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## **EFFECT OF MOISTURE, SALT CONTENT AND PH ON THE MICROBIOLOGICAL QUALITY OF TRADITIONAL EGYPTIAN DOMIATI CHEESE**

(With 3 Tables and 3 Figures)

By

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**تأثير الرطوبة والملح والاس الهيدروجيني على الخواص الميكروبيولوجية  
للجبين الدمياطى المصرى**

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يهدف البحث الى دراسة الخواص الكيمائية والميكروبيولوجية لعدد اربعون عينة من الجبن الأبيض الدمياطى المتداولة فى الأسواق المحلية بالقاهرة والجيزة. وقد تبين من فحص العينات أن متوسط النسبة المئوية للرطوبة 62,9 ± 0,09، ومتوسط النسبة المئوية لملح الطعام هو 6,6 ± 0,30، والاس الهيدروجيني كان 4,10 ± 0,05. ع في عينات الجبن الدمياطى على التوالي. وقد وجد ان اعلى نسبة من العينات وهى 47,5% و 45% و 70% تقع بين 3-4%، 4-5%، و 5-55%. كما أثبتت النتائج أن متوسط العدد الكلى للميكروبات والفطريات والخمائر وميكروب الكوليفورم والميكروبات المعوية وكذلك المكور العنقودي هو 26 و 10 X ± 14,0 X 10<sup>6</sup> و 3,1 X 10<sup>6</sup> ± 9,2 X 10<sup>6</sup> و 1 X 10<sup>6</sup> ± 2,5 X 10<sup>6</sup> و 0,13 X 10<sup>6</sup> ± 0,15 X 10<sup>6</sup> و 9,8 X 10<sup>6</sup> ± 19,0 X 10<sup>6</sup> و 1,3 X 10<sup>6</sup> ± 9,1 X 10<sup>6</sup> / جم من عينات الجبن الدمياطى. كما لم يتم عزل ميكروب السالمونيلا من جميع العينات التي تم فحصها من الجبن الدمياطى. وقد تبين وجود ترابط بين التركيب الكيمائى والمحتوى الميكروبي لعينات الجبن الدمياطى. هذا وقد خلص البحث الى أن نسبة الرطوبة والملح والاس الهيدروجيني لعينات الجبن الدمياطى لا تمثل الحماية الفعالة ضد الميكروبات.

### **SUMMARY**

This study was performed to investigate chemical and microbiological characteristics of 40 random samples of traditional white soft Domiati

cheese purchased from various markets in Cairo and Giza Governorates, Egypt. The mean gross composition of Domiati cheese samples was  $62.9\% \pm 0.09$  moisture;  $6.6\% \pm 0.30$  salt and  $4.1 \pm 0.05$  pH. The highest frequency distribution (47.5%); (45%) and (70%) lies within the range of 50-55% moisture; 3-4% salt content and 4-5 pH. Variations between the samples in terms of their gross composition suggested a lack of quality standards in cheese milk, cheese making procedure and ripening conditions. The levels of main microbial groups including total mesophilic, Coliform bacteria, mold, yeast and the presence of some potentially pathogenic microorganisms (*Salmonella* spp.) was determined. The mean total mesophilic, mold, yeast, *Coliform*, *Enterobacteriaceae* and *Staphylococci* counts were  $0.26 \times 10^6 \pm 0.14 \times 10^5$ ;  $3.1 \times 10^5 \pm 9.2 \times 10^4$ ;  $1 \times 10^4 \pm 0.25 \times 10^3$ ;  $0.13 \times 10^3 \pm 0.15 \times 10^2$ ;  $8.9 \times 10^4 \pm 0.19 \times 10^3$  and  $1.3 \times 10^4 \pm 1.1 \times 10^2$  respectively. *Salmonella* was not detected in any of the examined samples. There was correlation coefficient between moisture, salt content, pH and the isolated microorganisms. Our results suggested that moisture, salt content and pH applied to Domiati cheese did not constitute an effective barrier to microorganisms.

**Key words:** *Cheese, Domiati, microbial flora, chemical characteristics.*

## INTRODUCTION

Domiati cheese is the most popular type of pickled soft cheese by all socioeconomic classes in Egypt due to its nutritional value, convenience and good taste. When fully ripened it has strong sharp flavor as well as smooth body and texture (Yousef *et al.*, 2001 and Kepary *et al.*, 2007).

It is commonly made from whole or partially skimmed raw, pasteurized or sub-pasteurized milk. Although, Domiati cheese production should employ the full pasteurization process, there is a long standing tradition of making cheese from raw milk. The tendency to reduce the heat treatment of milk is due to the believe of cheese manufacture that this enhance the rate of ripening and produces cheese with full ripened flavor at much shorter time and higher intensity (Metwally, 2007). Because of raw milk utilization, some preventive measures have to be taken to assure elimination of manufactured Domiati cheese from undesirable bacteria. It is usually held at least 60 days to allow a time for inactivation of pathogens during ripening process but these conditions do not cause reduction of all pathogen

specially, if present in a high count, so outbreaks of food borne illness have been associated with cheese made from raw or sub-pasteurized milk. Low pH and salt content are two factors contributing to the inactivation of bacterial pathogens during 60 days ripening period (Abdelhady and Elassar, 2001; Hamed *et al.*, 2006 and Shehata *et al.*, 2007).

In addition to the microbial load present in raw milk, other organisms may gain entrance to Domiati cheese during different stages of processing, handling and storage. Such contamination may induce objectionable changes rendering the product unmarketable or even unfit for consumption. Some of the spoilage microorganisms have a public health hazard as *Staphylococci*, and some types of mould & yeast (Badawi and Hussain 1999; El-Abd *et al.*, 2003 and El-Baradei *et al.*, 2007). As the successful methods of improving the quality of the produced Domiati cheese installs recognition of the prevalent existing microorganisms. So the object of the present study is to examine the Domiati cheese concerning its chemical and microbiological aspects that may be responsible for rapid deterioration as well as to study the correlation coefficient of moisture, salt content and pH on the existing microorganisms present in Domiati cheese.

## **MATERIALS and METHODS**

Fourty random samples of Domiati cheese samples were collected from dairy shops in Cairo and Giza Governorates, Egypt, in sterile plastic bags and transferred directly to an insulated ice box. The samples (200 gm) were divided into two parts (100 gm each). The first part was examined for chemical analysis while the second part was examined microbiologically.

### **I. Chemical examination**

- 1.1. Determination of moisture content was applied according to Guinee and Fox, (1993).
- 1.2. Determination of salt content according to AOAC, (2003)
- 1.3. Determination of pH value according to Kosikowski and Mistry (1997).

### **2. Microbiological examination**

- 2.1. Preparation of decimal dilutions according to APHA, (2003)
- 2.2. Total mesophilic count according to Swanson *et al.* (1992)
- 2.3. Total mold count according to APHA, (2003)
- 2.4. Total yeast count according to APHA (2003)

- 2.5. *Coliform* count "MPN /g according to APHA, (2003)
- 2.6. Total *Enterobacteriaceae* count according to APHA, (2003)
- 2.7. Total *Staphylococcus* count according to Lancette & Tatini (1993)
- 2.8. Isolation and identification of *Salmonella* according to Krieg & Holt (1986).

## RESULTS

**Table 1:** Statistical analytical results of chemical analysis in examined Domiati cheese samples (N=40)

Analysis	Minimum	Maximum	Mean $\pm$ SEM
Moisture	51.26	70	62.9 $\pm$ 0.09
Salt	3.1	9.0	6.6 $\pm$ 0.30
pH	2.51	5.75	4.1 $\pm$ 0.05

\*N: Number of samples

**Table 2:** Statistical analytical results of microbiological analysis in the examined Domiati cheese samples (N=40)

Microorganisms	Positive samples		Min.	Max.	Mean $\pm$ SE
	No.	%			
Total mesophilic count	40	100	50	0.7 $\times 10^8$	0.26 $\times 10^6 \pm 0.14 \times 10^5$
Total mold count	29	72.5	100	1.9 $\times 10^8$	3.1 $\times 10^5 \pm 9.2 \times 10^4$
Total yeast count	29	72.5	50	0.2 $\times 10^6$	1.0 $\times 10^4 \pm 0.25 \times 10^3$
<i>Coliform</i> count	21	52.5	10	0.2 $\times 10^5$	0.13 $\times 10^3 \pm 0.15 \times 10^2$
<i>Enterobacteriaceae</i>	29	72.5	20	6.9 $\times 10^5$	8.9 $\times 10^4 \pm 0.19 \times 10^3$
<i>Staphylococcus</i> count	20	50	10	0.2 $\times 10^6$	1.3 $\times 10^4 \pm 1.9 \times 10^2$

\*N: Number of samples

**Table 3:** Correlation between the chemical composition and microorganisms in examined Domiati cheese samples (N =40).

Chemical composition	TMC	MC	TYC	Coliform	Enterobacteriaceae	Staphylococcus
Moisture	0.29	0.34	0.37	0.45	0.09	0.10
Salt	-0.28	-0.33	-0.36	-0.18	-0.13	0.37
pH	-0.20	-0.41	-0.40	-0.39	0.12	0.08

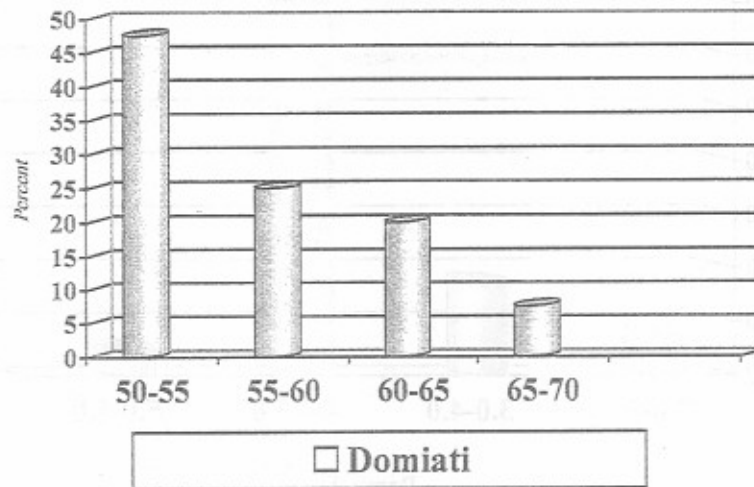
\* Correlation coefficient, significant at P<0.05 level

T.M.C.: Total mesophilic count

M.C.: Total mold count

T.Y.C.: Total yeast count

**Fig. 1:** Frequency distribution of moisture % in examined Domiati cheese samples



**Fig. 2:** Frequency distribution of salt % in examined Domiati cheese samples

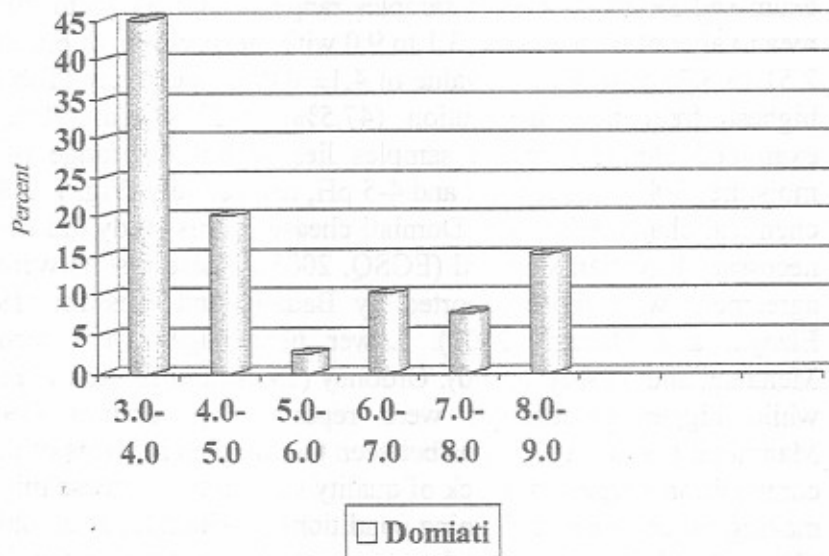
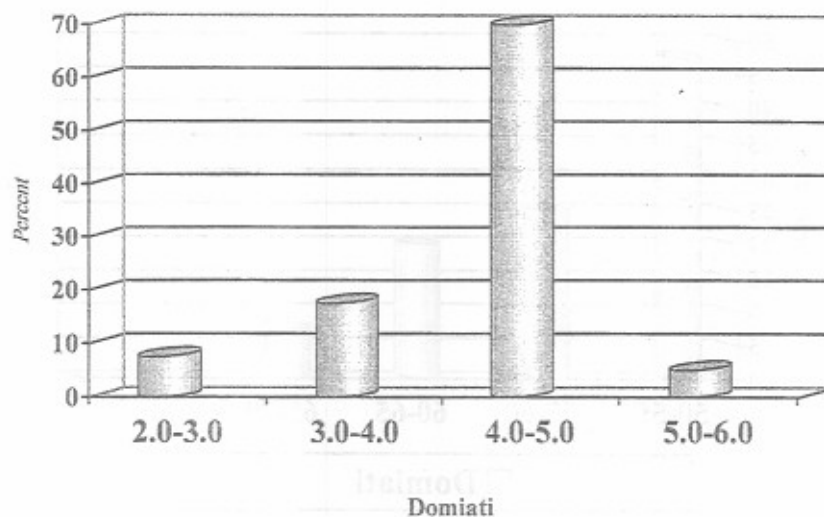


Fig. 3: Frequency distribution of pH value in the examined Domiati cheese samples



## DISCUSSION

According to the Egyptian Standard, (EGSQ, 2005), the moisture content of Domiati cheese must not higher than 60% and the salt content must be not more than 9%. The moisture, salt and pH content of the examined Domiati cheeses samples ranged from; 51.26 to 70% with a mean value of  $62.9 \pm 0.09$ ; 3.1 to 9.0 with mean values of  $6.6 \pm 0.30$  and 2.51 to 5.75 with a mean value of  $4.1 \pm 0.05$  respectively (Table 1). The highest frequency distribution (47.5%); (45%) and (70%) of the examined Domiati cheese samples lies within the range of 50-55% moisture; 3-4% salt content and 4-5 pH, respectively (Fig. 1, 2 & 3). The chemical characteristics of Domiati cheese in this study did not met the necessary Egyptian standard (EGSQ, 2005). These results were in good agreement with those reported by Badawi and Hussain (1999) and Elzayat and Osman (2001). Lower percentages were recorded by Mehanna and Rashed (1990); Ordoney (1999) and El-Abd *et al.* (2003), while higher percentages were reported by Ibrahim (1991) and Mahmoud (1993). Variations between the samples in terms of their gross composition suggested a lack of quality standards in cheese milk, cheese making procedure and ripening conditions (El-Baradei *et al.*, 2007). The pH of Domiati cheese samples were not only contribute the flavor and taste of the cheese but also maintain its convenient texture and protect it against spoilage microorganisms (Araujo *et al.*, 2002 and Turkoglu

*et al.*, 2003). The higher moisture content, the more potential off flavors and over ripening which results in many soluble breakdown products of acids, sugars, proteins and lipids (Cakmakci, *et al.*, 2000; Ceylan *et al.*, 2003 and Morales, *et al.*, 2003). Salt concentration in cheese influences many of the chemical, enzymatic, and microbiological processes that occur during cheese aging that create the typical flavor and texture of cheese (Fox, *et al.*, 2000; Melilli, *et al.*, 2003 and Battistotti, and Cocconcelli, 2004). Addition of salt to cheese decreases water activity and has an inhibitory effect on both desirable and undesirable bacteria present in cheese. Generally, cheeses with very high salt content remain firmer during aging (Candiotti *et al.*, 2001; Turkoglu *et al.*, 2003 and Ismail, 2005). The high salt content in some of the investigated samples may be due to the poor quality of the manufactured raw milk to prevent the formation of gas holes and abnormal flavor. The apparent variation among chemical examination of examined cheese samples may be due to the variation in composition and properties of the milk used for production of Domiati cheese.

From the summarized data given in Table (2) it is evident that the total mesophilic, mold, yeast, *Coliform*, *Enterobacteriaceae* and *Staphylococcus* counts of the examined Domiati cheese samples were ranged from 50 to  $0.7 \times 10^8$  with a mean value of  $0.26 \times 10^6 \pm 0.14 \times 10^5$ ; 100 to  $1.9 \times 10^8$  with a mean value of  $3.1 \times 10^5 \pm 9.2 \times 10^4$ ; 50 to  $0.2 \times 10^6$  with a mean value of  $1.0 \times 10^4 \pm 0.25 \times 10^3$ ; 10 to  $0.2 \times 10^5$  with a mean value of  $0.13 \times 10^3 \pm 0.15 \times 10^2$ ; 20 to  $6.9 \times 10^5$  with a mean value of  $8.9 \times 10^4 \pm 0.19 \times 10^3$  and 10 to  $0.2 \times 10^6$  with a mean value of  $1.3 \times 10^4 \pm 1.9 \times 10^2$  respectively. *Salmonella* species could not be isolated from any of the examined samples. The high numbers of all microbial groups in the examined samples suggested that the production and maturation of Domiati cheese should be improved by better hygiene (El-Baradei *et al.*, 2007). As shown in Table (3) there was significant positive correlation between total mesophilic count and moisture content. A negative correlation was found between total mesophilic count; salt and pH in the examined Domiati cheese samples which reflect their inhibitory effect. A significant ( $p < 0.05$ ) positive correlation was found between moisture content as well as mold, yeast and *Coliform* count. A significant ( $p < 0.05$ ) positive correlation was found between salt content and *Staphylococcus* count which reflect its high salt tolerance due to its rigid cell wall and higher internal turgor pressure (.Kunin and Rudy, 2007). A significant negative correlation ( $p < 0.05$ ) was found between pH and mold, yeast and *Coliform* count in the examined Domiati cheese

samples. This result could be account for the fact that yeast and mould could metabolize the lactic acid and lowered pH (Wang *et al.*, 2007). The results were well in line with those reported by Farag (1991); El-Gamal and Abdel-Khalek (1997); Abd El-Tawab *et al.* (1998); Ahmed and Saad, (1999); EL-Menshawi and Eid (2000); Sabreen, and Zaky, (2001); EL-Abd *et al.* (2003); Abd El-Hakeem, (2006) and El-Baradei *et al.* (2007). Higher results were reported by Allam (1995) while lower results were obtained by Halawa (1991); Abd El-Haleem, (1999); Nassib *et al.* (2003) and Metwally (2007). From the obtained results, it is obvious that most of the examined cheese samples had yeast and mold counts higher than the Egyptian Standards Limits (mold content must not exceed 10 cfu /g, while yeast must not exceed 400cfu/g) and should be rejected (EGSQ, 2005). The high incidence may be attributed to the numerous sources of cheese contamination. It may be contaminated through milk used, washing water, environment, utensils and equipment, as well as through persons taking part in manufacturing and handling the product (Mace *et al.*, 2004 and Mullan, 2007). The public health importance of molds has been emphasized as certain species can produce mycotoxins, which may induce food poisoning and neoplastic diseases including leukemia and other cancers among consumers. Also, some species of *Penicillium* have been associated with pulmonary and urinary tract infections in man (Saleh, 1989; Papageorgiou, *et al.*, 1998; El-Menshawi & Eid, 2000; Bockelmann, *et al.*, 2003; Cousin, 2005 and Brown, *et al.*, 2007). The obtained results indicated that most of the examined cheese samples had *Coliform* count higher than the Egyptian standards limits which suggested that the *Coliform* content must not exceeds 10 cfu/g of soft cheese. The presence of *Coliform* in cheese is supposed to indicate unsanitary conditions or practices during production, processing or storage. *Coliform* counts are traditional indicator of possible faecal contamination, microbial quality and wholesomeness and reflect the hygienic standards adopted in the dairy processing (Cakmakci *et al.*, 1995; Ozdemir *et al.*, 1998). A lack of good sanitary practices may result in a loss of quality, spoilage or, in some cases, create a health hazard. It has been suggested that the entire family *Enterobacteriaceae* used as indicator organisms for assessing the hygienic quality of food that because the enteric bacteria that fail to ferment lactose are of more public health than those that ferment lactose (Aman *et al.*, 1998; Niad, 2000 and Morales, *et al.*, 2003). The high rate of contamination of the examined cheese samples with *Enterobacteriaceae* is indicative for direct or indirect faecal pollution of



milk used, neglecting of hygienic measures during production and handling and possible presence of enteric pathogens (Soomro *et al.*, 2002 and Ceylan *et al.*, 2003). *Staphylococci* exist in air, dust, sewage, water, milk and food equipment, environmental surfaces, humans and animals. Humans and animals are the primary methods of transport (Delbes *et al.*, 2006). *Staphylococcal* food poisoning is being reported with increasing frequency specially in developing countries where food hygiene is still underway (Eid, 1997; Bakheit *et al.*, 1998; Ingham *et al.*, 2000; Loir *et al.*, 2003 and Anne-Galle *et al.*, 2005).

In conclusion this study clearly indicated the importance of production process, the amount of rennet used and the storage conditions should be standardized. The use of starter culture and nonstarter lactic acid bacteria should be investigated. On the other hand strict measures should be taken to prevent recontamination during production and storage.

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