

## THE EFFECT OF DIRECT ACIDIFICATION BY DIFFERENT ACIDULANTS ON THE PROPERTIES OF MOZZARELLA CHEESE

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### ABSTRACT

To study the effect of direct acidification either by using organic acids or natural source of these acids on the properties and quality of Mozzarella cheese, Lactic and acetic acids as organic acids and lemon, orange and pomegranate juice were used in direct acidification during Mozzarella cheese making and compared with that made by bio-acidification by starter bacteria as control treatment. Resultant cheese from all treatments and control were chemically, rheologically and microbiologically analyzed. Samples in three replicates were analyzed and the main of values was recorded. Results showed that, Mozzarella cheese made by direct acidification with lemon juice gained the best chemical, Rheological properties and high yield. Also, all treatments except which acidified with orange juice had good properties when compared with control Mozzarella cheese. Moreover, Mozzarella cheese made by pomegranate extract has good chemical and rheological properties but it wasn't appreciated to the judges. It was recommended from the previous results that the use of direct acidification in the Manufacture of mozzarella cheese to improve the rheological properties, reduced the processing time and increase the cheese yield. Finally, natural acidulants like lemon or some organic acids (acetic, lactic acid) can applied on the acidification and making of Mozzarella cheese with good and appreciated quality.

**Keywords:** mozzarella cheese, direct acidification, lemon juice, Pomegranate juice and orange juice.

### INTRODUCTION

Mozzarella cheese is a prominent member of the pasta filata, or stretched curd, cheese that originated in Italy. There are different legal standards for mozzarella cheese based on moisture and fat in dry matter (F/DM) content and maximum moisture content which are different from a country to another, (Jana and Upadhyay, 1991).

Acidification is one of the most important stages in cheese making which has assuring the desirable cheese curd and characteristics. Direct acidification technique for manufacture of cheese has gained considerable commercial interest as it does not rely on starter performance. The manufacture of mozzarella cheese using this technique has been attempted by many works Najafi *etal.*,(2006). Different types of acids have been used for preparation of mozzarella cheese. Breene *etal.*,(1964) used lactic acid or hydrochloric acid: Quarne *etal.*, (1968) used hydrochloric, phosphoric and lactic acids: Keller *etal.*, (1974) used phosphoric , acetic, hydrochloric, malic or citric acids: Patel *etal.*, (1985) used lactic acid whereas Dave *etal.*, (2003) used glucono-&- lactone. Najafi *etal.*, (2006)used lactic acid and citric acid to attain pH level of 5.3 ,5.6 and 5.8 to make mozzarella cheese. The type of acid used affected the solids not fat recovery whereas it had no effect on fat

recovery Quarne *et al.*, (1968). It also affected the curd characteristics, rate of curd formation, coagulation of milk from rennet action Breene *et al.*, (1964). Moisture content, mineral retention, rheological properties of cheese Keller *et al.*, (1974) and yield and elasticity Najafi *et al.*, (2006). Keller *et al.*, (1974) found that more hardness and least moisture content of mozzarella cheese was produced by using phosphoric acid while Mozzarella cheese produced by using citric and lactic acid had the high moisture content and was softer.

So, this work aims to evaluate the effect of direct acidification by organic acids and natural juice of lemon, orange and pomegranate on the properties of Mozzarella cheese.

## **MATERIALS AND METHODS**

Cow milk was obtained from Dairy Department, Faculty of Agriculture, Mansoura University, El-Mansoura, Egypt. Salt (NaCl): Commercial grade salt (NaCl) was purchased from the local market. Starters (*S. Thermophilus* and *L. delbrueckii* subsp. *bulgaricus*) obtained from CULTIVO LP France. Rennet: Local commercial liquid rennet was obtained from local market. It was added to the milk in a rate of 1 ml/kg milk. Acidulates: lactic acids and acetic acid were obtained from El-Gomhorea Chemicals Company. Natural juice lemon juice, orange juice, and Pomegranate juice were purchased from the local market. The above mentioned acidulates were directly added to the milk to pH 5.8.

Mozzarella cheese making: mozzarella cheese acidified by traditional yoghurt starter as control and other treatments which acidified with direct acidification by different acidulants were made as described by Kosikowski (1982). Fat content: The conventional Gerber's method was followed using the special butyrometer tubes for cheese as described by British Standard Institution's (B. S. I) Method (1955). Total solids were determined according to the British Standard Institution (B.S.I.) method (1955). Total protein was determined as described by Ling (1963).

pH value was measured by using a digital pH-meter Janway 3010 – England. 20grms of cheese sample was softened by mixing with the same amount of distilled water and the whole homogenous was left 5 minutes before measurement. Total volatile fatty acids were carried out according to Kosikowski (1982).

Meltability test of cheese samples was measured by using the Meltability test apparatus as outlined by Olson and Price (1958). Stretchability test was measured by using an iron bar test as reported by Davis (1966). Oiling off (fat leakage %) of cheese sample was determined as suggested by Nilson and Laclari (1976).

Microbiological analysis: Coli form bacteria, was enumerated according to Christen *et al.* (1993), while the *staphylococcus aureus* was enumerated according to Flowers *et al.* (1993).

### **Results and discussion**

Table (1) shows the chemical composition of cow milk had 13.35 % total solids, 3.70 % fat, 3.50 % total protein and 2.85 % casein.

**Table (1): Chemical composition of cow milk.**

	<b>T.S %</b>	<b>Fat %</b>	<b>Protein %</b>	<b>Casein %</b>
Cow milk	13.35	3.70	3.50	2.85

**Table (2): chemical properties of mozzarella cheese made from cow milk.**

Properties	Acidification type					
	starter bacteria**	Lactic acid	Acetic acid	Lemon juice	orange juice	Pomegranate juice
pH	5.23	5.23	5.28	5.22	5.30	5.20
Total solids (T.S %)	50.90	53.80	51.20	54.27	50.20	52.53
Fat %	21.20	24.00	22.00	24.20	20.50	22.80
Fat /dry matter( F/DM)	43.17	51.28	45.05	52.91	41.16	48.03
T.V.F.A	7.1	9.8	9.0	13	6.2	9.0
protein %	22.90	23.79	22.96	23.98	22.26	23.35

\*Total volatile free fatty acids = ml NaOH 0.1N/ 100g cheese

\*\* considered as control

Illustrated data in table (2) indicates that the pH value of cheese made by orange juice followed by that acidified with acetic acid were the highest among other treatments and control mozzarella cheese. In addition the mozzarella cheese acidified with pomegranate extract and lemon juice gained the lowest pH values (5.20 and 5.22) respectively. Similar results were found by (Keller *etal.*, 1974).

Table ( 2 ) indicates that the cheese made by direct acidification by lemon juice gave the highest total solids (54.27%) followed by that made by direct acidification with lactic acid, while the lowest total solids content was at that made by direct acidification of orange juice (50.20%). Also, these data reveals that all acidulates except orange juice gained higher total solids content than control (50.90%). Similar results were found by El-owni and Hamid (2008). These results might be resulted from the effect of the acidulant and heating on the whey protein and its precipitation on the cheese curd and final mozzarella cheese. On the other hand, Mozzarella cheese made by lemon juice secured the highest values of fat content (24.2%) followed by that made by lactic acid direct acidification (24.0%) when compared by other treatments and control mozzarella cheese. This might be as a result to the good curding, which reserve great amount of fat and other milk components in the cheese curd. On the other hand the least fat content (20.50%) was recorded in the cheese made by orange juice addition. These results were in agreement with (Zaki *et al.*, 1974).

Data in Table (2) indicates that fat / dry matter in control and all treated mozzarella cheese were more than 40%. In addition the mozzarella cheese acidified with lemon juice followed by that acidified with lactic acid had the highest F/DM content when compared with control and other treatments. These data are in agreement with Jana and Upadhyay, (1991).

T.V.F.A. content was higher in the cheese which acidified with lemon juice (13) followed by that made by direct acidified with lactic acid (9.8). Also, the lowest value of T.V.F.As was recorded by the mozzarella cheese which acidified with orange juice (6.2). These results might be due to the effect of direct acidification on the bacterial growth and the degradation of fat and the

releasing of free fatty acids. These data are in agreement with Mallatou *etal.*, (2003).

In the same Table (2) protein content of cheese made by lemon juice recorded the highest value (23.98) followed by that made by direct acidification by lactic acid, while cheese acidified with orange juice recorded the lowest protein content and this might be due to the decreasing of total solids content in the cheese and escape of a lot of milk components in the whey. These findings are in agreement with those reported by Abdel-Razeg *etal.*, (2006), who reported that the protein content in Sudanese bradied cheese (Mudafara) was in relation with the total solids and moisture content of cheese .

**Table (3): microbiological properties of mozzarella cheese made from cow milk.**

Properties	Acidification type					
	starter control	Lactic acid	acetic acid	lemon juice	Orange juice	Pomegranate juice
Staph. x 10 <sup>3</sup> c.f.u / 1gm	--	--	--	--	--	--
Coliform grope x 10 <sup>3</sup> c.f.u / 1gm	--	--	--	--	--	--

Data in table (3) shows that the mozzarella cheese which made by targeted acidulantes or control cheese were free from Coli form and *Staphylococcus sp.* this might be due to the effect of acidic condition and heat treatment during the making process of mozzarella cheese. These data were in agreement with Morea *etal.*, (1999), who reported that the decrease in the pH values had inhibited effect on the bacterial growth especially pathogenic bacteria.

**Table (4): Rheological properties of mozzarella cheese made from cow milk.**

Properties	Acidification type					
	starter bacteria	lactic acid	acetic acid	lemon juice	orange juice	Pomegr-anate juice
Meltability cm	6.7	8.9	6.9	12.2	5.1	8.1
Stretchability Cm	9.3	18.8	10.3	20.2	8.9	12.2
Oiling off %	25.00	32.23	25.20	32.54	24.80	28.07
Yield of cheese %	14.30	16.10	14.40	16.15	13.50	15.20

Table (4) indicates that all treatments gained an increase in the meltability but the mozzarella cheese acidified with starter bacteria gained the lowest value of meltability (6.7cm). In addition, mozzarella cheese acidified by lemon juice has the highest meltability value (12.2 cm) among other treatments and control. These results are in agreement with those reported by Naresh Kumar et al. (1994).

As for stretchability, it is clear from the same tables (4) that all acidulantes had a positive impact on the stretchability as they led to a pronounced increase with lemon juice, lactic acid ,pomegranate juice and

acetic acid (20.2, 18.8, 12.2 and 10.3cm), respectively when compared with control cheese. Among all direct acidification treatments orange juice treatment gained the least value of Stretchability for 8.9 cm. these results are in disagreement with those reported by Shukla and Lad Kani (1989).

Data presented in Tables (4) show that the direct acidification by lactic acid, acetic acid, lemon juice and pomegranate juice led to a considerable increase in cheese oiling off while, the best treatment was orange juice which led to a considerable decrease in cheese oiling off. These results are disagreement with El-Zoghby (1994).

Data presented in Tables (4) show that The yield of cheese made by lemon juice was the highest (16.15%) followed by that made by direct lactic acid acidification (16.10%), while the lowest was which made by orange juice (13.50%) when compared with control cheese(14.30%) and other treatments. The increase in the yield of cheese made by lemon juice and direct acidification by lactic acid might be due to the increasing in the denaturation and precipitation of whey protein and higher retention of water in the soft curd formed Abdel Razig, (1996). Also, these results agreed with those reported by El-Zoghby (1994) who showed that the use of direct acidification led to an increase in the yield of mozzarella cheese.

## **CONCLUSION**

The use of direct acidification method in the processing of mozzarella cheese must use to improve the rheological properties, reduced the processing time and increase the cheese yield. Also, natural acidulants like lemon or some organic acids (acetic, lactic acid) can applied on the acidification and making of Mozzarella cheese with good and appreciated quality.

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**تأثير التخمير المباشر بمحمضات مختلفة علي خصائص جبن الموزاريلا**  
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لدراسة تأثير التخمير المباشر سواء باستخدام الاحماض العضوية او استخدام العصائر الطبيعية للحمضيات علي خصائص وجودة جبن الموزاريلا. تم استخدام كلا من حمض اللاكتيك والاسيتيك كلا علي حده وكذلك التخمير بالعصير الطبيعي لكلا من الليمون والبرتقال والرمال كلا علي حده في التخمير المباشر خلال تصنيع جبن الموزاريلا ومقارنة صفات وخصائص الجبن الناتج بتلك المصنعة عن طريق التخمير بالبياديء. تم تقييم الجبن الناتج من جميع المعاملات كيميائيا وريولوجيا وميكروبيولوجيا ومقارنة نتائجها بعينة المقارنة (الكنترول). تم تحليل جميع المعاملات من خلال ثلاث مكررات وتم الاخذ بمتوسط النتائج المتحصل عليها. اوضحت النتائج ان التخمير المباشر ادي الي تقليل زمن التصنيع وكذلك حققت جميع المعاملات صفات جودة عالية مقارنة بالكنترول فيما عدا تلك المصنعة باستخدام عصير البرتقال. كذلك اشارت النتائج الي ان الجبن المصنع باستخدام عصير الليمون حققت افضل النتائج واعطت اعلي تصافي مقارنة بباقي المعاملات والكنترول. بالاضافة الي ذلك اوضحت النتائج الي ان جبن الموزاريلا المصنع باستخدام عصير الرمان حققت صفات جودة كيميائية وريولوجية وميكروبيولوجية عالية الا انه كان غير محبب للمحكمين نتيجة التغير اللوني بالجبن. وبذلك فإنه يوصي باستخدام التخمير المباشر في تصنيع جبن الموزاريلا وذلك لتقليل وقت التصنيع وكذلك زيادة محصول الجبن علاوة علي ذلك يمكن بنجاح استخدام بعض الاحماض العضوية بصورة مباشرة او عصير الحمضيات لانتاج جبن موزاريلا ذو خصائص جيدة مع زيادة في محصول الجبن الناتج.

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