CHAPTER 1
INTRODUCTION

1.1 Background
Cheese, a highly nutritious and palatable food, is of significant value in the diet because it contains almost all of the protein, essential minerals, vitamins and other nutrients of milk. Cheese was made as far back as 7000 BC. Its origin date back to ancient times when travelers from Asia are believed to have brought the art of cheese making to Europe. According to an ancient legend, the first cheese was accidentally made by an Arabian merchant who carried his milk in a pouch made from sheep’s stomach as he set out on a day’s journey across the desert. The rennet in the lining of the pouch combined with the heat of the sun caused the milk to separate into curd and whey. That night he found that the whey satisfied his thirst and the cheese (curd) had a delightful flavor which satisfied his hunger. There are numerous references to cheese making in the Bible while the writings of Homer and Aristotle indicate that cheese was made from the milk of cows, goats, sheeps, mares and asses.

Raw milk held at high ambient temperature in tropical countries like India has a shelf life from 2-3 hrs up to 24 hrs in refrigerated conditions. Cheese however has a shelf life from 4-5 days up to one year depending on the variety. Cheese there for provide an ideal vehicle for preserving the valuable nutrients in milk and making them available throughout the year. Cheese is primarily used for its organoleptic contributions to a food, but it also provides functionality and nutrition to various foods. Cheese is an excellent source of protein, fat and minerals such as calcium and phosphorous, vitamins and essential amino acids and therefore is an important food in the diet of both young and adolescent, convalescent and those who want to put on weight.

As an ingredient in foods, cheese is required to exhibit functional characteristics in the raw (e.g. sliceability, shreddability, grateability) and cooked (e.g. flowability, mouthfeel, flavour and/or stretchability) forms. There is a growing demand for cheeses and/or cheese toppings with customized functional attributes in the pizza, burger, and sandwich trade. Since cheese is an integral part of food products, it is becoming
increasingly important for cheese manufacturers to produce their cheese according to the functionalities required for the end use.

Cheese is made in almost every country of the world and there exist more than 2000 varieties. Despite the large number of varieties cheese may be classified in two broad categories: 1) Natural and 2) Processed. Natural cheese is the fresh or ripened product obtained from the acid, rennet or mixed coagulation of whole or partially skimmed milk. Natural cheese is produced by culturing of milk to form a cheese curd; through a series of steps to remove moisture, this curd becomes the finished cheese. However processed cheese begins with natural cheese that is blended with water, stabilizer and other components. Processed cheese is cooked to form a uniform product that is sold in slice, cubes or loaves. Natural cheese is most often classified according to moisture content (table 1) with the higher moisture content of the cheese correlated with a shorter shelf-life. Very high moisture cheeses such as cream and cottage are not aged and, thus are often called “fresh or unripened cheese”.

**Table 1 Classification of Cheese**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Moisture (%)</th>
<th>Cheese Texture</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Moisture</td>
<td>13-34</td>
<td>Very Hard</td>
<td>Parmesan and Romano</td>
</tr>
<tr>
<td>Medium Moisture</td>
<td>34-45</td>
<td>Hard</td>
<td>Cheddar, Swiss, Edam</td>
</tr>
<tr>
<td>High Moisture</td>
<td>45-55</td>
<td>Soft</td>
<td>Mozzarella, Blue, Brie</td>
</tr>
<tr>
<td>Very High Moisture</td>
<td>55-80</td>
<td>Very Soft</td>
<td>Cottage, Cream, Ricotta</td>
</tr>
</tbody>
</table>

Italy is the principal producer of a unique family of cheeses – the Pasta filata, of which Provolone, Caciocavallo, Scamorza and Mozzarella are the best known members. Pasta filata cheeses are distinguished by a unique plasticizing and kneading treatment of the curd in hot water, which imparts to the finished cheese its characteristics fibrous structure, and melting and stretching properties (Battistotti and Corradini, 1993).

1.2 **Mozzarella production**

Low moisture part skim (LMPS) Mozzarella finds more application than traditional Mozzarella on pizza because of its better slicing qualities. LMPS has a moisture content of 45.0 to 52.0 per cent and fat on dry matter (FDM) content of 30.0 to
45.0 per cent, as compared to 52.0 to 60.0 per cent moisture and 45.0 per cent FDM in Mozzarella.

Italian cheese variety production in US was 4.74 billion pounds in 2013 which is 2.2 percent above 2012 production (USDA NASS, 2014); this constitutes 42.7 per cent of the total cheese produced (USDA, 2014). The average per capita consumption of cheese in US was 24.5 pounds in 2012 (ICUSD, 2012). Cheddar and Mozzarella cheese accounting for 2/3 of total per capita consumption. Mozzarella accounted for 78.1 per cent of the Italian cheese varieties produced in United States in 2013. Over 75.0 per cent of all Mozzarella produced in the US was used for pizza (Alvarez, 1985). The dramatic growth in the consumption of pizza cheese in recent years highlights the importance of functionality as a major driving force in augmenting global cheese consumption.

Production of Mozzarella and pizza cheese increased over 35.0 per cent compared to total Canadian cheese production, which rose at only 11.0 per cent during 1990-1996 (www.4.agr.gc.ca).

With regard to Indian scenario, the total cheese production in India was only 7500 tonnes annually (www.foodindustryindia.com; www.icfdc.com). The per capita consumption of cheese was about 0.0037 Kg in 1994 (Sorensen, 1995). The cheese market is growing at the rate of 20.0 per cent per annum (Infoquest, 2003).

Cheese is gradually becoming popular among Indian populace on account of an increase in the purchasing power, change in lifestyle, more number of working women, growing awareness about the nutritional value of cheeses and above all, the introduction of fast food chains – pizza huts, US pizza, Amul pizza, etc. The major players in this category are Domino's, Pizza Hut and Pizza In. Gujarat Co-operative Milk Marketing Federation Limited – Amul's marketing organization has launched over 3,000 pizza retail franchise outlets all over India, in which they are selling frozen pizza with Mozzarella cheese topping.
1.3 Pizza Boom

The hungry citizens of US eat 350 slices of pizza a second, or 400 acres (17.4 million square feet) per day. As an industry in the US, pizza tops $30 billion. The country’s 69,000 pizzerias make up 17.0 per cent of all restaurants. The nation eats 3 billion pizzas in a year; 93.0 per cent of Americans eat at least one pizza per month. That makes 23 pounds (including the toppings) of pizza a year. If the end user of cheese is seeking a specific shred, melt, stretch, blister, colour, flavour or texture, cheese manufacturers have the challenge of customizing their product to fit the application.

1.4 Cheese analogues

Cheese analogues are the products made by processed cheese technique out of dairy, partial dairy or even non-dairy ingredients, which tend to resemble the particular natural cheese variety. As the taste and flavour do not seem comparable to those of natural cheeses, imitation products are mainly used in the catering industry and in the processing sector, for instance, in preparation of pizza, sandwich, burger and prepared dishes. Its lack of flavour can be boosted by permitted additives (Mc Carthy, 1990).

The annual production of cheese analogues stood at ~ 3,00,000 and 10,000 tonnes respectively in the US and UK in 1990 (Mc Carthy, 1990). Compared to the USA, the European market is relatively small (i.e. 20,000 tonnes). The sales of imitation cheese in the US are stabilizing at ~ 7.0 per cent; 3.0 per cent in Sweden; 1.0 per cent in UK and in Europe, the corresponding figure is less than 2.0 per cent (Mc Carthy, 1990; Schelhaas, 1993).

The growing gap between the demand and production of cheese has necessitated production of cheese analogues. Currently, the cheese analogues are assuming much greater significance (Holdt, 1992; Sorensen, 1995), and its production in India, in the near future, seems lucrative owing to:

(a) Cost considerations

The cost of natural cheese is relatively higher compared with the cheese substitutes/analogue. By substituting the higher priced milk with lower priced casein and by using some low cost ingredients (e.g. maltodextrin, starch, vegetable fat/oil), the analogue cheese can be prepared to have low cost so that it could be affordable to even the low-income group, generating more market.
(b) Health and nutritional concern

The cheese analogues can be formulated to make it more healthful as well as with higher nutritive value by enrichment with vital vitamins, mineral mixtures and even probiotics. Milk fat may be substituted with polyunsaturated fats containing vegetable oils to claim ‘cholesterol-free’ product. Even the dairy fat can be curtailed to produce ‘low or reduced calorie pizza cheese’. Moreover, ‘lactose-free’ cheese can also be prepared for people suffering from ‘lactose intolerance’.

(c) Extending shelf life and superior functional properties

The natural Mozzarella cheese has a storage life expectancy of about 4-5 weeks at refrigerated temperature. Moreover, the desirable functional properties of cheese for its end use on pizza are attainable only after a week or so of storage.

On the other hand, MCA can be produced which has inherent functional properties even in the freshly prepared product; the functional properties are also claimed to be quite stable during its refrigerated storage (Kiely et al., 1991a,b). Even the shelf life of imitation cheese has been claimed to be superior to that of conventional cheese (Anon., 1976).

(d) Consistent quality of cheese

Analogue cheeses can be produced having more consistent quality as against natural cheese, which may vary in composition and texture due to seasonal variation in the milk quality.

(e) Balancing the supply of natural cheese

In some parts of the world, where milk production is insufficient, the cheese analogues can be made using imported shelf stable dairy and non-dairy (vegetable origin) ingredients, fulfilling the requirement of cheeses. The imitation cheese can help in extending the supply of natural cheese. To cite an example, USDA permits combination of imitation cheese with natural and processed cheese at levels up to 50.0 per cent in cooking applications to be served at school lunch program.

(f) Part substitution of Mozzarella cheese with Mozzarella cheese analogue

A growing trend in the pizza industry is the use of non-Mozzarella cheeses such as Cheddar or processed as complete or partial replacements for Mozzarella cheese on pizza pie. Such replacement of Mozzarella with other cheeses may lead to substantial changes in the melted consistency and oiling-off properties of pizza cheese (Kiely et al., 1992). In this context, part substitution of Mozzarella cheese with MCA, which has
properties quite close to, that of pure Mozzarella, will ensure that the blend meets the end use specifications.

(g) Rationalization of the manufacturing process

The Mozzarella cheese obtained by conventional method (starter culture technique) is very time consuming (7-8 h including brining), necessitates careful control (skill) in its manufacture and involves considerable losses of milk solids (TS recovery is about 53.0-54.0 per cent), especially in the plasticizing water. The cheese analogue can be made in a shorter period (1-1.5 h) with reduced labour requirement; may eliminate the use of starter culture (tedious to maintain), reduces the extent of skill involved because of the simplified procedure, makes composition control easier and practically involves no losses of milk solids.

(h) Opportunity for development of new products

The production of cheese analogues may emerge as a result of the efforts by the industry to develop new products. Manufacture of cheese analogue can help in developing product having ‘tailor-made properties’ as per the specifications dictated by the pizza retailers. Even products can be prepared to have superior nutritional as well as shelf stable properties.

In India, a successful attempt has been made in developing MCA based on acid casein and vegetable oil/fat blend taking help of emulsifying salts (Jana, 1998) and rennet casein and speciality fat (Sharma, 2012). However, the flavour of the MCA was not up to the mark. Natural cheese may be added at low levels (e.g. 5.0 per cent) to impart cheesy flavour or to comply with a particular customer specification. A processed cheese type food has been developed using rennet casein and white butter at National Dairy Research Institute, Karnal (Varghese and Sachdeva, 2002). The method of manufacture of cheese analogues in advanced dairying countries is invariably patented and hence much detail about manufacture and quality characteristics of cheese analogues are not available in scientific literature. No attempt has been made in India to develop an entirely dairy based MCA using rennet casein and dairy cream.

It was contemplated that use of non dairy fat in the form of vegetable oil would render the MCA cost effective and having “cholesterol free” label and use of rennet casein would help in obtaining the desired texture normally associated with rennet cheese curd. Hence, it was envisaged to develop a method of preparing “Mozzarella
cheese analogue” using rennet casein as protein source and plastic cream as fat source along with other functional additives and cheese flavouring.

Accordingly, the study was planned and conducted with the following broad objectives:
1. To develop a tentative recipe for partial dairy Mozzarella cheese analogue.
2. To optimize the process parameter for manufacturing MCA of the defined composition.
3. To evaluate the effects of varying types and levels of selected ingredients on the quality of resultant cheese analogues.
4. To evaluate the composition, sensory characteristics and functional properties of cheese analogue of defined recipe.
5. To evaluate the acceptability of the cheese analogue in comparison to the traditional milk-based Mozzarella cheese (Natural Mozzarella Cheese).
6. To assess the cost-effectiveness of the Mozzarella cheese analogue.