

FATTY ACIDS CONTENT IN CATTLE MEAT (A REVIEW)

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SUMMARY: In this paper, an attempt was made to review the meat fatty acid content in cattle breeds. Cattle meat contain high proportions of saturated fatty acids, that influence cardiovascular diseases in human population. The content of polyunsaturated fatty acids (PUFA) and PUFA/SFA ratio in the beef meat depends on the breed and is higher in autothonous (old) breeds in Europe (Italian Podolian, Greek Katherini) and Asia (Japanese Black, Brahman, Hanwoo), compared with modern intensive meat production breeds (Charolaise, Limousine and Hereford). Stearoyl-CoA desaturase plays a key metabolic role by changing the saturated FA content of ruminant meat. The enzyme responsible for the conversion of all saturated fatty acids (SFA) to their respective monounsaturated fatty acids (MUFA) is $\Delta 9$ desaturase. This enzyme is encoded by the stearoyl coenzyme A desaturase (SCD) gene. The polymorphisms in fatty acids content could be potential useful genetic method to improve the nutritional quality of the cattle meat.

Key words: meat, fatty acids, content, breed, cattle.

INTRODUCTION

In the recent years, the consumer's decision to purchase a specific food, especially in developed countries, is greatly influenced by the perception of the food 'healthiness', which in the case of meat is largely related to its fat content and its fatty acid composition, namely the polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA) and the saturated fatty acids (SFA) contents (Hermansen, 2003; Dias et al., 2008). An imbalance of dietary cholesterol and fats are the primary cause of atherosclerosis and cardiovascular disease (Griel et al., 2006). Many studies demonstrate strong positive correlations between intake of SFA and the incidence of cardiovascular

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disease, a condition believed to result from the concomitant rise in serum low-density-lipoprotein (LDL) cholesterol as SFA intake increases (Daleu et al., 2010). According to these findings, health professionals world-wide recommend a reduction in the overall consumption of saturated fatty acids (SFA), trans-fatty acids (TA) and cholesterol, while emphasizing the need to increase intake of polyunsaturated fatty acids (PUFA). Until recently, dietary recommendations for humans promoting the consumption of less saturated fat have led to an increased interest in meats containing more unsaturated and polyunsaturated (PUFA) fatty acids and with a satisfactory PUFA/SFA ratio (Griel et al., 2006; Kris-Etherton and Innis, 2007).

Genetic variations among the cattle breeds, nutrition, housing systems, gender, age and climatic ambient are the major factors that change carcass characteristics, chemical composition and fatty acid profile (Čobić et al., 1988; Antov et al., 1995; De Smet et al., 2000; De Smet et al., 2004; Dias et al., 2008; Plavšić et al., 2008; Rotta et al., 2009; Daley et al., 2010). Breeds genetic variations is one of the most important factors for fat deposition, composition an fatty acids profile, which needs to be understood because of its genetic transmission (Perotto et al., 2000; Rotta et al., 2009). It was frequently demonstrated that content of PUFA and PUFA/SFA ratio in the beef meat is higher in autothonous (old) breeds in Europe (Italian Podolian, Greek Katherini) and Asia (Japanese Black, Brahman, Hanwoo), compared with modern intesinne meat production breeds (Charolaise, Limousine and Hereford) (Braghieri et al., 2000; Carnoala et al., 2000; Dymicka et al., 2004; Smith et al., 2006; Smith et al., 2009; Rotta et al., 2009; Dinh et al., 2010; Karatosidi et al., 2010). However, the detailed mechanisms of this variation, and whether or how they can be manipulated are not clearly known.

The aim of present paper is to review some recent results about fatty acids content variations in cattle breeds and possible mechanisms that influence to this phenomenon.

FIELD EXPERIMENTS RESULTS

The consumer market for beef has become increasingly demanding as a result of negative factors associated with meat quality. Among these factors is the relationship between beef consumption and heart disease, atherosclerosis, intestinal cancer and obesity, among other diseases. These desease is mainly influenced by the content of total lipids and total cholesterol in cattle meat (Rotta et al., 2009). Reductions in total fat and in saturated fatty acid (SFA) intake decrease the prevalence of coronary heart disease. Consequently, if the saturated fatty acids can be reduced and replaced with polyunsaturated fatty acids (PUFA) of known health benefits, then it could be expected that consumers would look more favorably on cattle meat (Williams, 2000).

It has been frequently demonstrated the significant variation among cattle breed in total content of polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA) and the saturated fatty acids (SFA) contents, as well as PUFA/SPA and MUFA/SFA ratio in meat (Braghieri et al., 2005; Smith et al., 2006; Bureš et al., 2006; Dias et al., 2008; Smith et al., 2009; Karatosidi et al., 2010) (Table 1).

Table 1. Fatty acid composition in cattle breeds meat

Breed	Fatty acids (% total fatty acid)			Fatty acids ration		Source, Country/Authors
	SFA	MUFA	PUFA	PUFA/SPA	MUFA/SFA	
Podolian	46.98	36.72	16.30	0.35	-	Italy Braghieri et al., 2005.
Katerini	46.42	28.32	16.16	0.32	-	Greece Karatosidi et al., 2010.
Podolian x Limousine	46.16	37.08	13.44	0.28	-	
Mirandesa	52.56	32.37	13.19	0.25	-	Portugal Dias et al., 2008.
Barrosa	52.93	34.50	11.80	0.22	-	
A. Angus	-	-	-	-	0.66	USA (Texas), Japan, Korea Smith et al., 2006. Smith et al., 2009.
Australian	-	-	-	-	0.77	
Japanese Black	-	-	-	-	1.86	
Hanwoo	-	-	-	-	1.28	
Brahman	-	-	-	-	1.85	
Hereford	-	-	-	-	1.59	
A. Angus	51.43	38.53	7.39	0.15	-	Czech Republik Bureš et al., 2006.
Charolais	53.30	35.29	8.31	0.16	-	
Simental	48.87	39.67	8.73	0.18	-	
Hereford	50.58	39.56	7.23	0.14	-	

The content of PUFA and PUFA/SFA ratio in the beef meat depends on the breed and is higher in autothonous (old) breeds in Europe (Italian Podolian, Greek Katherini) and Asia (Japanese Black, Brahman, Hanwoo), compared with modern intensive meat production breeds (Charolaise, Limousine and Hereford). The meat produced by Podolian and other Italian autothonous breeds showed a higher percentage content of polyunsaturated fatty acids and a beneficial PUFA/SFA ratio (Carnovale and Nicoli, 2000; Cifuni et al., 2004). A detrimental effect of crossbreeding (autohtonous x modern intensive breeds) on the PUFA/SFA ratio was observed as the meat from autothonous breeds showed higher and more beneficial levels of PUFA (Braghieri et al., 2005; Rotta et al., 2009).

Ruminant-derived foods contain high proportions of saturated fats, a result of microbial biohydrogenation within the rumen which rapidly saturates and thus limits the availability of free unsaturated fatty acids for absorption and assimilation (Anderson et al., 2011). Many attempts have been made in order to increase the PUFA content of meat, such as administration of fish oil or vegetable oils rich in PUFAs (coconut, olive, canola, sunflower, etc.). But, unfortunately most of the methods adopted are ineffective, since PUFAs administered by the diet undergo bio-hydrogenation inside the rumen. As a consequence, the fatty acids leaving the rumen and hence absorbed through the intestine and eventually incorporated into muscles are quite different from those introduced with the diet (González and Andrès, 2003; Jenkins and Bridges, 2007; Vicenti et al., 2009).

PHYSIOLOGICAL MECHANISME OF MEAT FATTY ACIDS PROFILE

Meat fatty acid composition is influenced by genetic factors, although to a lower extent than dietary factors. The species is the major source of variation in fatty acid composition with ruminant meats being more saturated as a result of biohydrogenation

in the rumen compared to the meat of monogastric animals. The level of fatness also has an effect on the meat fatty acid composition. The contents of saturated (SFA) and monounsaturated (MUFA) fatty acids increase faster with increasing fatness than does the content of PUFA, resulting in a decrease in the relative proportion of PUFA and consequently in the polyunsaturated/saturated fatty acids (P/S) ratio (De Smet et al., 2004).

Some authors determined enzyme activities in subcutaneous adipose tissue for enzyme activities from fatty acid (FA) composition data in order to explain the observed cattle breeds variability in fatty acid composition (Cameron et al., 1994). Stearoyl-CoA desaturase (SCD) plays a key metabolic role by changing the saturated FA content of ruminant meat. The enzyme responsible for the conversion of all saturated fatty acids (SFA) to their respective monounsaturated fatty acids (MUFA) is $\Delta 9$ desaturase. This enzyme is encoded by the stearoyl coenzyme A desaturase (SCD) gene. Tissue accumulates monounsaturated fatty acids, coincides with an increase in $\Delta 9$ desaturase gene expression and catalytic activity. Although differences in SCD gene expression may contribute to the meat fatty acid compositional differences between cattle breeds, biochemical and molecular genetic studies should be encouraged to unravel the mechanisms responsible for differences in the metabolism and incorporation of specific fatty acids in meat (Dance et al., 2009; Pauciullo et al., 2010). Such polymorphisms in fatty acids content could be potential useful genetic method to improve the nutritional quality of the cattle meat.

CONCLUSION

According to results of the present investigations, it is possible to concluded:

- 1) Diets high in saturated fats are associated with certain negative-health effects such as coronary heart disease.
- 2) Breeds genetic variations is one of the most important factors for fat deposition, composition an fatty acids profile. Rearing sistem (pasture vs. indoors) and diet (grass, hay, silage, corn, concentrate) are factors that can influence beef total fat and fatty acid composition, too.
- 3) The content of PUFA and PUFA:SFA ratio in the beef meat depends on the breed and is higher in autothonous (old) breeds in Europe and Asia, compared with modern intesinve meat production breeds.
- 4) Stearoyl-CoA desaturase plays a key metabolic role by changing the saturated FA content of ruminant milk and meat. The enzyme responsible for the conversion of all saturated fatty acids (SFA) to their respective monounsaturated fatty acids (MUFA) is $\Delta 9$ desaturase. This enzyme is encoded by the stearoyl coenzyme A desaturase (SCD) gene. Tissue accumulates monounsaturated fatty acids, coincides with an increase in $\Delta 9$ desaturase gene expression and catalytic activity.
- 5) Research carried out on Podolian cattle reared in Italy has reported the good nutritional value of meat, characterized by a lower concentration of saturated fatty acids as compared with other beef breeds, in turn of a better content of unsaturated and polyunsaturated fatty acids. This makes Podolian meat a valuable food since saturated fatty acids are held responsible for coronary diseases and cancer.
- 6) There is no evidence about PUFA and PUFA:SFA ratio in the Serbian Podolian breed.

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SADRŽAJ MASNIH KISELINA U MESU GOVEDA (PREGLED)

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Izvod

U radu je pokušano da se napravi pregled sadržaja masnih kiselina u mesu različitih rasa goveda. Meso goveda sadrži visok nivo zasićenih masnih kiselina (ZMK), što dovodi do pojave kardiovaskularnih obolenja kod ljudi. Sadržaj polinezasićenih masnih kiselina (PNMK) i odnos PNMK/ZMK u goveđem mesu zavisi od rase i veći je kod primitivnih evropskih i azijskih rasa, u poređenju sa modernim rasama za intenzivnu proizvodnju mesa. Stearoyl-CoA desaturaza ima ključnu metaboličku ulogu kod promene sadržaja ZMK u mesu goveda. Enzim Δ^9 desaturaza je odgovoran za konverziju svih ZMK u odgovarajuće mononezasićene masne kiseline. Sintezu ovog enzima kontoliše stearoyl coenzyme A desaturaza gen. Polimorfizam sadržaja masnih kiselina može biti potencijalno upotrebljiv metod poboljšanja nutritivnog kvaliteta goveđeg mesa.

Ključne reči: meso, masne kiseline, sadržaj, rasa, goveda.

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