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Research Article

EFFECT OF HYDROCOLLOIDS AS FAT REPLACER IN DEVELOPMENT OF LOW FAT MOZZARELLA CHEESE

Waqas Ahmad[1], Muhammad Shahbaz[1]*, Shamas Murtaza[1], Muhammad Amin[2]
[1]*Department of Food Science and Technology, MNS-University of Agriculture Multan*
[2]*Department of Horticulture, MNS-University of Agriculture Multan*
Corresponding author: shahbaz.ft@mnsuam.edu.pk

ABSTRACT

Cheese is the coagulated dairy product enriched with milk proteins, various minerals, vitamins and fat. Mozzarella cheese is white glossy soft, unripened cheese which contains 30-40% milk fat. Commonly 75% mozzarella cheese used as ingredient on pizza topping because of its stretching and melting characteristics but its high fat contents can cause serious health risks like cardiovascular problems and obesity. The current study was aimed to produce low fat mozzarella cheese by using hydrocolloid as fat substitute to overcome such health risks and quality defects on fat reduction. The prepared cheese was investigating the influence of hydrocolloid for its functional, proximate quality and sensory attributes of the developed product. The cheese was prepared at 2% fat level followed by the treatments used as @ 0.1%, 0.2%, and 0.3% levels of guar gum in 100 ml of milk. The results showed that the use of hydrocolloid affect significantly ($p<0.01$) the cheese composition, functionality, texture, sensory characteristics and yield. The composition of cheese increased while functional attributes and yield decreased significantly ($p<0.0.1$) on fat reduction. However, the increment of hydrocolloid improved these aspects with positive values on fat reduction. The control cheese samples showed the lower value of hardness while guar gum containing cheese had the higher hardness value that was deceased gradually on guar gum concentration. On sensory assessment full fat cheese awarded maximum scores then other treatments while the sample containing 0.1% guar gum was awarded comparable scores to full fat cheese. Hence, it was concluded that hydrocolloid particularly guar gum can effectively be used up to 0.1% to improve the quality defects of low fat mozzarella cheese.

Keywords: low fat, unripened cheese, biological properties, hydrocolloids

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1. INTRODUCTION

The presence of essential nutrients in milk considered to be the complete diet for all ages. Among the different countries, Pakistan ranks at the fourth position in milk production (Ajmal et al., 2015). The annual production of milk in Pakistan is estimated to be 56,080 million tonnes among which 20 % of the produced milk is wasted annually (GOP, 2017). Commonly milk is used in raw form and also converted into different value added products that are about 4% of the total milk production. Among the value added products cheeses are the very popular dairy product in the globe due to their multiple characteristics like nutrition, texture, flavor, taste and its functional properties (Murtaza et al., 2017).

In Pakistan buffalo milk is at the top rank with annual production of 34,122 million tonnes (GOP, 2017). It has promising research potential due to its nutritional

quality that offers remarkable prospects for fermented dairy products such as yoghurt and cheeses (Tahira et al., 2014; Murtaza et al., 2015). Several cheeses are available with unique characteristics (Falegan *et al.*, 2014). Among the different cheeses, mozzarella is known to be one of the most popular varity in the glob as it is being used primarily in pizza topping as an ingredient. Stretching and melting characteristics of mozzarella cheese makes it more popular as most of the people are using in which Italian cheese (80%) which collectively makes 32% of total cheese around the globe due to high in protein and its fat contents (Sattar et al., 2015).

Increased risks of cardiovascular problems due to its high fat contents can cause serious illness such as high cholesterol level, arthritis, memory loss, weight gain and obesity. Thus, to overcome such kind of risks low fat cheese is the healthy choice for consumers due to its different biological and nutritional properties. Fat reduction in cheese results in firm textured cheese that it takes longer melt and it is toughed those results in undesirable taste and flavor with reduced yield. Therefore, to minimize this issue, hydrocolloids are commonly used to enhance the stability of the low fat products (Rogers et al., 2010; Correll, 2011. Fat replacer is a low calories compound intentionally used in the place of natural fat. These are categorized as fat substitutes which are based on carbohydrates, protein and fat. They are recommended due to their hydrophilic nature.

Fat replacers are used to create fat mimetic role such as creaminess and lubricity in products (Madadlou et al., 2007). Hydrocolloids are one of the best fat replacer that are commonly applied in the food industry to improve the textural and functional properties of the food products (Totosaus *et al.*, 2008). These are extensively used in the dairy products as a fat mimetic to stabilize their structure, meltability, stretchability and textural characteristics of the desired food products (Simeone et al., 2004).

2. MATERIALS AND METHODS

This study was planned to produce low fat Mozzarella cheese by using hydrocolloid (guar gum) @ 0.1%, 0.2%, and 0.3% levels to improve the structural and functional properties of low fat cheese (milk fat 2%) as comparable to full fat cheese (4% milk fat level).

2.1 Preparation of Low fat Mozzarella cheese

Mozzarella cheese containing low fat contents was prepared after milk fat standardization using the method described by Sattar et al., (2015) with some modifications in order to incorporated hydrocolloid at 0.1%, 0.2% and 0.3% level of guar gum. Buffalo raw milk was purchased from locally established farm located on Vehari road Multan. The starter culture consisting on *Lactobacillus delbrueckii sp bulgaricus & Streptococcus thermophilus* and rennet enzyme (chymosin 500000 MCU/mL, Pifzer Inc, Milwaukee, WI, USA) used for cheese production procured from local distributor in Multan. Guar gum also procured from the local market of Multan.

Milk was pasteurized at 65°C after milk standardization at 2% and 4 % fat level followed by addition of guar gum as mentioned above. The milk was cooled at 40°C and added starter culture of *Lactobacillus delbrueckii sp bulgaricus & Streptococcus thermophilus* (Chr.Hansen company) at 1g/100L for 30 minutes of repining. After repining rennet was added at the amount of 2ml/1L milk for setting the curd. When the curd was consisted cut into cubes about one center meter cube in size. The cubes were cheddered and healed for 15 minutes at 45°C to drain the whey from the curd. After healing the curd was cooked and stretched at 45°C. The stretched cheese was molded into cube pack and stored at 6-8C for further analysis.

2.2 Analysis of cheese

2.2.1 Physiochemical analysis of low fat cheese

The cheese samples were analyzed for moisture by drying (AOAC, 926.08, 2000), pH was assesssed by pH meter (Ong et al., 2007), acidity by titration (AOAC, 920.124, 2000), protein by Kjeldhal (IDF, 2006), fat by Gerber method (Marshal, 1993) and ash content by igniting the cheese sample (AOAC No. 935.42 2000).

2.2.2 Functional Analysis

2.2.2.1 Meltability

Meltability of cheese was determined by compressing cheese samples in a graduated glass tube at 4°C for 4 hrs and heated at 110°C for 100 minutes. The sample was compressed in glass tube by plunger and the measurement was recorded using Vernier caliper scale (Zishu and Shah, 2007).

2.2.2.2 Stretch ability

Twenty gram cheese sample was taken in a cup and heated at 90ºC for 30 minutes and probe lowered in melted cheese and pulled and the distance extended by cheese strands was recorded in centimeters (Fife et al., 2002).

2.3 Textural analysis

Textural study of low fat mozzarella cheese sample was measured by performing the texture profile analysis according to protocol as mentioned by Zisu and Shah (2007). Cheese samples cut into 30 mm cubes using a stainless-steel cutter and equilibrated at 8°C for further 25 min and compressed immediately to 30% of original height in 2 consecutive cycles at a rate of 1 mm/s and reading was recorded as factor of hardness.

2.4 Sensory evaluation

The cheese was evaluated for sensory characteristics such as (Appearance, colour and flavour) using 9 point hedonic scale.

2.5 Yield calculation

The yield of LFMC was calculated by estimation of amount of cheese obtained by dividing the quantity of milk used for production of each sample according to protocol as adopted by Chatli et al., 2017.

2.6 Statistical Analysis

The data thus obtained was analyzed statistically by using two factorial Completely Randomized Designs (CRD) and ANOVA techniques Steel et al. (1997).

3. RESULTS

3.1 Influence of hydrocolloids on approximate attributes of low fat mozzarella cheese

The effect of hydrocolloids on all physicochemical attributes of mozzarella cheese containing low fat contents showed significant effect ($p<0.01$). The parameters such as moisture, fat, protein, ash, pH and acidity of low fat cheese samples were in the range 47.49-52.07%, 9.42-17.53%, 25.37-29.15%, 3.37-3.42%, 5.25-5.35 and 0.85-0.94% respectively (Table 1). The use of guar gum in the development of cheese containing low fat contents results higher the amount of moisture, fat and protein contents than control treatment while pH and acidity were no significant ($p<0.05$) increase or decrease.

3.2 Functional analysis

Functional analysis of the cheese has a vital role in their melting and stretching properties that are directly linked with rheological system of the product. Fat reduction results significant effect ($p<0.01$) on all the treatments of the cheese contain low fat contents as described (Table 2). The meltability and stretchability of low fat cheese was in the range of 49.35-56.4mm and 35.35-47.42mm, respectively in (Table 2). The present study depicted that the use of guar gum at 0.1% level improves the quality of the low fat mozzarella cheese other than control treatments such as 0.2% and 0.3% level of guar gum which in accordance with the previous findings of Sattar et al (2015).

3.3 Textural Attributes

The unique property of the cheese like textural analysis is influenced by the result of fat reduction. The textural attributes of the cheese are estimated by the protein to fat structural complex in which chemical composition of milk is very important.

Table.1 Mean values for physicochemical attributes

Treatment	Fat (%)	Moisture (%)	Protein (%)	Ash (%)	pH	Acidity (%)
C	17.533±0.09a	47.49±0.11c	25.37±0.10d	3.37±0.10a	5.25±0.03c	0.94±0.01a
GG0.1	9.427±0.09b	51.36±0.01b	29.15±0.08a	3.41±0.07a	5.35±0.01a	0.85±0.01d
GG0.2	9.460±0.08b	51.58±0.01a	28.96±0.07b	3.41±0.04a	5.26±0.01c	0.92±0.01c
GG0.3	9.467±0.10b	52.07±0.12a	27.72±0.11c	3.42±0.08a	5.31±0.01b	0.92±0.01b

C= Control
GG0.1= LFMC containing guar gum at 0.1% level
GG0.2= LFMC containing guar gum at 0.2% level
GG0.3= LFMC containing guar gum at 0.3% level

Table.2 Mean values for functional attributes

Treatment	Meltability (mm)	Strechability (cm)
C	56.40±0.01a	47.42±0.10a
GG0.1	47.46±0.01d	42.94±0.01b
GG0.2	48.42±0.01c	37.86±0.01c
GG0.3	49.35±0.01b	35.35±0.01d

C= Control
GG0.1= LFMC containing guar gum at 0.1% level
GG0.2= LFMC containing guar gum at 0.2% level
GG0.3= LFMC containing guar gum at 0.3% level

The results showed highest hardness in the treatment that contains 0.1% guar gum as illustrated below (Fig 1). During the present study the textural results regarding hardness

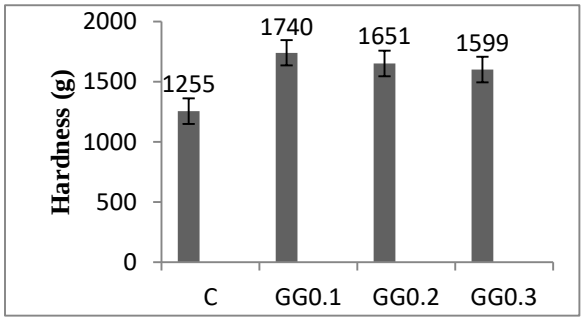

Figure 1. Effect of Hydrocolloids on Hardness of low fat mozzarella cheese

were significant ($p<0.01$) overall the treatments and the values were in the range of 1255 to 1740g that was decreased gradually with the use of level of guar gum effectively.

3.4 Sensory analysis

Keeping in view the significance of fat in appearance, color and flavor development, these three sensory parameters were analyzed in this study to explore the organoleptic profile of the cheese. Sensory analysis is the very important parameter for product evaluation after production and reflects ultimate product attributes of the food commodity. The current study was showed significant ($p<0.0.1$) results on all sensory parameters of the mozzarella chesses contain low fat contents. The sensory score rated in the range of 5.03 to 5.74 for appearance, 5.34 to 6.80 for color and 5.09 to 7.63 for flavor on the basis of hedonic scale in which control samples of cheese gained highest scores than others treatments but later on the treatment gained second highest scores is 0.1% level of guar gum as compared to 0.2% and 0.3% level of guar gum.

3.5 Cheese Yield

The study conducted by Verdier-Metz et al., (2001) stated that cheese is a concentrated

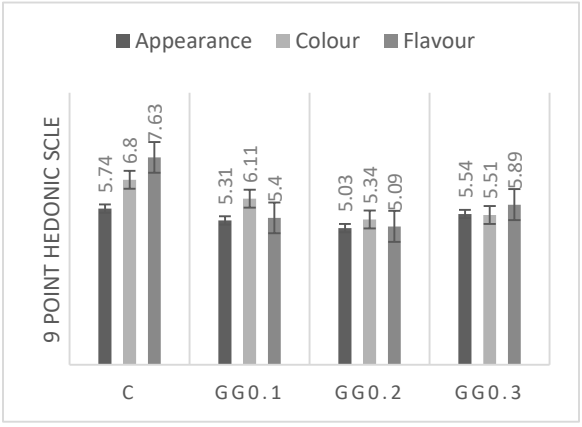

Figure 2. Effect of Hydrocolloid on Sensory attributes of Low Fat Mozzarella Cheese

C= Control, GG0.1= LFMC containing guar gum at 0.1% level, GG0.2= LFMC containing guar gum at 0.2% level, GG0.3= LFMC containing guar gum at 0.3% level

form of milk protein and fat which is directly linked to the cheese yield. When fat was reduced up to 50% then the yield of the cheese also decreased (Everett et al., 2004).

Figure 3 showed the significant ($p<0.01$) effect on all treatments. The cheese yield was in the range of 11.8 to 16.28.

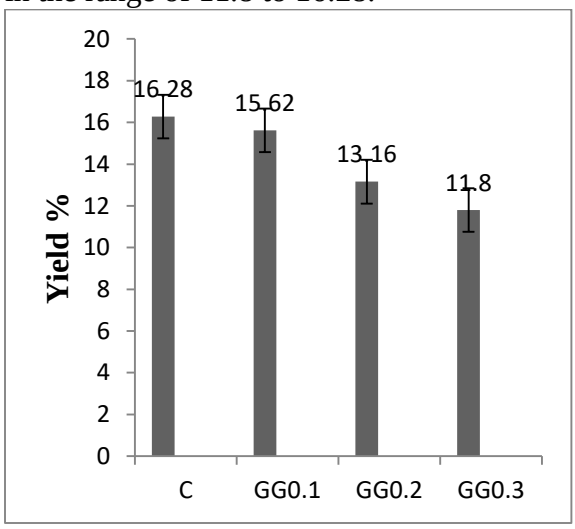

Figure 3. Effect of Hydrocolloid on Yield of Low Fat Mozzarella Cheese

C= Control
GG0.1= LFMC containing guar gum at 0.1% level
GG0.2= LFMC containing guar gum at 0.2% level
GG0.3= LFMC containing guar gum at 0.3% level

4. DISCUSSION

When fat level reduced up to 50% in milk the resultant cheese decrease significantly than controlled cheese sample. The use of hydrocolloids as fat replacer at different levels increases the composition of the cheese including moisture, protein, fat contents of low fat mozzarella cheese however; pH and acidity have no specific increase or decrease. The quality of raw material significantly influences the result of end product. The contents of moistures of the cheese increase with the increment of guar gum level due to water retention properties of guar gum (Rahimi et al., 2007). The presence of fat in milk products represents the softness, lubricity and creamy texture of the food product and it is increases with increment of guar gum due to its inverse relation with contents of moisture (Murtaza et al., 2016). The study conducted by Verdier-Metz et al., (2001) stated that cheese is a concentrated form of milk protein and fat which is directly linked to the cheese yield. The previous findings reported by Kavas *et al.,* (2004) and Koca and Metin, (2004) showed that the contents of protein of the cheese significantly increased with the addition of hydrocolloids. Ash analysis represents the ultimate inorganic contents of the food product. The contents of ash ultimately influence the quality of the food regarding minerals contents of the final food product attributes. Another conducted by (Sengul et al., 2006; Murtaza et al., 2017) found that ash is non significantly change in cheeses during storage and same results were found in our study. The pH in food commodity play a significant role for the execution the cheese making process and have ability to get desire texture and flavor of the final food products. It helps to measuring lactic acid level because lactic acid decreases the ph of the cheese during storage. In accordance with the previous finding (Sattar et al., 2015) in which confirmed that the acidity of low fat cheese decreases with increment the concentration of hydrocolloid. Meltability and stretchability indicates the functional behavior of the food product. The stretchability ultimately influences the functional properties of the cheese regarding its elasticity and length characteristics. Fat reduction in low fat cheese results poor functional defects including poor strechability and sensory (Mistry, 2001). The results found in the treatments regarding meltability and stretchability are highly significant in accordance with the previous research (Sattar et al., 2015) in which confirmed that the meltability and stretchability of low fat cheese increases with increment of concentration as described in (Table 2). Meltability is the term used in cheese characteristics in which it is spread and extend on heating. The results found in the treatments regarding meltability are highly significant in accordance with the previous finding (Nateghi et al., 2012) in which confirmed that the meltability of low fat cheese decrease with fat level decrease and it can be increased by increment of hydrocolloids (Hekken et al., 2007). Another

conducted by (Sameen et al., 2008) found that meltability is significantly increases in cheese sample with the addition of guar gum level and same results were found in present study. Fat replacer serves as lubricant that have ability to flow the protein and cheese flow on heating as explained by (McMahon et al., 1996).

The results found in the treatments regarding texture are highly significant in accordance with the earlier finding (Fenelon and Guinee, 2000) in which they confirmed that the hardness of low fat cheese decrese with increment of guar gum illustrated in (Fig. 1). The contents of moisture play a significant role in the cheese softness because it serves as a substance that bounded with protein matrix to retained water inside the matrix due to hygroscopic nature of hydrocolloid. In another study conducted by (Venugopal et al., 2001; Hennelly et al., 2006) found that hardness is significantly increased with addition of hydrocolloid and same results were found in present study.

The appearance, color and flavor of the food product ultimately influence the customer acceptances and marketing. The results found in the treatments regarding appearance are significant in accordance with the previous finding (Rudan et al., 1999) in which confirmed that the appearance of low fat cheese receives lower score as compared to full fat cheese. Intrinsic factors such as colorants, packaging and storage factors are responsible for the development of color characteristics in milk for cheese production. The results found in the treatments in accordance with the previous finding (Delwiche, 2004) in which confirmed that the color of low fat cheese significantly influenced. The control cheese sample scores were rated as more than low fat cheese the study was documented by (Deegan et al., 2013) which in accordance the result of present study. The results found in the treatments regarding sensory attributes of the cheese affected in accordance with the previous finding (Sahan et al., 2008) in which confirmed that the flavor of low fat cheese significantly influenced with the increment of hydrocolloid and also affected during the storage period.

Yield plays a significant role for the final product in terms of economic values. When fat was reduced up to 50% then the yield of the cheese also affected. The results found in the treatments in accordance with the previous finding (Murtaza et al., 2017) in which confirmed that the yield of low fat cheese significantly decreased with fat reduction and use of hydrocolloids resulted more yield as compared to control sample. It has been suggested that water can bind directly to fat replacers and the fat replacers can interfere with the shrinkage of the casein matrix. Therefore, this lowers the driving force involved in expelling water from curd particles (Rahimi et al., 2007).

5. CONCLUSIONS

At the end the research concluded that the treatment which showed the best results was 0.1% level of guar gum in overall the treatments. The results obtained through this study will be very helpful in further research work to explore the functions of hydrocolloids in different manners by various techniques and procedures to overcome such kind of quality defects in low fat dairy products.

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