

## **USING GOAT'S MILK IN MAKING THREE TYPES OF SOFT CHEESE**

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### **ABSTRACT**

Three types of white cheese namely Domiati, Akawi and Halloumi were made from goat's milk using yoghurt starter consisting of *Streptococcus thermophilus* and *Lactobacillus delbrueckii sub sp. Bulgaricus* (1:1) as a starter and rennet with addition of sodium chloride and calcium chloride. The three types of cheese were kept in refrigerator at 5°C for chemical analysis (fresh and after 15 and 30 days).

The current study showed variations in yields, recovered protein, TS and fat which significantly increased in the three types of cheeses, while fat/DM, TVFA's SN/TN and NPN/TN of the three types of cheeses made from goat's milk were not affected significantly.

Organoleptic properties of Domiati, Akawi and Halloumi cheeses differed in the score points for flavors, body and texture, saltiness and appearance. Fresh Akawi cheese gained the highest record in flavor and body and texture. It could be also noticed that the organoleptic properties slightly improved by pickling of the three types of cheese.

### **INTRODUCTION**

Cheese and fermented milk products are among the great food of the world. They are also one of life's wonders because they come in great diversity of flavours and tastes, in large variety of shapes, and are highly nutritious. More than 900 individual varieties of cheeses are being produced in the worlds (Banks, 1998) which are classified on the basis of their form, manufacturing, ripening and chemical composition (Walstra *et al.*, 2006).

The basic technology for the production of all types of cheese is the same with relatively little variations resulting in significant differences in the final cheese. The skill of cheese manufacture consists of some key factors i.e. composition of milk, extent of acid production, moisture, curd handling and ripening conditions of cheese (Lucey, 2003).

Production of cheese of certain composition, yield and quality from a given source of goat milk is of great economic concern to producers, manufacturers and consumers. Quality and composition of raw milk are among the major factors determining yield and quality of cheese. Reductions in cheese yield and quality can lead to economic losses, and a loss of 1% in cheese yield is considered intolerable to cheese makers (Lacroix *et al.*, 1991).

Traditional cheeses represent a cultural heritage and are the result of accumulated empirical knowledge passed from generation to generation. Every traditional cheese is connected to the territory of its origin and to the prevailing pedoclimatic conditions (Alichanidis and Polychroniadou, 2008).

Domiati cheese is the most popular soft cheese in Egypt, which can be consumed fresh or after pickling in salted whey for several months in

soldered tins. It requires a ripening period of 3-4 months in order to develop characteristic aroma and flavor (Askar *et al.*, 1982). Akawi cheese is a white cheese native to historical region of Palestine. It is commonly made using cow milk, but can be made with goat or sheep's milk. It is now manufactured in a large scale in the Middle East, Akawi cheese is a soft and white cheese, of smooth texture and mild salty taste (Tamime and Robinson, 1991). Halloumi cheese is the traditional cheese of Cyprus and now is made in some Middle East countries. It is a semi-hard cheese to hard elastic, and the texture is compact with no holes and unyielding to applied pressure, and it will only slice into fairly generous portions. The colour varies from white to distinctly yellowish when heated. Halloumi cheese is usually made from ewe's or goat's milk or mixed of them but for high demand of Halloumi cheese and low ewe's milk production, it is recently made from cow's milk. It can be consumed fresh and that tastes of immature Cheddar cheese (Shaker *et al.*, 1987).

The pedoclimatic conditions in most parts of East-Mediterranean countries are characterized by relatively small and irregular precipitations, hot and dry summers, and largely hilly terrain. Such an environment does not favor easy cereal production and development of rich pastures capable of meeting the roughage requirements of raising dairy cattle. However, it is suitable for sheep and goats, which are mostly raised in a nomadic or semi-nomadic system based on native pasture and crop residues (Boyazoglu and Morand-Fehr, 2001). The relatively high ambient temperature, the lack of refrigeration facilities, the difficulties of milk transportation and the fact that the cheeses were home-made or artisanal led to domination (> 50%) of the cheese market by the group of brined cheeses, which are ripened and preserved under brine until their consumption.

Although quality characteristics of cow milk cheese have been well established and documented, little research attention has been directed to effects of and milk composition on yield and quality of cheeses made from goat milk. A few studies have been published on properties of goat's milk cheese (Attaie and Richter, 1996), Goat's milk is one of the healthiest foods/drinks in the market. With its creamy texture, high mineral and vitamin content, goat milk replaces many of the supplements which people consume daily. Goat milk is better for most people than cow milk simply because it is composed of smaller fat globules which make it easier to digest. This speed of digestion releases more good bacteria and enzymes in the consumer's body, better enabling them to absorb and utilize the nutrients without discomfort, stomach ache, or a variety of other typical milk allergy symptoms. In Egypt goats' milk are not highly accepted. Cheese is more compact and has a longer shelf life than milk.

Therefore the present work aimed to study the effect of using goat's milk in making three types of cheese, namely Domiati, Akawi and Halloumi and investigate the physiochemical, proteolysis, and organoleptic properties for the three types of cheese as fresh and during pickling period.

## MATERIALS AND METHODS

### Materials:

Goat's milk used in the present study was obtained from the hard Sakha Animal Production Research Station, Animal Production Research Institute, Ministry of Agriculture. Yoghurt starter consisting of *Streptococcus thermophilus* and *Lactobacillus delbrueckii sub sp. Bulgaricus* (1:1) was obtained from CHR-Hansen Lab. (Denmark). Good quality rennet was obtained from the local market. Pure salts of sodium chloride and calcium chloride were obtained from El-Nasr Company, Egypt.

### Methods:

#### Cheese-making:

Aliquots of 30 kg of goat's milk having (4.4% fat, 3.278% protein and 11.98% total solids) were heated to 72°C/15 sec., and adjusted to 37°C, addition of CaCl<sub>2</sub> of yoghurt starter was then carried out. Goat's milk divided into two parts (10 kg for Domiati) and (20 kg for Hallomi and Akawi). Domiati cheese was manufactured mainly according to the method described by Fahmi and Sharara (1950). Halloumi and Akawi cheese (20 kg goat's milk) was manufactured as follows:

- renneting with commercial rennet;
- cutting the resultant curd after 50–60 min into 1–3 cm cubes; rest for 10–15 min on 37°C, then curd separated into 2 equal parts:

#### The first was used part for Akawi cheese:

Gentle stirring for 10 min. was carried out followed by additional salting (with dry salt 6%) and rest for 20 min. and stirring every 5 min. Curd was then transferred from whey carefully to the moulds after 2-3 hours of draining. The moulds are turned upside-down and left for 2-3 hours to complete the draining (Al-Atar, 2009).

#### The second part for Halloumi cheese:

Curds are scalded under constant stirring at about 40°C within 15 min and transferred into cheesecloth for draining, usually under pressure for 1 hr. The pressed curd is cut into cubes of 10 × 15 × 3 cm, transferred to their own hot deproteinated whey and heated up to 90–95 °C for 30 min. while stirring. The cooked curd is not stretched, salting in brine salt 6% for 1 hr. and cooled (Hayaloglu and Brechany, 2007).

The three types of cheese were kept in at refrigerator at 5°C for chemical analysis when fresh and after 15 and 30 days.

#### Chemical analysis of milk:

Fat, protein and total solids, recoveries of fat, protein and total solids were also calculated according to their actual amounts determined in cheese milk and resultant cheese (Ling, 1963).

Yield of fresh cheese was calculated using the following equation:

Yield (%) = weight of the resultant fresh cheese/weight of the milk used x 100

#### Chemical analysis of cheese:

Preparation of the samples cheese for chemical analysis was done by thoroughly mixing cheese in a mortar, and by using the homogenate for

the following determinations; titratable acidity and total solids being measured according to Ling (1963). Fat content of cheese was determined by Gerber methods as given by B.S.I. (1955). Total volatile fatty acids (TVFA's) of cheese samples were determined according to Kosikowski (1978). Total nitrogen, soluble nitrogen and non-protein nitrogen was determined using micro-Kjeldahl method as described by Ling (1963). This estimate was used for calculation of total protein content as follows: TP = TN x 6.38

**The sensory evaluation:**

The sensory evaluation was assessed according to the scoring card recommended by Naguib *et al.* (1974), given the following points for the different properties: flavour (60 points), body and texture (30 points), saltiness (5 points) and appearance (5 points).

**Statistical analysis:**

Analysis of variance and Duncan's test as well as average and standard error were carried out using a SPSS computer program (SPSS, 1999).

## RESULTS AND DISCUSSION

**Yield of fresh cheese:**

Data in Table (1) reveal that yield of fresh cheese was significantly affected by different types of cheese. Thus, yield of Domiati cheese was 25.20% and significantly increased to 27.70% in Akawi cheese, and significantly decreased to 21.03% in Halloumi cheese, which might probably due to whey proteins denaturation (Montilla *et al.*, 1995). The denatured whey proteins could form complexes with casein giving the irregularly dispersed curd accumulating more water in the inside spare spaces (Green and Grandison, 1987). These results for Domiati cheese yield (25.20%) were higher than that found by Emara (1990), who made Domiati cheese from Zaraibi goat's milk (20.35%) using 6% salt, and also been found to be 21.4% using milk of unknown breed of goats (Makled, 1994).

**Table (1): Yield and recovery of milk components of Domiati, Akawi and Halloumi cheese made from goats milk during pickling period. (Mean±SE of 3 replicates)**

Property	Domiati cheese	Akawi cheese	Halloumi cheese
Yield, %	25.20±0.053 <sup>b</sup>	27.70±0.800 <sup>a</sup>	21.03±0.070 <sup>c</sup>
Recovery of fat, %	98.44±0.038 <sup>a</sup>	91.38±0.450 <sup>b</sup>	98.78±0.560 <sup>a</sup>
Recovery of protein, %	56.66±0.410 <sup>c</sup>	78.77±0.640 <sup>a</sup>	70.28±0.490 <sup>b</sup>
Recovery, of TS, %	61.67±0.410 <sup>b</sup>	69.48±0.970 <sup>a</sup>	68.15±0.097 <sup>a</sup>

a,b and c means denoted within the same column with different superscripts are significantly different at (P<0.05)

Data also in Table (1) show the recoveries of main milk components in the resultant Domiati, Akawi and Halloumi cheese. Recovery of fat were 98.44, 91.38 and 98.78% for Domiati, Akawi and Halloumi cheese, respectively. The higher recovery of fat in Domiati and Hallomi cheese

compared with Akawi cheese might be due to the transferred curd into cheesecloth for draining whey. The fat recovery of goat milk cheeses in this study was higher than that of industrial scale cow's milk cheeses (ranging from 85 to 91%) (Phelan, 1981). On the other hand, recovery of protein in Akawi cheese significantly increased. Protein recovery of goat milk cheeses in this study was almost similar those reported for cow milk cheeses (74–77%) (Callanan, 1991). Moreover, recovery of TS in Domiati, Akawi and Hallomi were of 61.67, 69.48 and 68.15, respectively. Cheese curd retains most of the fat and casein in the original milk, while the whey contains mostly water, lactose, proteins and minerals that are soluble at the pH of cheese making. The yield of cheese depending on the chemical composition of the milk, efficient recovery of fat and protein in the cheese, losses of milk constituent in the whey resulting from milk handling and treatment and cheese making procedures, and the final moisture content of the cheese (Scott *et al.*, 1998). Reductions in cheese yield and quality can lead to economic losses, and a loss of 1% in cheese yield is considered intolerable to cheese makers (Lacroix *et al.*, 1991).

**Composition and some properties of cheese:**

Results in Table (2) show acidity, TS, fat/TS and total volatile fatty acids (TVFA's) of fresh and pickled cheese samples. Acidity of fresh cheese was significantly affected with the manufacture method of the three types of cheese. The recorded acidity values in fresh Domiati, Akawi and Halloumi cheese were 0.616, 0.410 and 0.393%, respectively. During pickling, significant increase was clearly observed in acidity of the three types of cheeses, especially, after 30 days.

**Table (2): Acidity (%), TS (%), fat/TS (%) and total volatile fatty acids of Domiati, Akawi and Halloumi cheese made from goats milk during pickling period. (Mean±SE of 3 replicates)**

Property	Pickling period	Domiati cheese	Akawi cheese	Halloumi cheese
Acidity, %	Fresh	0.616±0.008 <sup>Ca</sup>	0.410±0.040 <sup>Cb</sup>	0.393±0.01 <sup>Cb</sup>
	15 d	1.030±0.135 <sup>Ba</sup>	0.547±0.030 <sup>Bb</sup>	0.627±0.01 <sup>Bb</sup>
	30 d	1.443±0.070 <sup>Aa</sup>	1.040±0.02 <sup>Ab</sup>	0.930±0.03 <sup>Ab</sup>
TS, %	Fresh	28.544±0.40 <sup>Cb</sup>	30.360±0.46 <sup>Bb</sup>	40.710±0.36 <sup>Aa</sup>
	15 d	32.370±0.61 <sup>Bb</sup>	38.742±0.90 <sup>Aa</sup>	40.920±0.91 <sup>Aa</sup>
	30 d	35.550±0.40 <sup>Ab</sup>	39.870±0.03 <sup>Aa</sup>	41.920±0.94 <sup>Aa</sup>
Fat/DM %	Fresh	49.046±0.61 <sup>Aa</sup>	51.064±0.78 <sup>Ba</sup>	49.122±0.46 <sup>Aa</sup>
	15 d	51.776±0.92 <sup>Aa</sup>	50.391±0.24 <sup>Ba</sup>	48.918±0.93 <sup>Aa</sup>
	30 d	53.482±0.34 <sup>Aab</sup>	62.466±0.19 <sup>Aa</sup>	50.776±0.24 <sup>Ab</sup>
TVFA's*	Fresh	0.420±0.04 <sup>Ca</sup>	0.420±0.04 <sup>Ba</sup>	0.540±0.07 <sup>Ca</sup>
	15 d	0.580±0.04 <sup>Bb</sup>	0.530±0.02 <sup>Bb</sup>	0.806±0.02 <sup>Ba</sup>
	30 d	0.730±0.03 <sup>Ab</sup>	0.850±0.06 <sup>Ab</sup>	1.100±0.05 <sup>Aa</sup>

\* Expressed as ml 0.1 N-NaOH/ 10 g cheese.

a and b means denoted within the same row with different superscripts are significantly different at (P<0.05)

A, B and C means denoted within the same column with different superscripts are significantly different at (P<0.05)

Results in Table (2) show that the total solids (TS) were of 28.544, 30.360 and 40.710% in fresh Domiati, Akawi and Halloumi cheese, respectively, and significantly increased was affected by the types of cheese. Also it was noticed that total solids gradually increased up to the end of pickling period. These results are confirmed with those reported by Ibrahim *et al.* (1999). Fat/DM of fresh cheeses was not significantly affected with the manufacture method of the three types of cheese till the end of the pickling period (Table 2). The recorded Fat/DM values were 49.046 for Domiati, 51.064 for Akawi and 49.122% for Halloumi cheese. However fat content based on dry matter calculation gradually increased in the three types of cheese. This could be attributed to the decrease in cheese solids not fat content, which is a result of protein degradation, and its partial loss in whey during pickling. This was in agreement with El-Sissi and Shendy (2001) and Fatma (2004).

TVFA was not significantly affected by types of cheese and had no effect in this respect. The recorded TVFA values were 0.420, 0.420 and 0.540 in fresh Domiati, Akawi and Halloumi cheese, respectively. TVFA significantly increased in the three types of cheese with extended pickling. These results agreed with (El Abd *et al.*, 2003).

The general trend of Domiati cheese results agreed with that reported by Dariani *et al.* (1980); Emara (1990) and Makled (1994).

**Protein and proteolysis indices:**

Data in Table (3) shows that significant differences were observed between protein in fresh cheese.

**Table (3): Total protein (%), TSN/TN (%) and NPN/TN (%) of Domiati, Akawi and Halloumi cheese made from goats milk during pickling period. (Mean±SE of 3 replicates)**

Property	Pickling period	Domiati cheese	Akawi cheese	Halloumi cheese
TP, %	Fresh	9.135±0.58 <sup>Bb</sup>	9.645±0.355 <sup>Ab</sup>	15.600±0.48 <sup>Aa</sup>
	15 d	10.145±0.57 <sup>ABb</sup>	10.360±0.36 <sup>Ab</sup>	16.010±0.92 <sup>Aa</sup>
	30 d	14.035±0.95 <sup>Aa</sup>	11.595±0.87 <sup>Ab</sup>	16.135±0.91 <sup>Aa</sup>
SN/TN, %	Fresh	10.770±0.97 <sup>Ba</sup>	13.330±0.97 <sup>Ba</sup>	10.850±0.54 <sup>Ba</sup>
	15 d	15.090±0.92 <sup>ABa</sup>	17.960±0.98 <sup>ABa</sup>	14.375±0.97 <sup>Ba</sup>
	30 d	20.609±0.99 <sup>Aa</sup>	22.515±0.95 <sup>Aa</sup>	19.875±0.97 <sup>Aa</sup>
NPN/TN, %	Fresh	5.945±0.69 <sup>Aa</sup>	7.455±0.92 <sup>Aa</sup>	6.620±0.21 <sup>Aa</sup>
	15 d	7.885±0.12 <sup>Aa</sup>	8.510±0.91 <sup>Aa</sup>	7.715±0.98 <sup>Aa</sup>
	30 d	7.905±0.56 <sup>Aa</sup>	8.880±0.90 <sup>Aa</sup>	7.930±0.92 <sup>Aa</sup>

a and b means denoted within the same row with different superscripts are significantly different at (P<0.05)

A and B means denoted within the same column with different superscripts are significantly different at (P<0.05)

The recorded protein values were 9.135, 9.645 and 15.600% in Domiati, Akawi and Halloumi cheese respectively. Slight increase was observed during pickling period, especially, after 30 days in Domiati cheese. SN/TN% and NPN/TN% in Domiati, Akawi and Halloumi fresh cheese, were not significantly affected among the three types of cheese (Table 3). On the

other hand it could be observed that there was a significant increase in SN/TN% with the prolongation of pickling period, it could be due to the higher proteolytic action (Fahmy & Hanafy, 1992 and El Abd *et al.*, 2003).

**The organoleptic properties:**

It seems from the data given in Table (4) that the organoleptic properties of Domiati, Akawi and Halloumi cheeses varied in their score points for flavors, body and texture, saltiness and appearance. As fresh Akawi cheese gained the highest record in flavor and body and texture. It could be also noticed that flavors, body and texture, saltiness and appearance were slightly improved by pickling in the three types of cheese.

In spite of the differences in making technology and temperatures of ripening and storage applied for each type of cheese, it is clear that the rate of moisture loss is high during 15–30 d after manufacture and slows down during the rest of the ripening and storage period. This is due to (a) salt uptake from the brine, (b) acidity development with concomitant reduction of casein hydration as pH reaches its isoelectric point, and (c) proteolysis, which is intense during that time (Michaelidou *et al.*, 2003).

**Table (4): Scoring of the organoleptic properties of Domiati, Akawi and Halloumi cheese made from goat's milk during pickling period. (Average±SE of 15 determination from 3 replicates)**

Property	Pickling period	Domiati cheese	Akawi cheese	Halloumi cheese
Flavour (60)*	Fresh	48.33±0.69 <sup>Aab</sup>	54.33±0.98 <sup>Aa</sup>	45.00±0.63 <sup>Ab</sup>
	15 d	49.33±0.66 <sup>Ab</sup>	55.66±0.66 <sup>Aa</sup>	45.33±0.33 <sup>Ab</sup>
	30 d	50.00±0.33 <sup>Ab</sup>	55.66±0.66 <sup>Aa</sup>	49.33±0.66 <sup>Ab</sup>
Body & texture (30)	Fresh	25.33±0.66 <sup>Aa</sup>	27.66±0.33 <sup>Aa</sup>	24.66±0.88 <sup>Ba</sup>
	15 d	25.00±0.13 <sup>Aa</sup>	26.33±0.88 <sup>ABa</sup>	25.66±0.33 <sup>Aa</sup>
	30 d	25.00±0.00 <sup>Aa</sup>	25.66±0.33 <sup>Ba</sup>	25.66±0.33 <sup>Aa</sup>
Saltiness (5)	Fresh	4.22±0.00 <sup>aB</sup>	4.00±0.00 <sup>bB</sup>	4.26±0.33 <sup>aB</sup>
	15 d	4.40±0.00 <sup>bb</sup>	5.30±0.00 <sup>bB</sup>	4.80±0.16 <sup>aA</sup>
	30 d	5.00±0.00 <sup>aA</sup>	5.00±0.00 <sup>aA</sup>	5.00±0.00 <sup>aA</sup>
Appearance (5)	Fresh	4.66±0.33 <sup>Aa</sup>	4.83±0.16 <sup>Aa</sup>	4.50±0.28 <sup>Aa</sup>
	15 d	4.83±0.16 <sup>Aa</sup>	4.83±0.16 <sup>Aa</sup>	5.00±0.00 <sup>Aa</sup>
	30 d	4.83±0.16 <sup>Aa</sup>	5.00±0.00 <sup>Aa</sup>	5.00±0.00 <sup>Aa</sup>

\* Values in parenthesis represent the maximum attainable scores.

a and b means denoted within the same row with different superscripts are significantly different at (P<0.05)

A and B means denoted within the same column with different superscripts are significantly different at (P<0.05)

**Conclusion:**

It could be concluded from the current study that the different varieties of cheese Domiati, Akawi and Hallomi cheeses can be made from goat milk. Therefore this work was carried out as attempt to utilize the goat's milk in processing different types of cheese accepted by Egyptian consumers.

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**إستخدام لبن الماعز فى تصنيع ثلاث أنواع من الجبن  
هناء سيداحمد صقر ، ايمان فؤاد محمد و نعمه رانف عطالله  
معهد بحوث الانتاج الحيوانى ، مركز البحوث الزراعية ، وزارة الزراعة**

تم تصنيع ثلاثة أنواع من الجبن وهى الدمياطى، العكاوى والحلوم من لبن ماعز بإستخدام بىادىء الزبىادىء المحتوى على *Streptococcus thermophilus* and *Lactobacillus delbrueckii sub sp. Bulgaricus* بنسبة (١:١) كبادىء واطافة منفحة كلورىء الصوبىوم وكلورىء كالىسىوم. وقد تم تخزين الثلاثة أنواع من الجبن فى الثلاجة على ٥°م للتحليل الكىمىائى (طازجة وبعء ١٥ وبعء ٣٠ يوما).

أوضحت النتائج فى هءه الدراسة إلى وءوء تباىن فى تصافى الجبن نسبة استرجاع كل من البروتىن والءوامء الصلبة الكلية والءهن فى الثلاثة أنواع من الجبن ، بىنما لم بكن هناك اى فروق معنوية فى نسبة الءهن / الءوامء الصلبة ، الاءماض الءهنىة الطيارة ، النءروءىن الءانءب / النءروءىن الكلى ، البروتىن الءىر نءروءىنى / النءروءىن الكلى فى الثلاثة أنواع من الجبن المصنع من لبن الماعز.

لم تظهر الءواص الءسبة للءبن الءمىاطى والءكاوى والءلومى فى كل من الطعم والقوام والءركىب والءملبء اى اءءلافاء معنوية ، وأظهرت الجبن الءكاوى أعلى القىم فى الطعم والقوام والءركىب. وتلاحظ ءحسن طفىف للءواص الءسبة بعء الءخزىن فى الءلاث أنواع من الجبن المصنعة.

**قام بءءكىم البءء**

**كلية الزراعة – ءامعة المنصورة  
كلية الزراعة – ءامعة القاهرة**

**أءء / طه عبء الءلىم نصىب  
أءء / ءمال الءىن اءمء مهران**