



Original Research Article

Effect of Microwave Stretching on Quality Attributes of Mozzarella Cheese

Kaushal Kishor¹, Avinash Singh¹, Anoop Singh¹, Mukesh Kandpal¹ and Sandeep Rout^{2*}

¹Warner School of Food and Dairy Technology, SHIATS, Allahabad-211007, U.P., India

²SOFE, SHIATS, Allahabad-211007, U.P., India

*Corresponding author

ABSTRACT

The study was conducted with the objective preparation of mozzarella cheese and finds effect of microwave stretching on quality attributes of mozzarella cheese, optimize level of stretching and evaluate the organoleptic quality, chemical quality, microbiological quality of the production. Three different treatment and control were used different time of same temperature (40°C for 5 minute), (40°C for 7 minute), (40°C for 10 minute) for mozzarella cheese manufacture are indicating as follow T₀, T₁, T₂ and T₃ respectively. Four treatment combinations were used in the study and replicated five times. The product were analyzed for organoleptic attributes like (Flavour and taste, Body and texture, colour and appearance) by trained panellist using 9- point hedonic scale, physico chemical characteristics (moisture, fat, yield, total solid and acidity) and microbiological (coliform). The treatment T₁ (40°C for 5 minute) was found best for mozzarella cheese making in comparison to other treatment in the organoleptic characteristics. Thus as far product acceptability judged by organoleptic evaluation value is concern, the treatment can be rated is T₁ > T₂ > T₃.

Keywords

Mozzarella,
Stretching,
Texture,
Sensory

Introduction

Production and consumption of cheese is continuously increasing. The proportion of the world milk supply utilized in cheese manufacturing has increased significantly to a level of 13% over the past 40 years.

Milk solids are selectively concentrated and preserved in the form of a palatable food during cheese manufacture. Concentration milk solids is initiated by the formation of a curd using either acid or rennet. Once the curd is formed, further acidification, heating and salting are used to reduce moisture and preserve the milk solids. Modification of

these basic processes, through accident or necessity, through centuries of cheese making, has led to the development of the several hundred cheese varieties which now exist worldwide.

Cheese is one of the most important products of the dairy world. It is a bright star in the dairy products heaven and is considered nature's versatile food. Converting milk to cheese is means of conserving the major constituents, namely fat casein in most nutritious from by removing whey cheese contains high level

of protein which are rich source of essential amino acids. It is also a good source of certain vitamins and essential minerals (calcium and Phosphates), the figure peaked at 31% in 1955 and the annual world cheese production is 12.823 million tons.

Mozzarella cheese is a sliceable curd cheese originating in Italy. Traditional mozzarella is made from water buffalo (not North American buffalo or bison as many mistakenly think) milk, and its flavour is highly prized. Water buffalo milk is three times more expensive than cow's milk and is costly to ship, so expect a corresponding high price tag on imported buffalo mozzarella. Since these animals are herded in only a few countries, primarily Italy and Bulgaria, most mozzarella is now made from cow's milk. Water buffalo milk is very high in fat and casein and not easily digestible in its raw form. As such, it is used exclusively for making mozzarella and not as a beverage. Mozzarella contains 40 to 45 percent fat, although there are now lower fat, skim versions available.

This cheese is not aged like most cheeses and is actually best when eaten within hours of its making. The process of making mozzarella is called pasta filata, which means the curds are heated in water or whey until they form strings (hence the term "string cheese") and become elastic in texture. The curds are stretched, kneaded until smooth, and then formed into round balls to make fresh mozzarella cheese.

The annual production of mozzarella cheese in the United States is about 312 million kg. Which accounts for 17 percent of the total cheese produced and utilizes about 6 percent of total milk production of mozzarella cheese about 723600 tonnes in 1989 which accounts for the 28 percent of the nation's total cheese production.

The direct acid mozzarella cheese is gaining popularity because of the advantages offered in term of curtailed manufactures time and expenses. The technology was also simplified due to elimination of propagation and maintenance of starter cultures. One of the important advantages of this technique is to avoid the bacteriophage action in case of starter culture methods.

Pizza as well as mozzarella cheese is a relatively new introduction of Indian dietary system and gaining wide popularity (Fox *et al.* 2000). The increasing demand has generated a need for process and product standardization under Indian condition. At present the main constraint in the commercial exploitation appears to be the paucity of full understanding on the technical aspects in the manufacture of the product. Keeping in view the importance of the study was aimed to evaluate the effect of microwave stretching on quality attributes of mozzarella cheese at different time and temperature combination.

Material and Methods

The present investigation was carried out in Warner School of Food and Dairy Technology Laboratory, SHIATS, Allahabad. The following material is being used were procured viz. Milk is being obtained from the cattle of Animal science Department, SHIATS, Allahabad. Hydrochloric acid is being procured from m/s E. Merck (India) Ltd. Mumbai. Hydrochloric acid is being used after diluting to 50 percent with distilled water. Calcium Chloride is being procured from m/s F.merk (India) Ltd. Mumbai and used after diluting 20 times of its. Coagulating enzyme, Microbial rennet (meito rennet) produced by Mucor pusillus var. Lint is being procured from NDRI, Karnal and used @5g/100 L of milk. Commercial grade fine grain salt of m/s Tata chemicals, Bombay

were obtained from the local market. Food grade polyethylene pouches of 300 gauge thickness are being used for packaging the cheese. The various treatments were T₀ - Mozzarella cheese (stretching at 80°C in hot water), T₁ - Mozzarella cheese (stretching at 40°C in microwave for 5 min), T₂ - Mozzarella cheese (stretching at 40°C in microwave for 7 min), T₃ - Mozzarella cheese (stretching at 40°C in microwave for 10 min).

Physico-chemical analysis

Determination of total solids

The total solids content was estimated by the standard gravimetric method as described in IS:SP:18(part xi),1981 (Model 60 E/N, England).

Determination of moisture

Moisture content of the cheese was estimated gravimetrically using maronnier test. A representative sample (2–3gm) was weighed into a total solids dish with acid washed sand, glass rod and dried at 105°C for 2 to 3 hours to a constant weight the percent moisture was calculated as follows

$$\text{Percentage moisture} = \frac{\text{Loss in Weight} \times 100}{\text{Weight of sample}}$$

Determination of fat

The fat content of mozzarella cheese was determined by the method as per adopting the procedure as laid down in manual in dairy chemistry I.C.A.R (1972)

The Gerber Method is a primary and historic chemical test to determine the fat content of milk globule will set free which remain in liquid state due to heat produced by the acid. Definite quantity of H₂SO₄ and Amyl alcohol are added and maintain volume of water on centrifugation fat being higher

separates on top of the solution.

Titrateable acidity

The titrateable acidity of the mozzarella cheese was determined by the method described by the Association of official analytical chemists (1984). Result were reported as percent lactic acid using the following formula

$$\% \text{ Lactic acid} = 0.9 \times V/M$$

Where,

M=Quantity of cheese /milk used

V= Volume of 0.1N NaOH Used (in ml.)

Microbiological analysis of mozzarella cheese

Preparation of media

MacConkey's broth, nutrient agar, and potato dextrose agar were prepared according to the procedure laid in I.S.1479, part –III (1962) and manual dairy microbiology, I.C.A.R. publication (1972).

Statistical analysis

Numbers of treatments were 4, all treatments were replicated five times; mean values and standard deviation was reported. Analysis of variance (ANOVA) was performed. When the difference in ANOVA among the scores of samples was significant at 5% level pair comparison of samples were analyzed (Chandel, 1991).

Result and Discussion

The present study was planned to elicit the information of “Effect of microwave stretching on quality attributes of mozzarella cheese”. The data collected on different

aspect were tabulated and analyzed statistically using the methods of analysis of variation and critical difference. The significant and non-significant difference observed have been analyzed critically within and between the treatment combinations.

The results obtained from the analysis are present in this chapter under the following heading

Physico chemical characteristics

Organoleptic characteristics

Microbial characteristics

The mean values of organoleptic characteristics and physico chemical characteristics analysis data were presented in the table 1.

Physicochemical characteristics

Percentage moisture in mozzarella cheese

The data regarding moisture present in mozzarella cheese sample to different treatment are presented in table 2.

From table 2, the perusal of data of moisture percentage in mozzarella cheese sample of different treatment and control the highest mean moisture percentage was recorded in the mozzarella cheese sample T₀ (53.96), T₁ (51.47), followed by T₂ (50.42), T₃ (49.45). The difference between the mean values of T₀ - T₁ (2.49) was greater than the C.D. value, 0.590 Therefore, the difference was significant. The difference between the mean values of T₀ - T₂ (3.54) was greater than the C.D. value, 0.590. Therefore, the difference was significant. The difference between the mean values of T₀ - T₃ (1.05) was greater than the C.D. value 0.590. Therefore, the difference was significant. The difference between the mean value of T₁

-T₂ (4.50) was greater than the C.D. value 0.590. Therefore, the difference was significant. The difference between the mean value of T₁ - T₃ (2.02) was greater than the C.D. value, 0.590. Therefore, the difference was significant. The difference between the mean value of T₂ - T₃ (0.97) was greater than the C.D. value, 0.590 therefore, the difference was significant.

Percentage acidity test in mozzarella cheese

The data regarding Acidity percentage in mozzarella cheese sample of different treatment are presented in table 3.

From the data perusal of data on acidity percentage in mozzarella cheese incorporation with same time and different temperature, of different treatment and control the highest mean acidity percentage was recorded in the mozzarella cheese sample of T₃ (0.72) followed by T₂ (0.73), T₁ (0.73) and T₀(0.70). Therefore, the difference has significant effect of treatments on acidity percentage.

Percentage fat in mozzarella cheese

The data regarding fat percentage in mozzarella cheese sample of different treatment are presented in table 4.

From the perusal of data on fat percentage in mozzarella cheese incorporation with mozzarella cheese sample of different treatment and control the highest mean fat percentage mozzarella cheese sample of T₀ (21.13), T₁ (21.11) followed by T₂ (20.04), T₃ (19.96). Therefore, the difference was significant, indicating significant effect of treatment on fat percentage. The difference between the mean values of T₀ - T₁ (0.02) was smaller than the C.D. value, 0.30; Therefore, the difference was significant.

The difference between the mean values of $T_0 - T_2$ (1.09) was greater than the C.D. value, 0.30; Therefore, the difference was significant. The difference between the mean values of $T_0 - T_3$ (1.17) was greater than the C.D. value, 0.30; Therefore, the difference was significant. The difference between the mean values of $T_1 - T_2$ (1.07) was greater than the C.D. value, 0.30; Therefore, the difference was significant. The difference between the mean values of $T_1 - T_3$ (1.15) was greater than the C.D. value, 0.30; Therefore, the difference was significant. The difference between the mean values of $T_2 - T_3$ (0.08) was smaller than the C.D. value, 0.30; Therefore, the difference was significant. Sameen *et al.* (2008), who reported 21–25, 18.79, 20.0 and 17.13% fat in mozzarella cheese, respectively.

Organoleptic characteristics of mozzarella cheese

Flavour and taste in control & experimental mozzarella cheese

The data regarding flavour and taste score in mozzarella cheese in different treatment are presented in table 5.

From the perusal of data on flavor and taste score in mozzarella cheese sample of different treatment and control the highest mean flavour and taste score was recorded in the mozzarella cheese sample of T_0 (7.77) followed by T_2 (7.70), T_3 (7.55) and T_1 (7.52). Therefore, the difference was significant, indicating significant effect of treatment of flavour and taste score.

Colour and appearance in control and experimental mozzarella cheese

The data regarding colour & appearance score in mozzarella cheese incorporation sample of different treatment are presented

in table 6.

From the present of data on colour & appearance score in mozzarella cheese sample of different treatment and control the highest mean colour and appearance score recorded in the mozzarella cheese of T_0 (8), T_1 (8), T_2 (8), T_3 (7.25). Therefore, the difference was non –significant, indicating no significant effect of treatment on colour and appearance score, which may be ascribed to addition of different level of mozzarella cheese treatment. The results of present study are in line with the results of Matzdorf *et al.* (1994).

Body and texture in control and experimental mozzarella cheese

The data regarding body and texture score in mozzarella cheese sample of different treatment are presented in table 7.

From the perusal of data on body and texture score in mozzarella cheese sample of different treatment and control highest mean body and texture score was recorded in the mozzarella cheese sample of T_0 (8), followed by T_2 (8) by T_1 (7), T_3 (7). The difference between the mean values of $T_0 - T_1$ (0.54) was greater than C.D. value, 0.40. Therefore, the difference was non-significant. The difference between the mean values of $T_0 - T_2$ (0.54) was greater than C.D. value, 0.40. Therefore, the difference was non-significant. The difference between the mean values of $T_0 - T_3$ (0.0) was smaller than C.D. value, 0.40. Therefore, the difference was non-significant. The difference between the mean values of $T_1 - T_2$ (0.69) was greater than C.D. value, 0.40. Therefore, the difference was non-significant. The difference between the mean values of $T_1 - T_3$ (0.15) was smaller than C.D. value, 0.40. Therefore, the difference was non-significant. The difference between the

mean values of $T_2 - T_3$ (0.15) was smaller than C.D. value, 0.40.

Percentage total solid in mozzarella cheese

The data regarding total solid percentage in mozzarella cheese sample of different treatment are present in table 8.

From the perusal of data on total solid in mozzarella cheese incorporation with mozzarella cheese sample of different treatment and control the highest mean total solid percentage was recorded in the mozzarella cheese sample T_3 (50.55) followed by T_2 (49.58), T_1 (48.54), T_0 (46.04). The difference between the mean values of $T_0 - T_1$ (3.33) was greater than the C.D. value, 0.59. Therefore, the difference was significant. The difference between the mean values of $T_0 - T_2$ (2.66) was greater than the C.D. value, 0.59. Therefore, the difference was significant.

The difference between the mean values of $T_0 - T_3$ (1.97) was greater than the C.D. value, 0.59. Therefore, the difference was significant. The difference between the mean values of $T_1 - T_2$ (0.67) was greater than the C.D. value, 0.59. Therefore, the difference was significant. The difference between the mean values of $T_1 - T_3$ (1.36) was greater than the C.D. value, 0.59. Therefore, the difference was significant. The difference between the mean values of $T_2 - T_3$ (1.36) was greater than the C.D. value, 0.59. Therefore, the difference was significant.

Percentage stretch ability in mozzarella cheese

The data regarding stretch ability percentage in mozzarella cheese sample of different treatment are percentage in table 9.

From the perusal of data on stretch ability percentage in mozzarella cheese incorporation with mozzarella cheese samples of different treatment and control the highest mean total stretch ability was recorded in the mozzarella cheese sample of T_0 (163.0), followed by T_1 (71.0), T_2 (52.40), T_3 (40.80). The difference the mean values of $T_0 - T_1$ (92) was greater than the C.D. value, 4.44. Therefore, the difference was significant.

The difference the mean values of $T_0 - T_2$ (110.6) was greater than the C.D. value, 4.44. Therefore, the difference was significant. The difference the mean values of $T_0 - T_3$ (122.2) was greater than the C.D. value, 4.44. Therefore, the difference was significant. The difference the mean values of $T_1 - T_2$ (18.58) was greater than the C.D. value, 4.44.

Therefore, the difference was significant. The difference the mean values of $T_1 - T_3$ (30.2) was greater than the C.D. value, 4.44. Therefore, the difference was significant. The difference the mean values of $T_2 - T_3$ (11.6) was greater than the C.D. value, 4.44. Therefore, the difference was significant.

Percentage yield in mozzarella cheese

The data regarding yield percentage in mozzarella cheese sample different treatment are present in table 10.

From the perusal of data on yield percentage in mozzarella cheese incorporation with mozzarella cheese sample of different treatment and control the higher mean total yield was recorded in the mozzarella cheese sample T_3 (10.22) followed by T_2 (9.98), T_1 (9.92) and T_0 (9.56).

Table.1 Average of data of chemical, microbiological and organoleptic analysis in control and experimental mozzarella cheese

Parameters	Treatments				C.D. Value
	T ₀	T ₁	T ₂	T ₃	
1. Chemical analysis of mozzarella cheese					
Total solids %	45.28	48.12	49.5	50.85	0.59
Acidity %	0.68	0.75	0.73	0.72	NS
Moisture %	54.72	51.92	50.4	49.15	0.83
Fat %	21.34	21.05	20.00	19.67	0.30
Stretchability (cm.)	165	75	55	40	4.44
Yield %	10	10.5	9.3	10.2	NS
2. Organoleptic score (9 point hedonic scale)					
Colour& appearance	8	8	8	7.25	NS
Body and texture.	8	7	8	7	0.40
Flavour& taste	7.12	7.12	7.86	7.86	NS
4. Microbial analysis					
Coliform	NI	NI	NI	NI	

Table.2 Average of moisture control for experimental mozzarella cheese

Treatment	R1	R2	R3	R4	R5	Total	Mean	Range
T0	54.72	53.92	54.25	53.75	53.15	269.79	53.96	54.72-53.15
T1	51.92	51.56	50.95	51.85	51.05	257.33	51.47	51.92-50.95
T2	50.4	50.25	50.85	50.35	50.25	252.10	50.42	50.85-50.04
T3	49.15	49.25	49.65	49.35	49.85	247.25	49.45	49.85-49.15
CD at 5 %							0.590	

Table.3 Average percentage acidity in control and experimental mozzarella cheese

Réplications	Treatments			
	T ₀	T ₁	T ₂	T ₃
R1	0.68	0.726	0.716	0.708
R2	0.69	0.752	0.735	0.726
R3	0.72	0.708	0.726	0.735
R4	0.735	0.726	0.716	0.708
R5	0.69	0.756	0.736	0.715
Total	3.52	3.67	3.63	3.59
Mean	0.70	0.73	0.73	0.72
Range	0.735 - 0.68	0.756 - 0.708	0.736 - 0.716	0.735 - 0.708

Coefficient of Variation = 2.490

Table.4 Average percentage fat in control and experimental mozzarella cheese

Réplifications	Treatments			
	T ₀	T ₁	T ₂	T ₃
R1	21.34	21.05	20.1	19.67
R2	20.95	21.09	20.2	19.75
R3	20.67	21.01	20.17	19.34
R4	21.34	21.35	19.75	19.67
R5	21.34	21.05	20	19.98
Total	105.64	105.55	100.22	98.41
Mean	21.13	21.11	20.04	19.96
Range	21.34 – 20.67	21.35 – 21.01	20.17 – 19.75	19.98 – 19.34

Coefficient of Variation = 0.27; CD at 5% = 0.30 (Mean value of each treatment)

Table.5 Average of flavor and taste score in control and experimental mozzarella cheese

Réplifications	Treatments			
	T ₀	T ₁	T ₂	T ₃
R1	7.12	7.12	7.87	7.87
R2	8	8	8	8
R3	8	7.3	7.7	7.5
R4	8	7.7	7.3	7.3
R5	7.75	7.5	7.62	7.1
Total	38.87	37.62	38.49	37.77
Mean	7.77	7.52	7.70	7.55
Range	8 – 7.12	8 – 7.3	8 – 7.3	8 – 7.1

Coefficient Variation = 4.143

Table.6 Color and appearance score in control and experimental mozzarella cheese

Replication	Treatments			
	T ₀	T ₁	T ₂	T ₃
R1	8	8	8	7.25
R2	8	8	8	8
R3	8	8	8	8
R4	8	8	8	8
R5	8	8	7.75	8
Total	40.00	40.00	39.75	39.25
Mean	8	8	7.95	7.85
Range	8 – 8	8 – 8	8 – 7.75	8 – 7.25

Coefficient of Variation = 2.275

Table.7 Average of body and texture control and experimental mozzarella cheese

Réplifications	Treatments			
	T ₀	T ₁	T ₂	T ₃
R1	8	7	8	7
R2	8.12	7.75	7.75	7.36
R3	8	7.5	7.2	7.7
R4	8.5	8.2	7.8	7.75
R5	8.12	7.62	7.3	7.5
Total	40.74	38.07	38.05	37.32
Mean	8.15	7.61	7.61	7.46
Range	8.12 – 8	8.2 – 7	8 – 7.2	7.75 – 7

CD at 5%= 0.40 (Mean value of each treatment)

Table.8 Average percentage total solid in control and experimental mozzarella cheese

Treatment	R1	R2	R3	R4	R5	Total	Mean	Range
T0	45.28	46.08	45.75	46.25	46.85	230.21	46.04	45.28-46.85
T1	48.12	48.44	49.05	48.15	48.95	242.71	48.54	48.12-49.05
T2	49.6	49.75	49.15	49.65	49.75	247.90	49.58	49.6-49.75
T3	50.85	50.75	50.35	50.65	50.15	252.75	50.55	50.15-50.85
CD at 5%							0.59	

Table.9 Average percentage stretchability in control and experimental mozzarella cheese

Réplifications	Treatments			
	T ₀	T ₁	T ₂	T ₃
R1	165	75	55	40
R2	170	70	52	42
R3	160	65	50	40
R4	165	75	55	40
R5	155	70	50	42
Total	815	355	262	204
Mean	163.00	71.00	52.40	40.80
Range	170 – 155	75 – 65	55 – 50	42 – 40

CD at 5%= 4.44 (Mean value of each treatment)

Table.10 Average percentage yield in control and experimental mozzarella cheese sample

Treatment	R1	R2	R3	R4	R5	Total	Mean	Range
T0	10	8.3	9.52	10	10	47.82	9.56	10-8.3
T1	10.5	10	9.7	10.1	9.3	49.60	9.92	10.5-9.7
T2	9.3	10.3	10	9.8	10.5	49.90	9.98	10.5-9.3
T3	10.2	10	10.5	10.2	10.2	51.10	10.22	10.2-10

Table.11 Percentage coli form count (10^{-1}) cfu/ml of control and experimental mozzarella cheese showing the average for coli form of experiment in mozzarella cheese

Replication	Treatments			
	T0	T1	T2	T3
R1	Nil	Nil	Nil	Nil
R2	Nil	Nil	Nil	Nil
R3	Nil	Nil	Nil	Nil
R4	Nil	Nil	Nil	Nil
Total	Nil	Nil	Nil	Nil
Mean	Nil	Nil	Nil	Nil
Range	Nil	Nil	Nil	Nil

(G –ve =Gram negative bacteria)

Microbiological characteristics of mozzarella cheese

Coli form test in control and experimental in mozzarella cheese

It may be pointed at that none of sample of mozzarella cheese in different treatment showed presence of coli forms. Then between are (Gram negative bacteria) and non spore forma presence of strict hygienic which shows sewage contamination but the absence of these in samples showed that procedure was observed during mozzarella cheese. It is evident from the table the coli form count of experimental sample were 100 percent negative (Table 11).

It was concluded that from the treatments that T₁ was stretching in different time and temperature (40°C for 5min.) showed better quality as compared to other treatment. Treatment T₁ showed highest fat percentage as compared to other treatment. Treatment T₃ showed highest total solid percentage (50.85) followed by T₂ (49.5), T₁ (48.12), T₀ (45.28). T₁ showed highest moisture, fat, yield. Overall acceptability was higher of T₁ as compared to other treatment.

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