4 and the lowest value of flowability was observed in M2 sample. Maximum L^* value was observed in M2 sample whereas M3 sample showed maximum value of a^* , b^* , chroma value and hue angle. The highest value of whiteness index was found in sample M1. In textural characteristics, the value of the hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness of market Mozzarella cheese were found maximum in sample M2 among other samples.

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Fig. 6 Variation of a^* and hue angle of market Mozzarella cheese

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