Effect of Commercial Starter Cultures on the Fatty Acid Composition of Pastirma (Turkish Dry Meat Product)

M.I. AKSU AND M. KAYA

ABSTRACT: The effects of different commercial starter cultures on fatty acid composition of the pastirma (Turkish dry meat product) were investigated. It was observed that using commercial starter cultures (*Staphylococcus carnosus*, *Staphylococcus carnosus* + *Lactobocillus pentosus, Staphylococcus xylosus* + *Lactobacillus sakei*) in the manufacturing of pastirma had significant effects on fatty acid composition ($P < 0.01$). However; effect of each starter culture on fatty acid composition was different. Most of the change in fatty acid composition occured during drying steps in pastirma manufacturing. TBA values of pastirma samples produced with starters were lower than those of the control group.

Key words: pastirma, fatty acids, starter culture, TBA

Introduction

THE MOST POPULAR DRY-CURED MEAT PRODUCT PRODUCED IN Turkey is pastirma. Pastirma, a traditional Turkish meat product, is produced from whole muscle obtained from certain parts of beef and water buffalo carcasses. From a carcass, 16 to 20 different types of pastirma can be produced. Muscles are cured, dried, pressed, and coated with garlic containing paste, and dried again. The paste has a protective effect on mold growth and oxygen penetration on the surface of dried meat products. High nutrition values and typical aromas from the paste lead to increased pastirma consumption (Berkmen 1960; Anonymous 1983; Kaya and others 1996; Gökalp and others 1999; Tekinsen and Dogruer 2000). Pastirma is categorized as intermediate moisture food (IMF), therefore; it can be stored without refrigeration (El-Khetaib and others 1987; Leistner 1988).

Occurrence of biochemical reactions such as proteolysis and lipolysis during the production of raw-dried meat products is of importance with respect to the aroma, color, texture and nutritious value of the end product. Lipids and phospholipids are hydrolyzed by lipase and phospholipase, yielding free fatty acids which are oxidized to peroxides. Further reactions with compounds such as peptides and amino acids lead to formation of volatile compounds (Toldra 1994). It has been reported in related research that volatile compounds have a direct effect on the formation of aroma in raw-dried meat products (Berdaque and others 1991; Buscailhon and others 1993; Stahnke 1995 a, b). Lipid oxidation is quite important for formation of unique aroma in such products (Buscailhon and others 1993; Gray and others 1996; Morrissey and others 1998; Ordonez and others 1999; Gandemer 1999; Talon and others 2000). It was reported that salt, nitrite/nitrate and antioxidants are important factors affecting lipid oxidation during processing of meat products (Kanner 1994 and Christian and Giovanni 1999).

It was also reported that myristic, palmitic, stearic, oleic and linoelic acid contents of pastirma made from *M. longissimus dorsi* from beef carcasses were 1.78%; 29.71%; 18.87%; 48.76%; 0.88%, respectively (Askar and others 1993). They stated that the content of myristic, palmitic and linoleic acids in pastirma were lower than those of raw meat whereas other fatty acids increased in the processed product.

It was discovered that *Staphylococcus* increased fatty acids more effectively than lactic acid bacteria and *Micrococcus* in dry fermented sausage (Hierro and others 1997). Similar results were obtained in fermented sausage (Kennealy and others 1998). It was reported that lipid oxidation products were effective in the formation of aroma in dry cured ham and dry fermented sausages probably because of microbial activity (Chizzolini and others 1998). However; various researchers have stated that the main factor affecting lipolysis is muscular enzymes (Motilva and others 1993a, b; Molly and others 1996; Hierro and others 1997).

There is no research on fatty acids composition of pastirma produced in Turkey. In this study, fatty acid composition in pastirma samples produced with or without starter cultures was determined.

Materials and Methods

TWO TRIALS (TREATMENT 1 AND TREATMENT 2) WERE CARRIED out in this study. *M. longissimus dorsi* (24 h post mortem) from beef carcasses were used as raw material. After removing fat and connective tissue from surface, the muscle was cut vertically into two pieces. Four pastirma were produced from a carcass. Two carcasses were used for treatment 1, one carcass was used for treatment 2. Completely random block design for treatment 1 and completely random design for treatment 2 were employed. In treatment 1, commercial preparations of *Staphylococcus carnosus*, *S.carnosus* + *Lactobacillus pentosus* and *Staphylococcus xylosus* + *Lactobacillus sakei* were used as a starter culture (CHR Hansen, Rudolf Müller, Germany). In treatment 2, *S.carnosus* + *L.pentosus* was used as the starter culture. Starter culture (25 g starter/100 kg meat) was introduced into muscle with curing compounds (47 g NaCl, 0.750 g KNO_3, 1.0 g glucose, 1.0 g saccarose) and the curing process was employed in different trays for each group. As a control group, pastirma samples made without starter cultures were also used. In treatment 1, fatty acid composition was determined for both raw

© 2002 Institute of Food Technologists

material and pastirma. In addition, in treatment 2, fatty acid composition was also determined at various processing stages such as end of curing and end of second drying. The production process of pastirma is given in Table 1 (Gökalp and others 1999; Aksu 1999; Aksu and Kaya 2001). Paste mixture (cemen) used in this study contained 500 g flour *Trigonella foenum graecum* seed, 350 g smashed fresh garlic, 75 g paprika, 75 g red pepper and 1200 mL water. After the second drying step, dried meat samples were mounted with the paste and stored 4-5 d. The surface of the meat was coated with a paste mixture of 3 to 4 mm thickness (Cankaya 1997; Aksu 1999; Gökalp and others 1999).

Preparation of samples for analysis and fatty acid analysis was as follows: Fat (0.15 to 0.20 g) extracted by the ether method from each sample (total of two), was saponified with 5 mL NaOH with methanol in a water bath for 10 min. Five mL BF_3-methanol was added, and the extract was refluxed for 2 min. After adding 5 mL heptane to the mixture, it was boiled again for 1 min. The content of this mixture was transferred into 25 mL volumetric flasks and the volume was adjusted with saturated NaCl to 25 mL. One mL of the heptane phase from upper layer of the volumetric flasks was used to determine the fatty acids composition (Unsal 1996; Nas and others 2001). Fatty acids were analyzed by gas chromatography (Fisons Inst. HRGC Type Mega 2) with a capillary column (25 m × 0.25 mm ID), temperature (increasing from 150 °C to 200 °C with rate of 5 °C / min), FID detector (H_2 and dry air) at 260 °C, helium gas (1 mL / min, 150 kPa) and injection block temperature of 250 °C (Morrison and Smith 1964).

TBA values were determined by the modified method of Tarladgis and others (1960) as mg malonaldehyde/kg of pastirma (Ockerman 1985; Gökalp and others 2001). Moisture and pH values were determined by the method of Ockerman (1976) and Gökalp and others (2001).

Results were analyzed by ANOVA (SAS 1990). Comparison mean values were made using the Duncan test. Results of statistical analysis were shown as mean values ± standard deviation in tables.

Table 1–Production stages of pastirma.

	Production stage	Time	Temp (°C)	Relative humidity (%)
1	Curing*	2-3 d	6±1	80-90
2	First drying	4-5 d	15±1	80-85
3	First pressing**	17 h	7±1	
4	Second drying	3-6 d	20±1	70±2
5	Second pressing**	7 h	25±1	
6	Pasting (cemening)	4-5 d	7±1	
7	The last drying	2 d	15±1	70±2
		2 d	18±1	65±2
		6-7 d	20±1	60±2

*For 1 kg meat and fat, 50 g curing material.
**For 1 kg meat and fat, 25 kg weight.

Results and Discussion

FATTY ACID COMPOSITION OF RAW MEAT MATERIAL USED IN TREATment 1 were determined as 6.49 ± 0.68% $C_{14:0}$, 33.09 ± 1.05% $C_{16:0}$, 18.14 ± 0.27% $C_{18:0}$, 0.38 ± 0.09% $C_{20:0}$, 5.87 ± 0.26% $C_{16:1}$, 33.82 ± 2.69% $C_{18:1}$, 2.21 ± 0.38% $C_{18:2}$.

All the starter culture used in treatment 1 had significant effect on fatty acids composition ($P < 0.01$). The control group pastirma had lower saturated fatty acids composition than others according to the Duncan test results (Table 2).

The palmitic acid content of raw material was 33.09 ± 1.05%, but decreased in processed pastirma samples. The largest decrease was found in the control group. Others also found similar results in pastirma samples (Askar and others 1993). While the highest level of stearic acid was in the raw material, it decreased in pastirma samples (Table 2).

As in saturated fatty acid composition, changes in the unsaturated fatty acid composition in pastirma samples were also determined. While pastirma produced with *Staphylococcus xylosus* + *Lactobacillus sakei* had higher level of palmitoleic and oleic acid, pastirma produced with *Staphylococcus carnosus* + *Lactobocillus pentosus* had higher linoleic acid values (Table 2).

It was determined that linoleic and stearic acids decreased but palmitic acid increased during the production process in dry cured hams (Countron-Gambotti and Gandemer 1999). These researchers speculated that the decrease in linoleic acid was due to oxidation. Some researchers reported that fatty acid content in dry cured hams produced by the short term salting process were similar, to those produced by the long term salting process, except for the unsaturated fatty acid composition in the phospholipids (Countron-Gambotti and others 1999). Other researchers stated that the rate of unsaturation increased the ripening process in meat products, and that fermentation had affected this increase (Chasso and others 1993). Several researchers have reported that the saturated/unsaturated ratio of fatty acids with 16 and 18 C chains in dry fermented sausages changed during ripening (Motilva and others 1993; Fernandez and others 1995a). Researchers also determined a decrease in the amount of triglyceride but an increase in the amount of monoglycseride and free fatty acids during the ripening period of dry fermented sausages made with pacreatic lipase addition (Fernandez and others 1995b). It was found that the amount of saturated fatty acids decreased but the amount of unsaturated fatty acids increased during the fermentation process in fermented sausages made with starter cultures of *Pediococcus pentosecaus* and *Staphylococcus xylosus* (Johansson and others 1994). Other researchers also reported that *Staphylococcus xylosus* increased lipolysis in fermented meat products (Montel and others 1998).

In treatment 2, average values with respect to starter culture and the pastirma production stage factors were presented in Table 3. According to results obtained from ~~in~~ the analysis of variance, though effect of starter culture (*S.carnosus* + *L.pentosus*) using on fatty acids composition was not significant ($P > 0.05$), the effect of production stage on fatty acids composition was found to be significant ($P < 0.01$). The results of Duncan's multiple range test of average values in the production stages were also given in Table 4.

The amounts of palmitic and arachidic acids were higher in pastirma than in raw material. Statistical analysis showed that there was no significant difference in the amount of oleic acid among the raw material and pastirma ($P > 0.05$). The palmitoleic acid concentration in the raw material and the linoleic acid concentration in the pastirma were at the highest levels (Table 4).

The interaction of starter culture x production stage resulted in a significant effect on fatty acid composition ($P < 0.01$). At the end of the second drying, the amount of stearic acid was higher in the starter cultures samples (Table 3). However, at this stage, the amounts of palmitoleic and oleic acid were lower in starter culture samples than those of the control samples (Table 3). The greatest change in unsaturated fatty acids occurred in linoleic acid content. The amount of linoleic acid, 3.14% in the raw material, decreased in both the control group and samples with starter culture until the second drying step. However, at the end of processing, the amount of linoleic acid increased up to 12.41% in the control group, and up to 16.07% in pastirma samples with starter cultures. The amount of linoleic acid was higher in pastirma with starter cultures than in

Table 2–Fatty acid contents of pastirma samples produced in treatment 1 and results of Duncan test.

Group of pastirma	Fatty acid (%)								
	≤$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{20:0}$	Total saturated	$C_{16:1}$	$C_{18:1}$	$C_{18:2}$	Total unsaturated
Control (no starter)	2.54±0.05d	24.81±1.49d	9.44±3.89d	0.80±0.09b	37.58±5.34d	4.20±0.29c	46.27±3.57a	11.96±2.05b	62.43±5.34a
S.carnosus	4.74±1.39a	31.55±3.54a	13.62±3.53a	0.75±0.36d	50.81±8.67a	4.90±2.66b	36.19±11.07d	8.22±0.41c	49.33±8.83d
S.carnosus+ L.pentosus	3.49±1.07c	28.02±1.21c	13.08±0.63b	1.54±0.43a	46.14±2.09b	4.12±0.16d	37.36±4.48c	12.39±2.23a	53.87±2.09c
S.xylosus+L.sakei	4.66±1.07b	28.20±2.98b	9.48±0.86c	0.77±0.37c	42.94±4.75c	6.06±3.25a	43.62±7.80b	7.38±0.20d	57.07±4.75b

±, Standard deviation of four samples.
a-d, Any 2 means in the same column having the same letters are not significantly different at (P < 0.05).

Table 3–Fatty acids composition of raw material for pastirma production, control group and pastirma with starter culture at production stages (Treatment 2).

Production stage	Starter culture	Fatty acid (%)								
		≤$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{20:0}$	Total saturated	$C_{16:1}$	$C_{18:1}$	$C_{18:2}$	Total unsaturated
Raw material	(meat)	4.40±0.85	31.96±4.73	15.11±0.18	0.32±0.05	51.78±4.94	5.74±0.03	39.33±4.58	3.14±0.40	48.22±4.94
End of curing	Control*	3.56±1.00	31.11±0.30	22.21±3.95	0.58±0.20	57.45±4.85	3.52±1.09	36.19±4.05	2.84±0.29	42.55±4.86
	Sc+Lp**	2.79±0.00	31.30±1.09	15.46±1.48	0.15±0.00	49.62±0.49	4.39±1.20	43.48±1.67	2.52±0.07	50.39±0.49
End 2nd drying	Control	4.68±0.64	30.76±0.83	18.83±1.90	0.53±0.12	54.79±1.83	4.77±0.76	36.80±2.20	3.64±1.13	44.71±1.12
	Sc+Lp	0.79±0.20	37.11±0.76	31.27±1.70	0.11±0.15	69.23±0.52	2.53±0.75	27.68±1.67	1.52±0.07	30.77±0.52
Pastirma (End product)	Control	2.02±0.19	27.68±0.99	17.93±1.12	1.32±0.70	48.94±1.22	2.51±0.16	36.15±1.15	12.41±2.21	51.07±1.22
	Sc+Lp	4.10±2.05	25.76±1.15	12.82±0.89	1.85±0.59	44.52±3.51	3.50±0.00	35.92±0.09	16.07±3.60	55.48±3.50

* No starter
***Staphylococcus carnosus +Lactobacillus pentosus*
±, standard deviation of 2 samples

Table 4–Fatty acids composition of pastirma production stages and results of Duncan test (Treatment 2).

Production stage	Fatty acid (%)								
	-$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{20:0}$	Total saturated	$C_{16:1}$	$C_{18:1}$	$C_{18:2}$	Total unsaturated
Raw material	4.40±0.69a	31.95±3.86a	15.11±0.15c	0.32±0.04b	51.78±4.04bc	5.74±0.03a	39.33±3.74a	3.14±0.32b	48.22±4.04ab
End of curing	3.18±0.73ab	31.20±0.66a	18.83±4.60b	0.36±0.27b	53.54±5.33b	3.96±1.06b	39.84±4.90a	2.68±0.25b	46.47±5.33b
End 2nd drying	2.73±2.28b	33.94±3.72a	25.05±7.32a	0.32±0.27b	62.01±8.41a	3.65±1.43b	32.24±5.5b	2.58±1.39b	37.74±8.07c
Pastirma (End product)	3.06±1.69ab	26.72±1.42b	15.37±3.06c	1.58±0.60a	46.73±3.33c	3.00±0.58b	36.03±0.68ab	14.24±3.23a	53.27±3.33a

±, Standard deviation of 4 samples.
a-c, Any 2 means in the same column having the same letters are not significantly different at P < 0.05.

the control which may due to lipid oxidation. It was reported that the number of bacteria (lactic acid bacteria and *Micrococcus*/*Staphylococcus*) reached the maximum level at the end of the second drying (Aksu and Kaya 2001a,b,c).

In research, the amounts of palmitic, stearic, oleic and linoleic acids in pastirma produced from cow meat were determined (Askar and others 1993). When compared with the results of this study, while the amount of palmitic acid was similar with the result in treatment 1, the amounts obtained in treatment 2 were lower. The amount of stearic acid was in line with control group pastirma in treatment 2, but it was lower in pastirma with starter cultures. As compared with unsaturated fatty acids composition, the amount of oleic acid obtained from this study was lower, but the amount of linoleic acid was found considerably higher than that reported by Askar (Askar and others 1993).

The TBA, moisture and pH values of raw materials were determined in treatment 1 as 0.29 ± 0.01, 72.73 ± 0.71%, 5.87 ± 0.16, respectively. Statistical analysis showed that there was a significant (P < 0.01) difference among groups for TBA, moisture and pH values of pastirma. The lowest TBA and pH values were obtained in pastirma produced with *Staphylococcus xylosus* + *Lactobacillus sakei* (Table 5). Researchers indicated that pastirma provides good growth conditions for *Staphylococcus xylosus* + *Lactobacillus sakei* (Aksu and Kaya 2001).

The TBA, moisture and pH values of raw materials in treatment 2 were 0.42 ± 0.01, 75.48 ± 0.02%, 5.89 ± 0.16, respectively. The TBA, moisture and pH values of control group pastirma produced in this treatment were 1.24 ± 0.06, 38.06 ± 0.20%, 6.37 ± 0.22 and pastirma with *S.carnosus* + *L.pentosus* were 1.26 ± 0.07, 37.27 ± 1.98%, 6.27 ± 0.01, respectively. Higher pH values were determined in treatment 2 then treatment 1. This may be explained by higher proteolytic activity during processing in treatment 2. Furthermore, TBA values of pastirma from both treatments were close to values reported in the literature. For instance, severally researchers reported that TBA values of pastirma ranged from 0.16 to 1.589 mg malonaldehyde/kg (Begendik 1991; Askar and others 1993; Yagli and Ertas 1998). The TBA values were low in pastirma samples with starter culture. It was concluded that this result is due to catalase

Table 5–The TBA, moisture and pH values of pastirma samples (Treatment 1, end of product).

Group of pastirma	TBA*	Moisture (%)	pH
Control (no starter)	2.29±0.20a	43.72±2.85c	5.92±0.02a
S.carnosus	1.58±0.27c	44.40±1.58b	5.89±0.01b
S.carnosus + L.pentosus	2.25±0.01b	42.92±1.31d	5.76±0.03c
S.xylosus + L.sakei	1.20±0.30d	45.79±0.17a	5.63±0.02d

* as mg malonaldehyde/kg
±, Standard deviation of 4 samples.
a-d, Any two means in the same column having the same letters are not significantly different at P < 0.05.

activation of *Staphylococcus carnosus* and *Staphylococcus xylosus*. The enzyme catalase decomposes H_2O_2 and removes its strong oxidative effect (Gökalp and others 1999).

Conclusions

PALMITIC, STEARIC, OLEIC AND LINOLEIC ACIDS WERE DOMINANT in fatty acids composition of pastirma. From the data obtained, it can be concluded that the change in fatty acid composition during the production process was affected in part by the starter culture use. A higher saturated fatty acids were found in pastirma produced with starter cultures. However, the amounts of linoleic acid were higher in pastirma produced with *Staphylococcus carnosus* + *Lactobacillus pentosus* than that in other pastirma samples.

References

Aksu MI. 1999. Research on the possibility of starter culture use in pastirma production [Ph.D. Thesis]. Atatürk Univ. Graduate Institute of Science. Erzurum. p 18-21.
Aksu MI, Kaya M. 2001a. The effect of starter culture use in pastirma production on the properties of end product. Turk J Vet Anim Sci (Forthcoming)
Aksu MI, Kaya M. 2001b. Some microbiological and chemical properties of pastirma produced using potassium nitrate and starter culture. Turk J Vet Anim Sci 25:847-854.
Aksu MI, Kaya M. 2001c. The use possibilities of commercial starter culture in pastirma production. Turk J Vet Anim Sci 26:917-923.
Aksu MI, Kaya M. 2001d. Production of Past•rma with different curing methods and using starter culture. Turk J Vet Anim Sci 26:909-916.
Anonymous. 1983. Pastirma. The Number of Turk Standards:1071, Institute of Turk Standards. Ankara.
Askar A, El-Samahy SK, Shehata HA, Tawfik M. 1993. Pasterma and beef bouillon. The effect of substituting KCl and K-lactate for sodium chloride. Fleischwirtschaft 73(3):289-292.
Begendik M. 1991. Research into the effects of sodium nitrite and salting method on sensory, physical and chemical properties of pastirma [Ms. Thesis]. Ankara Univ. Graduate Institute of Sci. Ankara, Turkey. p 23-24.
Berdaque JL, Denoyer C, Quere JL, Semon E. 1991. Volatile components of dry-cured ham. J Agric Food Chem 39:1257-1261.
Berkmen L. 1960. Studies on the endurance of pathogens in specific Turkish meat food product. DIE Fleicshwirtschaft 11:926-931.
Buscailhan S, Berdague JL, Monin G. 1993. Time-related changes in volatile compounds of lean tissue during processing of french dry-cured ham. J Sci Food Agric 63:69-75.
Cankaya H. 1997. The effects of calcium chloride on some quality and technological properties of pastirma. (Ms Thesis). Atatürk Univ. Graduate Institute of Science. Erzurum.
Chasco J, Beriain MJ, Bello J. 1993. A study of changes in the fat content of some varieties of dry sausage during the curing process. Meat Sci 34:191-204.
Chizzolini R, Novelli E, Zanardi E.1998. Oxidation in traditional mediterranean meat products. Meat Sci 49(1):S87-S99.
Christian SV, Giovanni P. 1999. Lipid and cholesterol oxidation products in dry-cured ham. Meat Sci 52:397-401.
Coutron-Gambotti C, Gandemer G. 1999. Lipolysis and oxidation in subcutaneous adipose tissue during dry-cured ham processing. Food Chem 64 (1):95-101.
Coutron-Gambotti C, Gandemer G, Rousset S, Maestrini O, Casabianca F. 1999. Reducing salt content of dry-cured ham: effect on lipid composition and sensory attributes. Food Chem 64(1):13-19.
El-Khateib T, Schmidt U, Leistner L.1987. Microbiological stability of Turkish pastirma. Fleicshwirtschaft 67(1):101-105.
Fernandez M, Hoz L, Diaz O, Cambero MI, Ordonez JA. 1995a. Effect of addition of pancreatic lipase on the ripening of dry-fermented sausages- part 1. Microbial, physico-chemical and lipolytic changes. Meat Sci 40:159-170.
Fernandez M, Hoz L, Diaz O, Cambero MI, Ordonez JA. 1995b. Effect of addition of pancreatic lipase on the ripening of dry-fermented sausages- part 2. Free fatty acids, short-chain fatty acids, carbonyls and sensory quality. Meat Sci 40:351-362.
Gandemer G. 1999. Lipids and meat quality: lipolysis, oxidation, Maillard reaction and flavour. Sci Aliments 19(3-4):439-458.
Gökalp HY, Kaya M, Tülek Y, Zorba O. 2001. Guide for quality control and laboratory application of meat products (4th press).Atatürk Univ. Publ. No:751. Faculty of Agric. No:318. Erzurum.
Gökalp HY, Kaya M, Zorba O. 1999. Technology of pastirma and some other dried products. Engineering of Meat Products Processing. (3rd Press). Atatürk Univ. Publ. No: 786. Faculty of Agric. No: 320. Erzurum. p 309-339.
Gray IJ, Gomaa EA, Buckley DJ. 1996. Oxidative quality and shelf life of meats. Meat Sci 43:S111 S123.
Hierro E, Lorenzo H, Juan AO. 1997. Contribution of microbial and meat endogenous enzymes to the lipolysis of dry fermented sausages. J Agric Food Chem 45:2989-2995.
Johansson G, Berdague JL, Larsson NT, Borch E. 1994. Lipolysis, proteolysis and formation of volatile components during ripening of a fermented sausage with *Pediococcus pentosecaus* and *Staphylococcus xylosus* as starter cultures. Meat Sci 38:203-218.
Kanner J.1994. Oxidative processes in meat and meat products: quality implications. Meat Sci. 36:169-189.
Kaya M, Aksu MI, Gökalp HY. 1996. Dry curing-raw meat products. Sempozyum of Meat and Meat Products'96. Istanbul Univ. Vet Fac p:26-34
Kenneally PM, Schwarz G, Fransen NG, Arendt EK. 1998. Lipolytic starter culture effects on production of free fatty acids in fermented sausages. J Food Sci 63(3):538-543.
Leistner L.1988. Hurdle technology in meat products and other foods. Lebensmittelqualität Wissenchaft und Technik, R. Stufe (Hrsg), Wissenschaftliche Arbeitstagung "25 Jahre Institut für Forschung und Entwicklung der Maizena Ges. MbH", in Heilbornn, 2. Bis 4 März 1988.
Molly K, Demeyer D, Civera T, Verplaetse A. 1996. Lipolysis in a Belgian sausage: Relative importance of endogenous and bacterial enzymes. Meat Sci 43(3-4):235-244.
Montel MC, Masson F, Talon R. 1998. Bacterial role in flavour development. Meat Sci. 49:S111 S113.
Morrison WR, Smith LM. 1964. Preparation of fatty acid methyl esters and dimethylacetals from lipids with boron fluoridemethanol. J Lipid Res 5:600.
Morrissey PA, Sheehy PJA, Galvin K, Kerry JP, Buckley DJ. 1998. Lipid stability in meat and meat products. Meat Sci.49(1):S73-S86.
Motilva MJ, Toldra F, Aristoy MC, Flores J. 1993a. Subcutaneous adipose tissue lipolysis phenomena in the processing of dry-cured ham. J Food Biochem 16:323.
Motilva MJ, Toldra F, Nieto P, Flores J. 1993b. Muscle lipolysis phenomena in the processing of dry cured ham. Food Chem 48:121.
Nas S, Gökalp HY, Unsal M. 2001. Vegetable Oil Technology. (4th press) Pamukkale Univ. Publ. Faculty of Engineering. No:005. Denizli, Turkey.
Ockerman HW. 1976. Quality control of post-mortem muscle tissue. Vol 1. Meat and Additives Analysis. 13th edition. The Ohio State Univ. Columbus. Ohio. p 10.0, 50.0, 90.0-93.0.
Ordonez JA, Hierro EM, Bruna JM, Hoz L. 1999. Changes in components of dry-fermented sausages during ripening. Crit Rev Food Sci Nutr. 39(4):329-367.
SAS. 1990. SAS users quide. Cary.N.C: SAS Instiutute Inc.
Stahnke LH. 1995a. Dried sausages fermented with *Staphylococcus xylosus* at different temperatures and with different ingredient levels- Part I. Chemical and bacteriological data. Meat Sci 41(2):179-191.
Stahnke LH. 1995b. Dried sausages fermented with *Staphylococcus xylosus* at different temperatures and with different ingredient levels- Part II. Volatile components. Meat Sci 41(2):193-209.
Talon R, Walter D, Montel MC. 2000. Growth and effect of *Staphylococci* and lactic acid bacteria on unsaturated free fatty acids. Meat Sci 54:41-47.
Tarladgis BG, Watts BM, Younathan MT, Dugan LR. 1960. A distillation method for the quantitative determination of malonaldehyde in rancid food. J Am Oil Chem Soc 37:44-46.
Tekinsen OC, Dogruer Y. 2000. Pastirma. From Every Aspects. Selcuk Univ. Press. Konya.
Toldra F. 1994. Proteolysis and lipolysis in flavor development or dry-cured meat products. Meat Sci 49(1):S101-S110.
Unsal M. 1996. Some properties of fresh tail fat treated with different technological process and determination of some changes in some properties during storage under various conditions [Ph. D. Thesis]. Atatürk Univ. Graduate Institute of Science. Erzurum, Turkey. p 38-39.
Yagli (Gür) H, Ertas AH. 1998. Effect of sodium ascorbate on some quality characteristics of Turkish pastirma. Turk J Agric Foresty. 22:515-520.

MS 20010187, Submitted 4/16/01, Accepted 10/9/01, Received 10/9/01

The authors are with the Food Engineering Dept., Agricultural College, Atatürk Univ., 25240, Erzurum, Turkey. Direct inquiries to author Aksu (E-mail: miaksu@hotmail.com).