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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Fatty acid composition of tissues of Turopolje hogs and crossbreeds

M. Đikić, I. Jurić, S. Mužic
University of Zagreb, Faculty of Agriculture, Zagreb, HR-10000 Svetošimunska c. 25., Croatia

ABSTRACT

Purpose of this research is to investigate the proportion and composition of intramuscular fat (IMF) in MLD and fat in backfat (BF) by analyzing saturated (SFA), monounsaturated (MUFA) and polysaturated (PUFA) fatty acids at hogs of Turopolje breed (T) and crossbreeds CLT (♀CL modern genotype×♂T). The pigs were produced in the outdoor system of the forest biocoenosis (Quercus robur, Fraxinus excelsior and Fagus silvatica) and marsh meadows (Deschamsietum caespitosa) in Turopolje region, which is a part of Lonjsko polje, a world known Croatian nature park. Modified traditional Croatian technology of low input of feed in ecosystem (0.5 kg of corn seed/animal/day) was implemented in the extensive management. Slaughter weight and cold carcass weight for T (86.5 kg and 69.5 kg) and CLT (126 kg and 106.1 kg) was analyzed on the slaughtering line. Sample of MLD and belonging BF were taken from the left side for fatty acid analyses. IMF in MLD and fat in fat tissue was analyzed by the Soxlet method. Fatty acids were analyzed by gas chromatography (ISO 5505/1990 method). Share of IMF in MLD in T and CLT groups of fattened pigs was 3.03% and 3.96%, respectively, while fat in BF was 92.98% and 90.8%. Following proportions of fatty acids were established for IMF in MLD and fat in BF:SFA 39.68% and 37.05%; MUFA 54.84% and 50.7% and PUFA 5.67% and 12.18%, respectively. Quality of IMF in MLD, when analyzed through UFA:SFA ratio, in both research groups was satisfactory from the aspect of human nutrition. Established values of C 18:2 and C18:3 in IMF of MLD and fat in BF for T group were 5.46% and 0.21%; and 11.4% and 0.78%, respectively. For CLT group these values were 6.4% and 0.48%; and 10.03% and 0.88%, respectively.
(Keywords: Turopolje pig breed, crossbred, fatty acid, muscle and fat tissue)

INTRODUCTION

Turopolje pig breed is the oldest Croatian autochthonous pig breed and one of the older European ones, too. Based on the historical literature, *Đikić* and *Jurić* (2001) stated that the development of this breed started with Turopolje pig, with the participation of Šiška and some other European breeds of pigs during the XVII. and XIX. century. References on the issue of pig breeds that participated in this process are so diverse that it is not possible to be certain about which of them participated in creation of Turopolje pig. Today, examination of this breed on molecular level is in progress (*Harcet et al.,* 2002). Based on the historical sources, authors set the hypothesis that Turopolje pig is an autochthonous Croatian pig, created in the period of domestication in the area of Turopolje. Turopolje pig was originally created as, and today it still is, a breed for the

outdoor system of production in the ecosystem of flood forests of *Quercus robur*, *Fraxinus excelsior*, *Fagus silvatica* and the *Deschamsietum caespitosa* meadows and continental climate. Today and in the past, an old Croatian technology in breeding and production is used in the outdoor system. This technology is of a low feed input, with the possibility of utilization of natural resources of the environment (acorn, grass, soil). Turopolje pig breed has no commercial importance in today's pig meat production in Croatia. However, as Turopolje pig is a part of Croatian and world cultural heritage and biological diversity (*Robić et al.,* 1996), it has been involved in a program of protection and preservation since 1994, according to the principles of Convention on biological diversity. Besides that, research on biological characteristics of the breed are also being carried out (*Đikić et al.,* 1999; *Đikić* and *Jurić,* 2001; *Harcet et al.,* 2002). Carcass composition and meat quality is investigated by *Đikić et al.* (2002), due to the fact that *Sellier* (1998) reported that old pig breeds could be important in future selection of pigs, based on meat quality. In that context, intramuscular fat and fatty acid composition gain on importance (*Walstra et al.,* 2000; *Meadus,* 1998; *Gerbens et al.,* 1998 and *Nechtelberger et al.,* 2001).

Goal of this research was to establish the fatty acid composition of *MLD* intramuscular fat and backfat of Turopolje pig breed and their crossbreeds. Besides that, our intention is to investigate the possibilities of using this breed in meat processing, especially in production of dry-cured products.

MATERIALS AND METHODS

Research was carried out on fattened castrates of Turopolje pig breed (T, n=10) and crossbreeds (CLT, n=6). CLT crossbreeds were produced by mating T boars and CL sows (♂C–Hypor×♀Landrace). The whole productive cycle took place in the outdoor system of forest biocoenosis *(Quercus robur, Fraxinus excelsior and Fagus silvatica)* and marsh meadows *(Deschamsietum caespitosa)* in Turopolje.

Traditional Croatian technology of low feed ecosystem input (0.5 kg of corn seed/animal/day) was implemented in the extensive management. Natural resources (acorn, soil, pasture) were utilized, but having in mind the environmental balance, as well. No industrial feed, vitamin or mineral was used nor in piglet rearing, neither in fattening. Average age of fattened pigs of Turopolje breed was 595±14 days (birth from May 26-June 8, 1999 and slaughtering on January 10, 2001) and of crossbreeds it was 770 days (birth on December 2, 1998, slaughtering on January 10, 2001). Slaughtering weights of fattened pigs were established on slaughtering line, while weight of the halves warm and cold (after 24 hours of cooling on +4°C), were established after the slaughtering. Content of intramuscular fat (IMF) in samples taken from the left side (between the 13th and 14 ribth) of musculus longissimus dorsi (MLD) and fat in samples of belonging back fat (BF) was analyzed by method according to Soxhlet.

Composition of saturated (SFA), mono-unsaturated (MUFA) and polysaturated (PUFA) fatty acids was analyzed by gas chromatography (ISO 5508/1990 Method). Data was processed by GSM procedure SAS (1996).

RESULTS AND DISCUSSION

Table 1 shows carcass weights, percentages of IMF in MLD and fat in back fat tissue, as well as SFA, MUFA and PUFA values.

Table 1

Live and carcass weight of hogs and composition of fatty acid in IMF MLD and fat BF

Trait		Group					
		T			CLT		
		$\bar{x}$	S	min-max	$\bar{x}$	s	min-max
LW	kg	87.0	8.5**		126.0	5.5**	
CW	kg	69.50	8.68**		106.1	8.52**	
IMF	MLD	3.03	0.65	2.28-4.60	3.96	0.54	2.74-6.50
	BF	92.98	3.76	84.08-96.76	90.80	5.63	81.90-95.94
SFA	MLD	39.68	3.74	35.43-46.49	40.15	3.80	35.43-44.45
	BF	37.05	3.37	34.52-41.78	37.96	4.25	34.04-43.95
MUFA	MLD	54.84	2.95	50.07-59.01	52.92	2.85	49.62-56.96
	BF	50.70	1.97	48.18-55.31	51.43	1.34	50.12-53.19
PUFA	MLD	5.67	2.87	3.35-12.76	6.88	4.39	3.09-14.79
	BF	12.18	2.41	7.67-15.88	10.61	2.85	6.05-14.09

***P<0.01*

Taking into account the age of pigs at slaughtering, results for slaughtering weight and weights of the sides obtained in both groups, as shown in *Table 1*, indicate low weight gain and different feed utilization efficiency of some animals in the outdoor system. Differences in weight are statistically significant, as expected, due to the age of pigs and their different genetic background. Although Turopolje pig is considered to be a late-mature, dual-purpose type of pig for production of both meat and fat, results of its' crossbreeds, due to their economical justification, nevertheless suggest further multidisciplinary examination. Health of the animals, management and technology of low input of feed should be looked into more closely, as well as the ecosystem as a natural source of feed, because the whole process of pig production (from birth till the end of fattening) takes place in the outdoor system of production.

Percent of IMF in MLD established in hogs of Turopolje breed (3.03) is lower than in CLT crossbreeds (3.96), while it was other way around when content of fat in BF is considered (92.98 and 90.80), but differences were not statistically significant, although that was the case in carcass weights and age of hogs.

These results are higher than values (2.53%) reported by *Kolodziej et al.* (2001) and are far above those (0.99%) reported by *Walstra et al.* (2000). Both authors carried out their researches on high meat yielding genotypes from industrial production. *Oliver et al.* (1997) established 3.96% of IMF in ML *thoracis* in Iberian breed hogs and 0.66% in Landrace, but under conditions of intensive production. This is a very interesting information, because older references citated by *Đikić* and *Jurić* (2001) point out that both Turopolje and Iberian breed descend from sus mediterraneus pig. Besides that, literature in past and meat consumers these days say that Turopolje pig has very juicy and tasteful meat, what could be a result of rather high IMF percentage in meat. Percent of IMF in MLD, established in hogs of both groups, coincides with the present picture of importance of IMF percentage for meat quality and it is one of the most recent breeding goals in pig selection.

Latest market demands on the European market, regarding the quality of fresh meat, are on the level of 2-3% of IMF, with no visible marbling. In the same time, on Japanese market pork should have more than 3% IMF, with noticeable marbling, while on the North American market IMF should be below 2% with wide spread opinion that pork is always too fatty for human health (*Maedows,* 1998).

Gerbens et al. (1998) set methods and discover a gene for Duroc pigs (heart and adipocyte fatty acid binding protein H-FAB, A-FAB) responsible for meat marbling, i.e. IMF. Also, pig population analyses in pig selection are implemented in some countries (*Maedows,* 1998; *Nechtelberger et al.,* 2001).

Content of fatty acids in IMF of MLD (Table 1) shows no significant differences in SFA, MUFA and PUFA percentage between the two groups. However, values for MUFA are higher and those for PUFA are lower in T hogs (54.84% and 5.67%, respectively), than in group CLT (52.92% and 6.93%, respectively). This could indicate that those differences are caused by the genetic base of hogs, because halves of CL sows have high meat percentage 54.5% (*Đikić,* 2001). According to data published by *Kolodziej et al.* (2001), there is a positive significant correlation (r=0,44) between percentage of muscles in carcass and PUFA and a negative one between total cholesterol in meat and PUFA (r=-0.59).

Table 2

Fatty acid composition in IMF of MLD

Fatty Acid	GROUP					
	TUROPOLJE PIG			CROSSBREEDS (CL×T)		
%	$\bar{x}$	SD	Min-Max	$\bar{x}$	SD	Min-Max
C<12	0.87	0.73	0.18-2.11	0.95	0.51	0.17-1.57
C12	0.23	0.26	0.08-0.75	0.47	0.22	0.09-0.33
C14	1.30	0.19	0.84-1.49	1.80	0.30	1.32-2.11
C15	0.16	0.18	0.05-0.52	0.13	0.10	0.03-0.26
C15:1	0.20	0.22	0.09-0.71	0.36	0.21	0.06-0.61
C16	25.20	2.30	22.91-29.53	24.78	2.64	22.50-28.34
C16:1	4.01	0.93	1.56-4.85	3.82	0.38	3.28-4.43
C17	0.23	0.03	0.18-0.28	0.22	0.06	0.13-0.29
C17:1	0.20	0.10	0.15-0.44	0.30	0.10	0.19-0.44
C18	11.06	1.28	9.75-13.28	10.68	1.02	9.38-12.12
C18:1	48.70	2.85	43.92-52.92	46.23	3.33	41.46-51.16
C18:2	5.46	2.85	3.14-12.55	6.40	4.36	2.34-14.31
C18:3	0.21	0.10	0.11-0.34	0.48	0.27	0.19-0.75
C20	0.13	0.02	0.12-0.16	0.16	0.07	0.03-0.22
C20:1	0.62	0.21	0.51-1.15	1.33	0.74	0.54-2.57
C22	0.74	0.65	0.16-1.96	0.86	0.66	0.21-2.04
C22:1	0.68	0.31	0.48-1.37	0.55	0.36	0.07-0.96
C24	0.00	0.00	0.00	0.14	0.08	0.06-0.21
C24:1	0.00	0.00	0.00	0.34	0.40	0.06-0.80

SFA was high in both experimental groups (39.68% and 40.15%), while PUFA content was low (5.67% and 6.88%). This indicates a poor meat quality, especially having in

mind the most recent data reported by *Newton* (2001) and *Hayes* (2001) regarding the role of PUFA in human nutrition connected to prevention of cardiovascular diseases, autoimmune disorders, diabetes and arthritis. But when the relation between UFA and SFA is analyzed in both of the experimental groups, it could be concluded that, due to high content of MUFA, meat is of somewhat higher quality and similar to meat of meat-type pig genotypes in which *Kolodziej et al*. (2001) found 61.63% UFA. Nevertheless, quality of meat of our experimental groups is below the quality of the Iberian breed and Landrace for which Oliver established UFA content of 65.23% and 67.77%, respectively.

Fatty acid composition of fat in BF of both experimental groups, if analyzed as total UFA and SFA, shows more favorable relation than established by *Barton–Gade* (1987) in different genotypes of high meat yielding pigs, where UFA was 57.26-59.52% and SFA 40.48-43.21%. In the same time, values for UFA and SFA established by *Oliver et al.* (1997) for Iberian breed and Landrace are much higher - 65.23% and 34.64% for Iberian breed and 67.77% and 32.14% for Landrace, respectively.

Tables 2 and *3* show fatty acid composition of IMF in MLD and fat in BF.

Table 3

Fatty acid composition in fat tissue of BF

Fatty Acid %	GROUP					
	TUROPOLJE PIG			CROSSBREEDS (CL×T)		
	$\bar{x}$	SD	Min-Max	$\bar{x}$	SD	Min-Max
C<12	0.12	0.10	0.05-0.38	0.20	0.17	0.05-0.52
C12	0.09	0.04	0.06-0.17	0.13	0.07	0.06-0.24
C14	1.20	0.11	1.05-1.35	1.30	0.21	1.17-1.80
C15	0.08	0.06	0.05-0.24	0.07	0.04	0.04-0.14
C15:1	0.07	0.04	0.01-0.14	0.11	0.11	0.03-0.29
C16	22.50	1.63	20.77-25.31	23.70	2.75	19.81-27.73
C16:1	2.60	0.54	1.79-3.82	2.26	0.38	1.89-2.74
C17	0.40	0.03	0.37-0.47	0.36	0.066	0.30-0.48
C17:1	0.30	0.07	0.25-0.51	0.28	0.047	0.23-0.35
C18	11.80	2.06	7.04-14.35	11.71	1.644	10.45-14.92
C18:1	46.55	1.66	43.56-49.65	47.52	1.25	45.83-48.88
C18:2	11.40	1.95	7.34-13.17	10.03	2.55	5.64-12.89
C18:3	0.78	0.24	0.33-1.09	0.88	0.30	0.41-1.20
C20	0.15	0.04	0.10-0.24	0.17	0.06	0.10-0.28
C20:1	0.87	0.14	0.71-1.20	1.17	0.32	0.90-1.72
C22	0.62	0.27	0.31-1.22	0.77	0.49	0.40-1.71
C22:1	0.32	0.18	0.08-0.71	0.24	0.09	0.11-0.36
C24	0.09	0.04	0.06-0.14	0.10	0.03	0.08-0.13
C24:1	0.06	0.02	0.05-0.08	0.00	0.00	0.00

However, it has to be (*Table 1*) stated hereby that PUFA content in IMF of MLD in Turopolje breed and CLT crossbreeds is very low (5.55% and 6.93%, respectively), related to significance given to PUFA. Among them, without doubt, the most imported are C18:2 and C18:3 as precursors of omega-3 and omega-6 fatty acids that are recently

of particular interest in human diet formulation (*Lawrie,* 1998; *Newton,* 2001; *Hayes,* 2001). It is just the analysis of the results (*Table 2* and *3*) that show very low C18:2 and C18:3 content in IMF of MLD and fat in BF of both research groups, when compared to results of *Oliver et al.* (1997), *Kolodziej et al.* (2001), *Barton-Gade* (1987) and *Cameron et al.* (1989).

However, data referred by *Cameron et al.* (2000) and *Horberg et al.* (2001) suggest that nutrition and management could change these relations in pig fat and meat. But, it has to be added that in IMF of MLD and BF of both groups of hogs, the C18:1 content in UFA shows very high values in relation to C18:2 and C18:3. That is one of properties needed for production of quality dry-cured meat products, for which it is intended in future to use meat of Turopolje pig and its' crossbreeds.

CONCLUSIONS

Content of IMF in MLD established in Turopolje pig (3.03%) and CLT crossbreeds (3.96%) correspond with recent standards of modern pig meat market.

Quality of IMF in MLD and fat in BF of both experimental groups, analyzed through SFA, MUFA and PUFA content, show especially low PUFA values, raising the question of analysis and, perhaps, change of technology of hogs feeding in the outdoor system.

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Corresponding author:

Marija Đikić
Faculty of Agriculture, University of Zagreb
HR-10000 Zagreb, Svetošimunska c. 25., Croatia
Tel.: 385 1 239 3799, Fax: 385 1 239 3947
e-mail: mdikic@agr.hr