



## Original Research Article

### Effect of Microwave Stretching on Quality Attributes of Mozzarella Cheese

Kaushal Kishor<sup>1</sup>, Avinash Singh<sup>1</sup>, Anoop Singh<sup>1</sup>, Mukesh Kandpal<sup>1</sup> and Sandeep Rout<sup>2\*</sup>

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

<sup>2</sup>SOFE, SHIATS, Allahabad-211007, U.P., India

\*Corresponding author

#### A B S T R A C T

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 T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> 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 T<sub>1</sub> (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 T<sub>1</sub> > T<sub>2</sub> > T<sub>3</sub>.

#### 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 T<sub>0</sub> - Mozzarella cheese (stretching at 80°C in hot water), T<sub>1</sub> - Mozzarella cheese (stretching at 40°C in microwave for 5 min), T<sub>2</sub> - Mozzarella cheese (stretching at 40°C in microwave for 7 min), T<sub>3</sub> - 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 H<sub>2</sub>SO<sub>4</sub> 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 T<sub>0</sub> (53.96), T<sub>1</sub> (51.47), followed by T<sub>2</sub> (50.42), T<sub>3</sub> (49.45). The difference between the mean values of T<sub>0</sub> - T<sub>1</sub> (2.49) was greater than the C.D. value, 0.590 Therefore, the difference was significant. The difference between the mean values of T<sub>0</sub> - T<sub>2</sub> (3.54) was greater than the C.D. value, 0.590. Therefore, the difference was significant. The difference between the mean values of T<sub>0</sub> - T<sub>3</sub> (1.05) was greater than the C.D. value 0.590. Therefore, the difference was significant. The difference between the mean value of T<sub>1</sub>

-T<sub>2</sub> (4.50) was greater than the C.D. value 0.590. Therefore, the difference was significant. The difference between the mean value of T<sub>1</sub> - T<sub>3</sub> (2.02) was greater than the C.D. value, 0.590. Therefore, the difference was significant. The difference between the mean value of T<sub>2</sub> - T<sub>3</sub> (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 T<sub>3</sub> (0.72) followed by T<sub>2</sub> (0.73), T<sub>1</sub> (0.73) and T<sub>0</sub>(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 T<sub>0</sub> (21.13), T<sub>1</sub> (21.11) followed by T<sub>2</sub> (20.04), T<sub>3</sub> (19.96). Therefore, the difference was significant, indicating significant effect of treatment on fat percentage. The difference between the mean values of T<sub>0</sub> - T<sub>1</sub> (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 <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |            |
| 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

| Réplifications | Treatments     |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
|                | T <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| 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

| Réplications | Treatments     |                |                |                |
|--------------|----------------|----------------|----------------|----------------|
|              | T <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| <b>R1</b>    | 21.34          | 21.05          | 20.1           | 19.67          |
| <b>R2</b>    | 20.95          | 21.09          | 20.2           | 19.75          |
| <b>R3</b>    | 20.67          | 21.01          | 20.17          | 19.34          |
| <b>R4</b>    | 21.34          | 21.35          | 19.75          | 19.67          |
| <b>R5</b>    | 21.34          | 21.05          | 20             | 19.98          |
| <b>Total</b> | 105.64         | 105.55         | 100.22         | 98.41          |
| <b>Mean</b>  | 21.13          | 21.11          | 20.04          | 19.96          |
| <b>Range</b> | 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

| Réplications | Treatments     |                |                |                |
|--------------|----------------|----------------|----------------|----------------|
|              | T <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| <b>R1</b>    | 7.12           | 7.12           | 7.87           | 7.87           |
| <b>R2</b>    | 8              | 8              | 8              | 8              |
| <b>R3</b>    | 8              | 7.3            | 7.7            | 7.5            |
| <b>R4</b>    | 8              | 7.7            | 7.3            | 7.3            |
| <b>R5</b>    | 7.75           | 7.5            | 7.62           | 7.1            |
| <b>Total</b> | 38.87          | 37.62          | 38.49          | 37.77          |
| <b>Mean</b>  | 7.77           | 7.52           | 7.70           | 7.55           |
| <b>Range</b> | 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 <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| <b>R1</b>    | 8              | 8              | 8              | 7.25           |
| <b>R2</b>    | 8              | 8              | 8              | 8              |
| <b>R3</b>    | 8              | 8              | 8              | 8              |
| <b>R4</b>    | 8              | 8              | 8              | 8              |
| <b>R5</b>    | 8              | 8              | 7.75           | 8              |
| <b>Total</b> | 40.00          | 40.00          | 39.75          | 39.25          |
| <b>Mean</b>  | 8              | 8              | 7.95           | 7.85           |
| <b>Range</b> | 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 <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| <b>R1</b>      | 8              | 7              | 8              | 7              |
| <b>R2</b>      | 8.12           | 7.75           | 7.75           | 7.36           |
| <b>R3</b>      | 8              | 7.5            | 7.2            | 7.7            |
| <b>R4</b>      | 8.5            | 8.2            | 7.8            | 7.75           |
| <b>R5</b>      | 8.12           | 7.62           | 7.3            | 7.5            |
| <b>Total</b>   | 40.74          | 38.07          | 38.05          | 37.32          |
| <b>Mean</b>    | 8.15           | 7.61           | 7.61           | 7.46           |
| <b>Range</b>   | 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 <sub>0</sub> | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> |
| <b>R1</b>      | 165            | 75             | 55             | 40             |
| <b>R2</b>      | 170            | 70             | 52             | 42             |
| <b>R3</b>      | 160            | 65             | 50             | 40             |
| <b>R4</b>      | 165            | 75             | 55             | 40             |
| <b>R5</b>      | 155            | 70             | 50             | 42             |
| <b>Total</b>   | 815            | 355            | 262            | 204            |
| <b>Mean</b>    | 163.00         | 71.00          | 52.40          | 40.80          |
| <b>Range</b>   | 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 T<sub>1</sub> was stretching in different time and temperature (40°C for 5min.) showed better quality as compared to other treatment. Treatment T<sub>1</sub> showed highest fat percentage as compared to other treatment. Treatment T<sub>3</sub> showed highest total solid percentage (50.85) followed by T<sub>2</sub> (49.5), T<sub>1</sub> (48.12), T<sub>0</sub> (45.28). T<sub>1</sub> showed highest moisture, fat, yield. Overall acceptability was higher of T<sub>1</sub> as compared to other treatment.

### References

- A.O.A.C., 1984. Official methods of analysis, 14<sup>th</sup> edn. Association of Official Agricultural Chemists Inc., Arlington, V.A.
- Chandel, S.R.S. 1991. A handbook of agriculture statistics, 8th edn, Anchal Prakashan, Kanpur.
- Fox, P. F., Guinee, T.P., Cogan, T.M., McSweeney, P.L.H. 2000. Fundamentals of cheese Science. Aspen Publishers, Inc., Gaithersburg, MD.
- ICAR, 1972. A manual of dairy chemistry. ICAR, New Delhi.
- Matzdorf, B., Cuppett, S.L., Keeler, L.J., Hutkins, R.W. 1994. Browning of temperature of mozzarella cheese during high pizza baking. *J. Dairy Sci.*, 77: 2850–2853.
- Sameen, A.A., Muhammad, F., Huma, N., Nawaz, H. 2008. Quality evaluation of mozzarella cheese from different milk sources. *Pak. J. Nutr.*, 7: 753–756.