

Determination of Fatty Acid Composition of Afyon Tulum Cheese

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Abstract Afyon Tulum Cheese is variety one of Tulum Cheeses and it's a cheese consumed enjoyed. In this study were investigated fatty acids compositions at Afyon Tulum Cheese which are ready for consumption in Afyonkarahisar markets and four groups of Afyon Tulum Cheese which are different manufactured by producers. Volatile fatty acids (C_{4:0}-C_{10:0}) elevated up to the 30th day ($p < 0.05$) and decreased up to the 90th day during the ripening. The levels of free fatty acids (C_{12:0}-C_{18:2}) generally decreased on the 30th day while it started to increase again until the end of ripening period. The levels of fatty acid distribution in ready for consumption Afyon Tulum Cheeses were seen to be C_{18:1} (27.48) at highest and C_{4:0} at least. As a result it has been suggested that the distribution of fatty acids in Afyon Tulum Cheese should be detected; production techniques should be standardized in modern establishments and the cheese should be ripened and kept under appropriate circumstances.

Keywords: Afyon Tulum Cheese, cheese, Fatty Acid, MSFA, PSFA

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1. Introduction

Tulum cheese, a special cheese produced in Turkey, is not well known in other countries. Tulum is a semi-hard cheese that can be made from whole; semi skimmed or skimmed sheeps, goats, cows, and buffalos milk or their mixture. It has a crumbly texture and a strong flavor (Yilmaz et al 2005). Tulum cheese, the most-produced type of cheese then feta and cheddar cheese and has a high economic value in Turkey (Çakmakçı et al 2008). Afyon Tulum Cheese is variety one of Tulum Cheeses and it's a cheese consumed enjoyed. Applied in the production of Afyon Tulum Cheese salting two different (dry and brine) and ripening temperature different (18-20°C – 7 days; +4°C -90 days) (Kara 2012).

Fatty Acids (FAs) are released usually by the actions of lipases (from different sources) during lipolysis (Deeth 2006). Short-chain fatty acids direct impact on cheese flavour, Free Fatty Acids (FFAs) also act as precursor molecules in a series of catabolic reactions that lead to the production of other flavour compounds such as methyl ketones, esters, thioesters (Urbach 1993; Fox and Wallace 1997; Mcsweeney and Sousa 2000). Low concentrations of fatty acids in cheese indicate a young cheese, one that has not undergone much ripening. At very high concentrations, fatty acids are perceived as off-flavors. Yet, when existing at just the right levels, fatty acids contribute to the well balanced, full flavor that is

associated with cheese (House and Acree 2002). Numerous studies (Zhang et al 2006) using dietary modification have been conducted to manipulate milk fatty acid composition in order to reduce concentrations of saturated fatty acids and increase the concentrations of polyunsaturated fatty acids (PUFA) (Zhang et al 2006). Explain about methods which these studies were applied to reduce SFA and increase PUFA. The studies on FFAs contents of Tulum cheese are limited. For this reason, this study free fatty acids was investigated in ripening period of Afyon Tulum Cheese and available for consumption at marketing.

2. Material and Method

In this study analyzed fatty acid composition at 25 units Afyon Tulum Cheese which are ready for consumption in Afyonkarahisar markets. Afyon Tulum Cheese were transported the laboratory under cold conditions (+4°C).

Four groups of Afyon Tulum Cheese (A, B, C and D groups) were manufactured and analyzed fatty acid composition at during ripening. Used in the manufacture experimentally of Afyon Tulum Cheese; raw cow's milk, commercial liquid rennet (Naturen, Peyma Hansen, İstanbul, Turkey), sheep skins which was fresh and obtained from 1-2 age old sheep, and used traditionally as the packaging material of Afyon Tulum Cheese, were obtained from private sector. A, B, and C groups of Afyon Tulum Cheese were manufactured by traditional cheese producers. D group of Afyon Tulum Cheese was

manufactured experimentally in the Department of Food Hygiene and Technology (Kara 2012). After the production of 4 groups (A, B, C, and D) Afyon Tulum Cheese samples were obtained from the 0th, 7th, 30th, 60th and 90th days of ripening.

2.1. Free Fatty Acid Analysis

Fatty acids were extracted from cheeses reported by Collins et al (2003), Fat samples were methylated according to the procedure of AOCS (1997). Fatty acid methyl esters were analyzed using a gas chromatograph (HP Agilent 7890A). The instrument used with flame ionization detector (FID) and capillary column (HP 88, 100 m, 0.25 mm I.D., 0.20 µm). Helium was used as the carrier gas. The column oven temperature was held for 5 min at 100°C, then programmed at a rate of 10°C/min to a final temperature 250°C. Injector and detector temperatures were 250°C. A standard fatty acid mixture

containing 37 fatty acids (Supelco 37 mix.) and purified known individual fatty acids were used to provide standard retention times.

2.2. Statistics Analysis

The data obtained from two replications were analyzed by ANOVA using the SPSS statistical package program and differences among the means were compared using Duncan's Multiple Range test.

3. Result and Discussion

Concentration of FFA in Afyon Tulum Cheese samples collected from the market are shown in Table 1. FFA in Afyon Tulum Cheese samples (A, B, C, D) during ripening are shown in Table 2 and Table 3.

Table 1. Total Fatty Acids Composition of Afyon Tulum Cheese (g / 100 g)

n:25	Butyric acid (C _{4:0})	Caproic acid (C _{6:0})	Caprylic acid (C _{8:0})	Capric acid (C _{10:0})	Lauric acid (C _{12:0})	Myristic acid (C _{14:0})	Palmitic acid (C _{16:0})	Stearic acid (C _{18:0})	Oleic acid (C _{18:1})	Linoleic acid (C _{18:2c})
Mean	1.14	1.55	1.82	6.54	4.17	12.44	24.74	10.05	27.48	1.88
SD	0.21	0.28	0.54	0.96	0.87	0.89	0.84	0.62	0.66	0.23
Min	0.69	1.02	0.94	4.80	2.89	9.91	22.89	9.00	26.09	1.40
Max	1.53	1.97	2.57	8.83	5.65	13.73	26.65	11.20	28.85	2.28

SD: Standart Deviation

Table 2. Volatile Free Fatty Acids at During Ripening of Afyon Tulum Cheese (g / 100 g)

Days	Butyric acid (C _{4:0})	Caproic acid (C _{6:0})	Caprylic acid (C _{8:0})	Capric acid (C _{10:0})	
A	0	1.50±0.04c12	2.20±0.07b1	2.48±0.05b1	8.19±0.08a ^{h1}
	7	1.59±0.07c1	1.87±0.04c1	2.05±0.04b2	6.87±0.08c ²
	30	2.66±0.01a1	2.77±0.12a1	3.16±0.38a1	8.80±0.70 ^{a1}
	60	1.39±0.01d1	1.85±0.02c1	2.21±0.02b1	7.41±0.37bc1
	90	1.87±0.04b1	2.12±0.05b1	2.23±0.04b1	7.15±0.17c1
B	0	1.42±0.09b2	2.09±0.05b1	2.49±0.05b1	8.47±0.13a1
	7	1.12±0.07b3	1.80±0.05c1	2.21±0.07c1	7.50±0.23b1
	30	1.93±0.00a2	2.31±0.00a2	2.77±0.04a1	7.66±0.06b2
	60	1.41±0.36b1	1.94±0.11bc1	2.20±0.11c1	7.27±0.32bc1
	90	0.53±0.00c4	1.17±0.02d3	1.78±0.03d2	6.88±0.10c2
C	0	1.44±0.02b2	1.58±0.05a2	1.24±0.01a2	3.13±0.14a2
	7	1.27±0.07c23	1.50±0.07a2	1.21±0.01ab3	3.07±0.11a3
	30	1.37±0.02b4	1.59±0.01b3	1.16±0.05bc2	2.93±0.02ab3
	60	1.18±0.00d1	1.38±0.02a1	1.10±0.01c2	2.79±0.05b2
	90	1.57±0.00a2	1.51±0.01a2	1.12±0.00c3	2.73±0.01b3
D	0	1.63±0.00a1	1.60±0.02a2	1.15±0.02a2	2.75±0.08b3
	7	1.45±0.07b12	1.57±0.06a2	1.16±0.04a3	2.82±0.10b3
	30	1.49±0.00b3	1.52±0.00a3	1.18±0.00a2	3.03±0.03a3
	60	1.45±0.02b1	1.50±0.04a1	1.13±0.02a2	2.76±0.06b2
	90	1.41±0.01b3	1.51±0.04a2	1.24±0.13a3	2.71±0.01b3

A, B, C: Grups of Afyon Tulum Cheese manufactured by cheese producers;

D: Group of Afyon Tulum Cheese manufactured at Department of Food Hygiene and Technology;

^{a-d} Means in each column with different letters were significantly affected by storage period ($p < 0.05$);

¹⁻³ means with different numbers were significantly different between cheese samples at a similar ripening period ($p < 0.05$);

In the study conducted, no statistically significant difference in terms of all fatty acids was found between group A and B during the ripening ($p > 0.05$). Similarly, no statistically significant difference was detected between groups B and C ($p > 0.05$). However, a statistically significant difference was found between the groups A/B and B/C ($p < 0.05$).

For all groups, volatile fatty acids (C_{4:0}-C_{10:0}) elevated up to the 30rd day ($p < 0.05$) and decreased up to the 90th day ($p < 0.05$) during the ripening. In the studies that were connately conducted (Yilmaz et al 2005; Atasoy and Türkoğlu 2008; Türkoğlu 2011; Guizani et al 2013),

volatile fatty acids were reported to elevate during the ripening save that unlike the other studies, they elevated up to the 30rd day and periodically decreased on the latter days (60-90 days). During the ripening, the level of free fatty acids (C_{12:0}-C_{18:2}) generally decreased on the 30rd day ($p < 0.05$) while it started to increase again until the end of ripening period ($p < 0.05$). The other studies carried out on different cheese types (Yilmaz et al 2005; Atasoy and Türkoğlu 2008; Türkoğlu 2011; Guizani et al 2013) reported a regular increase in the levels of free fatty acids until the end of the ripening period. Afyon Tulum Cheese is a kind of cheese of which production consists of

7 days of ripening in brine, dry salting and ripening at relatively high temperatures (18°C, 7 days). It has been reported that these production features of Afyon Tulum Cheese help the cheese to obtain consumption characteristics in a very short time (appx. 30 days) (Kara,

2012). As a result, regarding the other studies, some differences after the 30rd day can be seen in the distribution of fatty acids during the ripening. It may be borne in mind that these differences may spring from the various applications in cheese production technology.

Table 3. Free Fatty Acids at During Ripening of Afyon Tulum Cheese (g / 100 g)

Days	Lauric acid (C _{12:0})	Myristic acid (C _{14:0})	Palmitic acid (C _{16:0})	Stearic acid (C _{18:0})	Oleic acid (C _{18:1})	Linoleic acid (C _{18:2c})
0	4.91±0.15a1	13.02±0.05a2	25.03±0.28a2	9.50±0.72a1	22.93±1.09a1	1.97±0.06a1
7	4.24±0.09b1	12.48±0.01a2	26.17±0.45a3	10.30±0.62a1	24.00±0.91ab1	2.11±0.18a1
A 30	4.17±0.38b1	10.84±0.93b2	26.83±1.83a2	10.56±1.02a2	19.55±0.01c1	1.97±0.00a12
60	4.24±0.04b1	12.02±0.29a2	25.42±0.08a2	9.54±0.18a1	25.27±0.47a1	2.27±0.27a1
90	4.33±0.01b1	12.27±0.19a3	25.42±0.34a3	9.61±0.20a2	24.51±0.17ab3	2.16±0.33a1
0	5.00±0.10a1	13.25±0.05a2	25.14±0.48a2	9.63±0.80b1	23.14±0.43a1	1.84±0.16b1
7	4.47±0.16b1	12.61±0.13b2	25.64±0.24a3	10.26±0.76b1	23.51±0.67a1	2.18±0.05ab1
B 30	3.43±0.06c2	10.05±0.15d2	25.71±0.08a2	12.17±0.14a1	22.48±2.25a1	2.24±0.26ab1
60	4.31±0.16b1	11.84±0.42c2	27.81±2.56a2	9.47±0.07b1	23.28±0.44a2	1.99±0.07ab12
90	4.30±0.07b1	12.57±0.00b23	26.13±0.35a3	10.46±0.03b1	24.81±0.07a3	2.31±0.16a1
0	3.62±0.14a2	13.61±0.12a1	33.25±0.12ab1	8.55±0.01ab1	25.27±0.61ab1	1.76±0.01a1
7	3.58±0.15a2	13.18±0.22b1	32.49±0.02bc2	8.72±0.01a12	25.92±0.20ab1	1.77±0.01a2
C 30	3.59±0.01a2	13.68±0.16a1	34.14±0.00a1	8.79±0.06a3	23.22±0.01b1	1.70±0.12a2
60	3.43±0.05a2	13.36±0.07ab1	33.67±0.18a1	7.88±0.01bc2	26.20±0.14a1	1.74±0.00a2
90	3.38±0.01a3	12.74±0.04c2	32.10±0.03c2	7.54±0.03c3	27.12±0.03a1	1.81±0.00a12
0	3.52±0.11a2	13.21±0.20a2	33.17±0.00a1	8.65±0.35ab1	25.01±0.33a1	1.71±0.09a1
7	3.62±0.13a2	13.63±0.30a1	33.65±0.24a1	8.38±0.73ab2	24.98±0.04a1	1.65±0.01a2
D 30	3.74±0.01a12	13.62±0.14a1	33.75±0.69a1	9.02±0.05a3	22.73±0.16a1	1.79±0.15a12
60	3.57±0.09a2	13.73±0.66a1	34.30±0.59a1	7.85±0.12b2	24.81±0.89a12	1.68±0.14a2
90	3.55±0.06a2	13.38±0.20a1	33.95±0.30a1	7.84±0.09b3	25.28±0.17a2	1.60±0.02a2

A, B, C: Grups of Afyon Tulum Cheese manufactured by cheese producers;

D: Group of Afyon Tulum Cheese manufactured at Department of Food Hygiene and Technology;

^{a-d} Means in each column with different letters were significantly affected by storage period ($p < 0.05$);

¹⁻³ means with different numbers were significantly different between cheese samples at a similar ripening period ($p < 0.05$);

In the four cheese groups (A, B and C were made by manufacturers; and D was produced traditionally in the laboratory), statistical differences have been observed in terms of fatty acids. The differences between the pairs may cause from the differences between the feeding of the animals which the milk was supplied, therefore it can be connected to the differences in the raw material and the conditions of manufacturing.

In Afyonkarahisar, the levels of fatty acid distribution in ready for consumption Afyon Tulum Cheese were seen to be C_{18:1} (27.48) at highest and C_{4:0} at least. In the study, Afyon Tulum Cheese has been reported to maintain a high percentage of unsaturated fat while it maintains low percentages of saturated fat excluding C_{14:0} - C_{18:0}. The total average of unsaturated fatty acids has been reported to be 29.36 g / 100 g. In similar studies, Kinik et al (2005), reported that canned tulum cheese had unsaturated fatty acids at the level of 27.49; Gün and Simsek (2006), found the levels from 27.52 to 37.63 in Akçakatkı cheese.

On comparing the last days of the ripening of ready for consumption Afyon Tulum Cheese and traditionally produced Tulum Cheese in terms of the levels of fatty acids, significant differences have been observed. These differences may result from the source of the milk used in the production of cheese, animals' feeding patterns, the possible divergence between the production techniques, and the period of ripening (offering to the market early or late).

4. Conclusion

As a consequence, in this study, distribution of the fatty acids in Afyon Tulum Cheese, which is a traditional

cheese, during the production and ripening phases and in the samples in the market, has been researched. It has been found that fatty acids generally decrease or increase irregularly after the 30rd day. Afyon Tulum Cheese has ripened earlier than usual due to the production technology, therefore the distribution of fatty acids has changed since then. The differences between the groups and the samples obtained from the market show that there is not a total standard in cheese production. So, it has been suggested that the distribution of fatty acids in Afyon Tulum Cheese should be detected; production techniques should be standardized in modern establishments and the cheese should be ripened and kept under appropriate circumstances.

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