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The effect of quality properties on Tulum cheese using different package materials

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This study examined the effects of starter culture, pasteurization and packaging on the chemical, textural and sensory properties of traditional Tulum cheese. Cheese samples produced from pasteurized milk were found to have higher dry matter, fat and protein contents and acidity values than cheese samples produced from raw milk. No significant difference was found in the sensory properties of cheese produced from raw and pasteurized milk. In view of these findings, the use of pasteurized milk in the production of Tulum cheese can be recommended as a suitable alternative to raw milk, and the use of cloth packaging material in place of animal skin can also be recommended.

Key words: Maturation, package, Tulum cheese.

INTRODUCTION

Tulum cheese is a popular Turkish cheese variety that is traditionally produced from raw milk, processed and aged in goatskins. With the exception of Thrace, Tulum is produced in every region in Turkey, although the methods and ripening times vary significantly (Karacabey and Uraz, 1974; Karaibrahimoğlu and Üçüncü, 1988). As a result, it is not always possible to find Tulum cheese of a standard quality. Varieties of Tulum cheese are referred to by the names of the regions where they are traditionally produced and they include Erzincan (Şavak), Divle, Çimi and Izmir (Salamurali) Tulum. Since there is no standard method for producing Tulum, the chemical composition of the cheese can vary greatly. Most studies of Tulum have focused on current production techniques and composition, with most researchers emphasizing the wide range of microbiological, chemical and sensory characteristics of the cheese (Gönç, 1974; Alperden et al., 1980; Akyüz, 1981; Demirci, 1988; Bostan, 1991; Kurt et al., 1991).

Although Tulum is sometimes packaged in sheepskin, goatskin is generally preferred for its durability. The cheese is normally placed in the inner lining of the goatskin, but in some cases, particularly in the Aegean Region, the outer skin is shaved, turned inside out and

filled (Eralp, 1974). In recent years, the growing difficulty and expenses involved in procuring skins, as well as their lack of durability, has led to an increasing use of plastic materials for packaging Tulum. Plastic containers are preferred because they are easy to find and inexpensive. Whereas some researchers (Bostan et al., 1992; Güven and Konar, 1994; Keleş and Tekinşen, 1995; Tekinşen et al., 1998) state that Tulum cheeses stored in plastic jars and polyethylene bags are superior to goatskin cheeses with regard to certain characteristics, others (Akin and Ayar, 2000; Bostan et al., 1992; Şengül and Çakmakçi, 1996) have identified adverse aspects of plastic packaging and emphasize that different materials should be used for preserving Tulum cheese.

Recently, an interest in improving hygiene has led to the increase use of pasteurization and cultures as well as healthier packaging materials in academic situations and in practical application in the dairy industry. This study examined the effects of replacing the raw milk traditionally used in Tulum production with pasteurized milk and culture and using different packaging materials in place of the traditional animal skin.

MATERIALS AND METHODS

Material

Raw cow milk was obtained from the Şekersüt dairy farms in Konya. Frozen starter culture Yb 41 (*Streptococcus salivarius*

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Figure 1. Packaging materials used in cheese production.

subsp. *thermophilus* + *Lactobacillus delbrueckii* subsp. *bulgaricus*) and rennet were obtained from Peyma-Chr Hansen's Inc. (Denmark). Sheepskin, plastic containers (Pektim Inc.), poplar wood, percale cloth (Elit Inc.) and polyethylene vacuum packaging (Bardakçi Plastic Inc.) were used for packaging cheese samples (Figure 1).

Cheese production

Tulum cheese samples were manufactured in line with Akyüz (1981), Kurt and Öztekin (1984), Kurt (1990) and Güven and Konar (1994) and the procedures by the cheese masters at the Şekersüt Dairy Plant in Konya was used. Figure 2 shows the production flow chart used in processing the samples.

Tulum cheeses were produced using raw milk (Group 1) and pasteurized milk (65°C, 30 min) (Group 2). 1.2% starter culture (*S. salivarius* subsp. *thermophilus* + *L. delbrueckii* subsp. *bulgaricus*) and 0.02% CaCl₂ were added to Group 2. Prepared cheeses were transferred to packages and ripened at 7 ± 1°C, 85 ± 2% RH for 90 days. Cheeses were analyzed in duplicate at 0, 30, 60 and 90 days.

Yields

Yields of each sample were determined according to Alpkeçten (1993).

Chemical analysis

The following chemical analysis were conducted: Total solids

(gravimetric method), fat content (Gerber method), fat/salt in dry matter (calculation), salt content (Mohr method, according to Kurt et al., 1996), SH (titration method), pH value (pH-meter, according to Kosikowski (1982) and total protein content (measurement of total nitrogen using the Kjeldahl method and multiplying by 6.38, according to Kosikowski (1982) and Kurt et al. (1996).

Sensory analysis

At 90 days, cheese samples were tested by a panel of six individuals familiar with cheese grading.

Textural analysis

Mechanical properties of cheese samples were analysed using a Texture Analyser (TA.XT2i, UK) equipped with a 5 kg load cell. A spherical probe (P/0.25S-P/1S 1") was inserted into each sample at a speed of 1 mm/sec to a depth of 10 mm. Samples were cut into 4 cm squares and wrapped in air-tight, thin, flexible plastic film immediately after cutting and then allowed to adjust to room temperature (22 ± 2°C) for 30 min prior to testing. Testing was conducted in triplicate, and the mean value was recorded (Drake and Gerald, 1999; Kaya, 2002).

Statistical analysis

Statistical analysis was performed using the SAS software program (Software, 2005). Data was analyzed using one-way analysis of variance (ANOVA) and Duncan's multiple range tests.

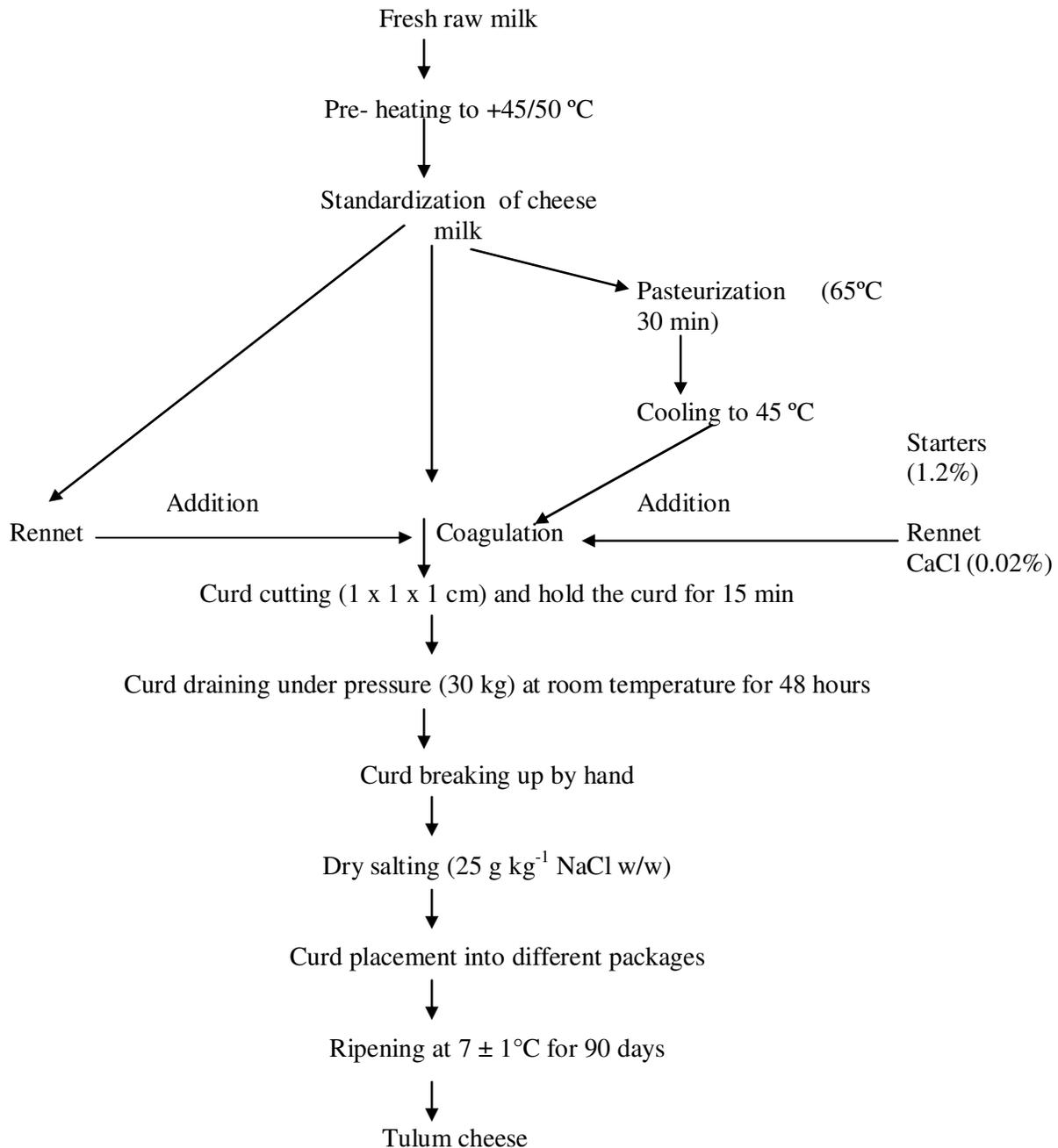


Figure 2. Flow diagram of manufacture of Tulum cheese.

RESULTS AND DISCUSSION

Yield

Pasteurization was found to increase yield in comparison with production using raw milk. Whereas 200 kg of raw milk yielded 17.70 kg (salt not included) of cheese ready for packaging (8.85%) and 200 kg of pasteurized milk yielded 21.65 kg (salt not included) of cheese ready for packaging (10.83%).

Sensory characteristics

Sensory characteristics of Tulum cheeses, which have been produced with 2 different methods and which have been allowed to mature for 90 days in 5 different packages, were assessed by the panelists on the 90th day and scoring and statistical assessment of the results is presented in Table 1.

Packaging materials were found to have significant ($P < 0.01$) effect on the sensory assessment of the samples.

Table 1. Sensory analysis values of Tulum cheeses varying according to different times, treatments and packaging materials.

Impact Factor	Factor description	N	Flavor	Body	Appearance	Colour
Package Type	Skin	12	44.04 ^a	28.29 ^a	13.62 ^a	9.66 ^a
	Cloth	12	41.41 ^b	24.95 ^b	12.66 ^b	7.45 ^{cd}
	Plastic can	12	34.58 ^c	21.62 ^c	11.33 ^c	8.20 ^b
	Wood	12	41.08 ^b	25.62 ^b	12.12 ^{cb}	7.87 ^{cb}
	Vacuum	12	33.83 ^c	27.41 ^a	13.83 ^a	7.16 ^d
Treatment	Raw	30	40.05 ^a	25.00 ^b	13.08 ^a	7.91 ^a
	Pasteurize	30	37.93 ^b	26.16 ^a	12.35 ^b	8.23 ^a
General average		17.14	38.98	25.57	12.71	8.06

a, b, c, d Means within a row without a common superscript differ significantly.

Table 2. Variance analysis results of sensory values of Tulum cheeses.

Variation source	SD	Flavor	Body	Appearance	Colour
Package	4	57.48**	22.11**	10.77**	26.33**
Treatment (raw-Pasteurize)	1	15.74**	5.62***	6.68***	3.48
Package * Treatment	4	1.90	2.90***	0.75	9.38**

p < 0.01; *p < 0.05.

Table 3. Chemical analyses values of Tulum cheeses varying according to different times, treatments and packaging materials.

Impact Factor	Factor description	N	Dry matter	Fat	Fat in dry matter	Salt	Salt in dry matter	Protein	pH	SH
Package Type	Skin	16	57.87 ^b	26.12 ^a	45.17 ^c	3.99 ^a	6.87 ^b	22.74 ^d	5.12 ^b	91.12 ^a
	Cloth	16	54.92 ^c	26.43 ^a	48.10 ^a	3.79 ^c	6.89 ^b	24.31 ^b	5.19 ^a	87.87 ^c
	Plastic can	16	53.83 ^d	38.06 ^a	47.47 ^b	3.83 ^b	7.05 ^a	21.67 ^e	5.21 ^a	83.62 ^d
	Wood	16	61.16 ^a	27.06 ^a	44.37 ^d	4.02 ^a	6.54 ^c	25.46 ^a	5.14 ^b	91.00 ^a
	Vacuum	16	53.34 ^e	25.75 ^a	48.28 ^a	3.71 ^d	6.96 ^{ab}	23.13 ^c	5.13 ^b	89.12 ^b
Treatment	Raw	40	55.70 ^b	27.15 ^a	48.79 ^a	3.86 ^a	6.93 ^a	22.33 ^b	5.15 ^b	81.45 ^b
	Pasteurize	40	56.75 ^a	30.22 ^a	44.56 ^b	3.88 ^a	6.80 ^b	24.59 ^a	5.16 ^a	95.65 ^a
Ripening time (day)	0	20	53.24 ^d	23.50 ^a	44.17 ^d	3.22 ^d	6.06 ^d	19.05 ^d	5.19 ^b	83.00 ^c
	30	20	54.71 ^c	34.85 ^a	45.45 ^c	3.56 ^c	6.52 ^c	21.52 ^c	5.30 ^a	82.70 ^c
	60	20	56.68 ^b	27.70 ^a	48.95 ^a	4.30 ^b	7.60 ^a	25.04 ^b	5.14 ^c	88.10 ^b
	90	20	60.26 ^a	28.70 ^a	48.15 ^b	4.38 ^a	7.28 ^b	28.24 ^a	5.00 ^d	100.40 ^a
General average		22	61.37	28.68	46.67	3.86	7.65	23.5	5.15	88.55

a, b, c, d Means within a row without a common superscript differ significantly (p < 0.05).

Milk treatment was also found to have a significant effect on body and appearance ($P < 0.05$) and on taste ($P < 0.01$), but not on color assessment. Package x treatment interaction was found to have a significant effect on color ($P < 0.01$) and body ($P < 0.05$) assessment (Table 2). Samples produced from pasteurized milk were found to be superior in terms of body and color, whereas samples produced from raw milk were found to be superior in terms of taste and appearance (Table 1). The lowest sensory values were obtained with plastic containers and vacuum packaging, whereas the highest values were obtained with skin, followed by cloth and wood packaging. Similar results were reported by Şengül and

Çakmakçı (1996) and Akin and Ayar (2000).

Chemical characteristics

Chemical analysis of Tulum cheeses by ripening time, milk treatment and packaging are given in Table 3. Tulum cheeses produced with pasteurized milk had the highest values for all chemical characteristics measured except for fat in dry matter and salt in dry matter. In general, while dry matter, salt, protein and SH values increased during the ripening period, fat values were found to fluctuate, although the changes were not statistically significant.

Table 4. Variance analysis results of chemical values of Tulum cheeses.

Variation source	SD	Dry matter	Fat	Fat in Dry matter	Salt	Salt in Dry matter	Protein	pH	SH
Package	4	2556.30**	0.90	162.89**	157.94**	34.18**	161.42**	16.19**	150.70**
Ripening Period	3	2754.34**	0.89	321.33**	3643.41**	564.38**	1526.89**	212.24**	1371.00**
Treatment (Raw-Pasteurize)	1	327.89**	0.38	1139.78**	3.84	17.96**	482.29**	4.17***	4032.80**
Package * Ripening Period	12	732.71**	1.02	72.78**	49.93 **	9.12**	53.81**	7.97**	55.50**
Package * Treatment	4	103.87**	1.06	32.67**	61.64**	25.25**	44.96**	16.39**	214.05**
Ripening Period * Treatment	3	84.30**	0.94	24.41**	14.49**	5.12**	47.63**	86.03**	330.00**
Package * Ripening Period * Treatment	12	62.68**	1.04	29.10 **	25.23**	5.78**	29.43**	6.70**	47.58**

p<0.01, *p<0.05

These findings are related to the water loss that occurs during ripening.

Similar results are seen in studies by Arici and Şimşek (1991) when analysing the effects of culture use in Tulum cheese. Ateş and Patir (2001) also performed a similar study. Güven and Konar (1994) found changes in Tulum cheeses that matured in polyethylene bags. Şengül and Çakmakçı (1996) compared the chemical characteristics of cheeses ripened in plastic containers and spruce wood packaging. In our study, we found that samples in wooden packaging had higher amounts of dry matter, salt and protein, whereas samples in plastic containers had higher amounts of fat and salt in dry matter and a higher pH. Cheese packaged in cloth had the highest fat in dry matter content, whereas cheese packaged in skin had the highest SH values. These findings can be explained by the facts that wooden packages absorb more water and that salt and protein levels increase in line with an increase in dry matter. Other studies (Bostan et al., 1992; Tekinşen et al., 1998; Keleş and Tekinşen, 1995; Şengül and Çakmakçı, 1996; Akin and Ayar, 2000) have also found that packaging and ripe-

ning period have significant effects on the chemical characteristics of Tulum cheese.

ANOVA results for chemical characteristics are given in Table 4. ANOVA showed milk treatment, packaging and ripening period and the interaction among these factors to have a significant effect ($P < 0.01$) on dry matter, fat in dry matter, salt in dry matter, protein and SH. Significant ($P < 0.05$) effects were seen also in pH values. No significant effects were seen in fat ratios or salt values.

Textural characteristics

Textural characteristics of Tulum cheeses by ripening time, milk treatment and packaging are given in Table 5. A general increase in firmness and adhesiveness was observed in both pasteurized and raw milk cheese samples during the ripening period. This increase was significant between days 0 and 30 for all 5 packaging materials tested. Calvo et al. (2007) and Kaya (2002) have stated that an increase in curd firmness related to moisture loss can be observed at the beginning of the ripening period and then a decrease in curd

firmness has been observed, contrary to proteolysis and an increase has been observed in adhesiveness values. Similar results are seen in our study. Typically, firmness and adhesiveness values of Tulum cheeses produced with pasteurized milk have been determined to be higher than cheese samples produced with raw milk.

Packaging material was found to have an effect on cheese firmness, but not on cheese adhesiveness. Firmness was highest in cheeses packaged in skin and lowest in cheese packaged in vacuumed plastic packaging. Firmness was significantly higher ($P < 0.05$) in the samples packaged in skin when compared to all other packaging materials tested. Samples packaged in cloth, plastic containers and wooden packaging were not significantly different in terms of firmness, but all of them were significantly firmer than vacuum-packed samples ($P < 0.05$).

ANOVA results for textural characteristics are given in Table 6. ANOVA showed that treatment, ripening period and ripening period x treatment had a significant ($P < 0.01$) effect on cheese firmness (Table 6). Ripening period, package x ripening period, ripening period x treatment and

Table 5. Textural analysis values of Tulum cheeses varying according to different times, treatments and packaging materials.

Impact Factor	Factor description	N	Firmness	Adhesiveness
Package Type	Skin	24	31.45 ^a	0.30 ^a
	Cloth	24	25.80 ^b	0.31 ^a
	Plastic can	24	25.17 ^b	0.29 ^a
	Wood	24	25.45 ^b	0.28 ^a
	Vacuum	24	21.58 ^c	0.34 ^a
Treatment	Raw	60	20.95 ^b	0.29 ^a
	Pasteurize	60	30.83 ^a	0.32 ^a
Ripening time (day)	0	30	18.59 ^c	0.14 ^a
	30	30	38.11 ^a	0.25 ^b
	60	30	14.74 ^d	0.26 ^b
	90	30	32.11 ^b	0.57 ^c
General average		32.72	25.88	0.30

^{a, b, c, d} Means within a row without a common superscript differ significantly ($p < 0.05$).

Table 6. Variance analyses results of textural analyses values of Tulum cheeses.

Variation source	SD	Firmness	Adhesiveness
Package	4	33.52**	0.77
Ripening Period	3	406.42**	65.93**
Treatment (Raw-Pasteurize)	1	325.69**	1.04
Package * Ripening Period	12	31.28**	9.41**
Package * Treatment	4	8.66**	2.08
Ripening Period * Treatment	3	26.28**	4.76**
Package * Ripening Period * Treatment	12	4.53**	2.51**

** $p < 0.01$.

package x ripening period x treatment were also found to have a significant ($P < 0.01$) effect on cheese adhesiveness.

Conclusion

The results of chemical and sensory analysis of Tulum cheeses produced with raw and pasteurized milk, cultured and packaged in 5 different types of materials suggest that more appropriate and profitable production can be achieved by using pasteurized milk and culture instead of raw milk. Moreover, cloth and wood packages can be considered as appropriate alternatives to traditional animal skin. More detailed research on this topic should be conducted. The manufacture of Tulum cheese in healthier conditions and packaging can play an important role in keeping alive this much-loved, traditional product by presenting consumers with a healthier alternative.

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