POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES
Pol. J. Food Nutr. Sci. 2003, Vol. 12/53 No 4, pp. 59–62

THE QUANTITATIVE AND QUALITATIVE CHANGES OF THIAMINE IN STERILIZED PORK IN THE PRESENCE OF SELECTED TECHNOLOGICAL ADDITIVES

Krystyna Szymandera-Buszka

Department of Human Nutrition, A. Cieszkowski Agricultural University, Poznań

Key words: pork, thiamine, sterilization, oxidized lard, casein hydrolysate, rosemary extract

The aim of the work was to determine the effect of sterilization of pork in the presence of oxidized lard and selected antioxidants on quantitative and qualitative changes of thiamine in pork. The antioxidants were casein hydrolysate and rosemary extract.

It was found that sterilization itself caused the greatest losses in both forms of thiamine. In the case of adding fresh lard to the meat, the total thiamine losses were 58%, and introduction of the oxidized fat increased the losses to 63%. The bound thiamine determined the size of the losses. Application of rosemary extract with fresh fat during thermal processing lowered the loss of the bound thiamine by 5%, while casein hydrolysate contributed to decreasing the loss of the bound thiamine by 4.5%. In the presence of the oxidized fat, a similar protective activity with respect to thiamine of both antioxidants was found with better effect obtained with casein hydrolysate.

INTRODUCTION

Measurement of group B vitamins is, besides amino acid composition, a basic index of nutritive value of meat and its products. This particularly concerns thiamine which is related to the fact that, besides cereals, slaughter animal meat is the main source of this vitamin in a human diet. Taking into account the need to prolong storage time of meat products, fat oxidation accelerated by the thermal processing gains more importance. It is well known that oxidative transformations constitute a serious technological problem contributing to lowering sensory parameters of fats, lowering their nutritive and even wholesome value [Janitz, 1987; Janitz *et al.,* 1990; Kappus, 1991; Ziemlański & Budzyńska-Topolowska, 1991; Frankel, 1996].

Directed by the above premises a study on the effect of fat oxidation products on quantitative changes of thiamine was started, mainly with respect to unfavourable effect of high temperature [Dwivedi & Arnold, 1972; Seuß, 1984; Szymandera-Buszka & Janitz, 1999]. During frying, the losses caused by high temperature are intensified by activity of the resulting products of fat oxidation and amount from 10 to 50% [Bognar, 1978; Howarter & Klein, 1978; Bowers & Craig; 1987; Cooksey *et al.*, 1990]. During storage of beef with an addition of oxidized oil, an increase in the losses of total thiamine by 40–50% was observed at greater susceptibility of bound thiamine to decomposition [Szymandera-Buszka, 1998].

The thiamine losses caused by the activity of the fat oxidation products result from high sensitivity of thiamine to oxido-reductive factors [Dwivedi & Arnold, 1972]. Introduction of casein hydrolysate, soy hydrolysate or rosemary extract as antioxidant substances [Koziorowska, 1988; Pikul, 1992; Pokorny *et al.*, 1998] facilitates lowering the thiamine losses related to present fat, by about 5% [Szymandera-Buszka & Janitz, 1999].

Considering the fact that slaughter animal meat is one of the main sources of thiamine in a human diet, recognition of the scale of mutual effects of technological factors on thiamine content in meat products becomes a necessity resulting from nutritive and wholesome premises.

The aim of the work was to determine the effect of pork sterilization process in the presence of oxidized lard and selected antioxidants on the quantitative and qualitative changes in thiamine. Casein hydrolysate and rosemary extract were used as antioxidants.

MATERIALS AND METHODS

In the study, pork – *m. longissimus dorsi* was the source of thiamine. Each muscle was divided into two parts along the longer axis.

To add technological components, the meat was previously comminuted with a mincer with 2 mm mesh. The minced meat mass was precisely mixed with each component.

Quantitative proportion and variability of each component was as follows: (I) pork lard – fresh with Lea number = 0.5 (obtained with a scraper method in the Meat Processing Plant "Pozmeat" in Poznań, Poland) was added in the proportion of 30 g/70 g of meat; (II) pork lard – oxidized, obtained from incubation at a temperature of 60±1°C till obtaining the Lea number of 15, was mixed with the meat in the proportion of 30 g/70 g of meat; (III) casein hydrolysate (Bestfoods POLSKA "Amino") with total nitrogen content of 3.04%, and amino nitrogen 1.72%, which was introduced in liquid form in the proportion of 2 g/100 g of meat; and (IV) rosemary extract (*Rosmarinus officinalis-Labitate*) obtained using ethanol extraction (0.5 kg dry comminuted

Author's address for correspondence: Krystyna Szymandera-Buszka, Katedra Technologii Żywienia Człowieka, Akademia Rolnicza im. A. Cieszkowskiego, ul. Wojska Polskiego 31, 60-624 Poznań, tel.: (48 61) 848 73 79; fax: (48 61) 848 74 31; e-mail krbuszka@ owl.au.poznan.pl

mass of rosemary was washed with 1000 cm^3 of 96% ethanol, macerated for 24 h and then the solvent was evaporated at 50–60°C). The extract was added in the proportion of 20 mg/100 g of meat.

After mixing with the above-mentioned components, the meat was placed in glass jars (170 cm^3) with twist-off type cap (*ca.* 55 mm diameter). The painted-black jars containing 100 g of meat were closed in nitrogen atmosphere. Sterilization was carried out in an autoclave at 121°C for 20 min taking into account the time needed for heating up and cooling.

The thiamine content was determined with a thiochromium method by analyzing quantitative changes in total and free thiamine [Rettenmaier *et al.*, 1979; Janitz, 1985]. The amount of the bound thiamine was calculated from the difference between the total thiamine and the free one. The results of thiamine content were presented as recalculated into fat-free dry mass. Therefore the water content was determined with the drier method [PN-ISO 1442: 2000], and that of fat with the extraction-weight method according to Soxhlet using petroleum benzine as a solvent [PN-ISO 1444: 2000].

The obtained results of thiamine content were subjected to an analysis of variance at a significance level of $\alpha=0.01$.

RESULTS AND DISCUSSION

The efficay of the protective activity of rosemary extract and casein hydrolysate with respect to thiamine during sterilization in the presence of oxidized lard is given in Table 1 and in Figure 1.

On the basis of the results presented, it is possible to state that the sterilization process causes the greatest losses of both forms of thiamine, which supports earlier studies [Janitz, 1978], and the presence of the products of fat oxidation intensifies the unfavourable effect of thermal processing.

The sterilization process, disrupting thiazole ring, caused losses of the total thiamine reaching 58% in the case of adding fresh lard to the meat, while addition of the oxidized fat further increased the total thiamine loss up to 63%. The losses were mainly related to the bound thiamine whose reduction in the case of the presence of fresh and oxidised lard amounted to 84% and 89%, respectively. Free thiamine revealed lower susceptibility to decomposition in the presence of the discussed factors, being degraded in

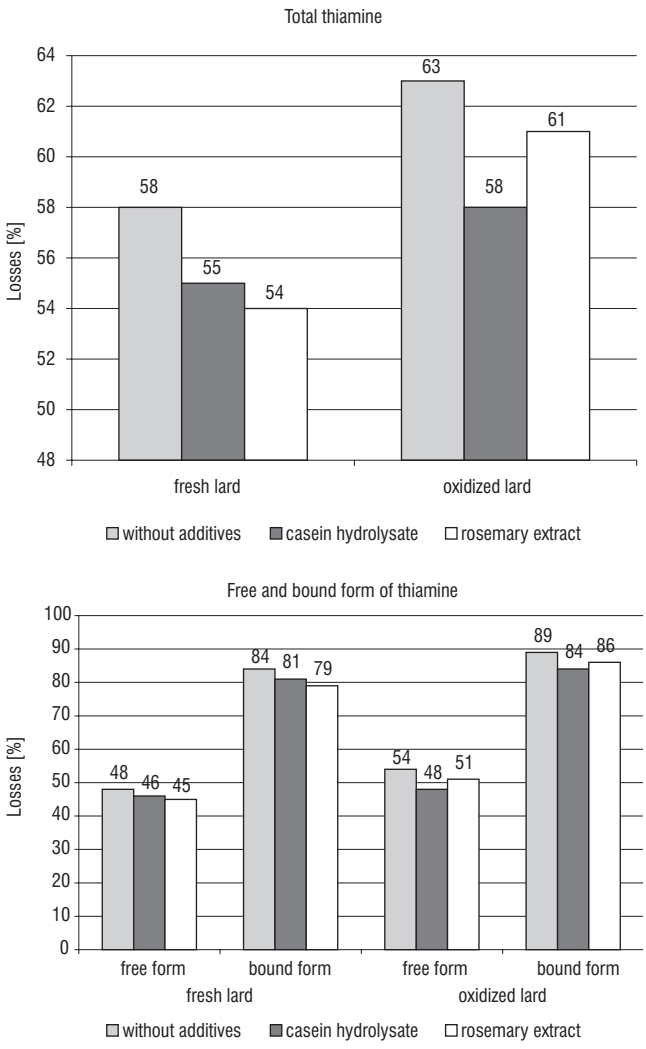

FIGURE 1. Quantitative and qualitative losses of thiamine in meat sterilized in the presence of oxidized lard and selected antioxidants.

48% in the presence of the fresh lard and in 54% after addition of oxidized fat. It should be supposed that during thermal processing in the presence of the oxidized fat, thiamine is partially protected by peptides and free amino acids, such as cysteine, formed due to protein fragmentation [Janitz & Czyżewska, 1983].

Confirmation of an unfavorable effect of fat oxidation products on the content of both free and bound thiamine is

TABLE 1. Effect of oxidized lard and selected antioxidants on the quantitative and qualitative changes in thiamine in meat during sterilization.

Technological processing		Thiamine content [mg/100g free-fat dry matter]					
		Total		Free form		Bound form	
		x_t	%	x_f	%	$x_t - x_f$	%
Meat sterilized without additives		1.86[a]*	46.97	1.62[a]	55.29	0.24	23.30
Meat sterilized+ fresh lard	without additives	1.68[c]	42.42	1.52[b]	51.88	0.16	15.79
	+ casein hydrolyzate	1.79[b]	45.20	1.59[a]	54.27	0.20	19.42
	+ rosemary extract	1.82[b]	45.96	1.61[a]	54.95	0.21	20.86
Meat sterilized + oxidized lard	without additives	1.46[e]	36.87	1.35[d]	46.08	0.11	10.68
	+ casein hydrolyzate	1.66[c]	41.92	1.51[b]	51.54	0.15	15.79
	+ rosemary extract	1.56[d]	39.39	1.42[c]	48.46	0.14	13.84

% – thiamine content as compared to its content in raw meat, * – the means marked with different letters in the same column are statistically significantly different at $p<0.01$.

lowereing the losses due to the application of antioxidants [Zwierzykowski, 1976; Pazoła & Korczak, 1987; Amarowicz & Shahidi, 1997; Korczak, 1998, 2000; Korczak *et al.*, 1999]. The application of rosemary extract as an antioxidant limiting formation of peroxides, during thermal processing with an addition of fresh fat, limited losses of the free thiamine by 3%, and of the bound one by 5%. Due to reactions of amino acids, peptides and products of the Maillard's reaction, casein hydrolysate brought about lowering of the free thiamine by 2.5%, and of the bound one by 4.5%.

In the environment with an addition of oxidized fat, protective activity of both antioxidants with respect to thiamine was found, with predomination of casein hydrolysate. Amino groups of casein hydrolysate lowered the losses of both free and bound thiamine by 5% by means of decomposition of peroxides. The application of rosemary extract resulted in lowering the free thiamine by 2%, and of the bound one by 3%.

CONCLUSIONS

The results obtained allowed, the following conclusions to be drawn:

1. The application of sterilization as thermal processing causes losses in the total thiamine of over 50%, with greater susceptibility to decomposition revealed by the bound thiamine.

2. Introduction of oxidized lard as a source of products of fat oxidation increased the total thiamine losses to 63%. This concerns the bound thiamine more than the free one.

3. The addition of casein hydrolysate and rosemary extract to meat affects lowering the quantitative losses of both free and bound thiamine caused by the fat introduced during thermal processing.

REFERENCES

1. Amarowicz R., Shahidi F., Antioxidant activity of peptide fractions of capelin protein hydrolysate. Food Chem., 1997, 58, 355.
2. Bognar A., Einfluss neuartiger Bratverfahren und den Nährwert von Schweinefleisch. Lebensmittelchemie und Gerichtliche Chemie, 1978, 32, 110.
3. Bowers J.A., Craig J., Components of vitamin B in turkey breast muscle. J. Food Sci., 1987, 43, 1916.
4. Cooksey K., Klein B.P., Mc Keith F.K., Thiamine retention and other characteristics of cooked beef loin roasts. J. Food Sci., 1990, 55, 863.
5. Dwivedi B.K., Arnold R.G., Chemistry of thiamine degradation with 4-methyl-S(β-hydroksyethyl) thiazole from thermally degraded thiamine. J. Food Sci., 1972, 37, 689.
6. Frankel E.N., Oxidation of polyunsaturated lipids and its nutritional consequences. Oils-Fats-Lipids 1995, 1996, *In*: Proceedings of the 21st. World Congress of the ISF, v. 2, PJ Barnes and Associates, Bridgwater, 265.
7. Howarter K.B., Klein B.P., Thiamine content and palatability of quick breads made with soy-egg flours. J. Food Sci., 1978, 43, 1010.
8. Janitz W., Czyżewska S., Thermischer Abbau des freien Thiamins im Schweinefleisch bei Vorhandensein technologischer Zusätze und Schwefelaminosäuren. Fleischwirtschaft, 1983, 63, 1761.
9. Janitz W., 1978, Wpływ zmian autolitycznych mięsa i użytych dodatków technologicznych na kształtowanie się wybranych wskaźników wartości odżywczej sterylizowanych konserw mięsnych. Skrypty AR, Poznań (in Polish).
10. Janitz W., 1985, Chemiczne wskaźniki wartości odżywczej mięsa i jego przetworów oraz tłuszczu zwierzęcego. Skrypty AR, Poznań, pp. 83–90 (in Polish).
11. Janitz W., Technologiczne i żywieniowe konsekwencje reakcji utlenionych tłuszczów z białkami mięsa. Med. Wet., 1987, 43, 25 (in Polish).
12. Janitz W., Grześkowiak B., Korczak J., Berghofer E., Einfluss technologischer Massnahmen auf die Reaktionen oxidierter Fette mit Fleischproteinen. II Nährwertveränderungen. Fleischwirtschaft, 1990, 70, 600.
13. Kappus H., Lipid peroxidation: Mechanism and biological relevance. 1991, *In:* Free Radicals and Food Additives (eds. Auroma O. I., Halliwell B.). Taylor and Francis, London, 59.
14. Korczak J., Czynniki warunkujące właściwości przeciwutleniające hydrolizatów białkowych soi i kazeiny. Roczniki Akademii Rolniczej w Poznaniu, Rozprawy Naukowe, 1998, Zeszyt 281 (in Polish).
15. Korczak J., Substancje przeciwutleniające w żywności. Mat. Krajowej Konf. Naukowo-Technicznej "Dodatki do żywności w przemyśle spożywczym" Kołobrzeg, 2000, 5 (in Polish).
16. Korczak J., Janitz W., Hęś M., Nogala-Kałucka M., Gogolewski M., Stabilizacja oleju rzepakowego przy wykorzystaniu naturalnych przeciwutleniaczy. Rośliny Oleiste, 1999, 20, 569 (in Polish).
17. Koziorowska B., Przeciwutleniające działanie roślin przyprawowych w żywności. Przegl. Gastr., 1988, 43(4), 14 (in Polish).
18. Pazoła Z., Korczak J., Przemysłowe preparaty o smaku mięsnym jako źródło naturalnych przeciwutleniaczy. Mat XVIII Sesji Naukowej KTiChŻ PAN, Gdańsk, 1987 (in Polish).
19. Pikul J., Utlenianie lipidów i powstawanie obcego zapachu oraz smaku w ogrzewanym i przechowywanym mięsie. cz.II. Gosp. Mięsna, 1992, 44 (08), 22 (in Polish).
20. PN-ISO 1442: 2000, Mięso i przetwory mięsne. Oznaczanie zawartości wody (metoda odwoławcza).
21. PN-ISO 1444: 2000, Mięso i przetwory mięsne. Oznaczanie zawartości tłuszczu wolnego.
22. Pokorny J. Reblova Z., Trojakova L., Korczak J., Janitz W., Antioxidant activites of herbs and spices. 1998, *In*: Proceedings of World Conference on Oilseed and Edible Oils Processing, Istambul 1996, (eds. Koseoglu S.S., Rhee K.C., Wilson R.F.). vol. II: Advances in Oils and Fats, Antioxidants, and Oilseed By-Products, AOCS Press, Champaign, 265.
23. Rettenmaier R., Vuilleumier J.P., Müller-Mulot W., Zur quantitativen Vitamin-B1- Bestimmung in Nahrungsmitteln und biolgischem Material. Z. Lebensm. Unteres.- Forsch.-Ber., 1979, 168, 120.
24. Seuß I., Einfluss der Räucherung auf nährwertbestimmende Bestandteile von Fleischerzeugnissen 1. Thiamin und Riboflavin. Fleischwirtschaft, 1984, 64, 1172.

25. Szymandera-Buszka K., Oddziaływanie wybranych czynników technologicznych na zmiany ilościowe tiaminy wolnej i związanej w mięsie wołowym. Mat. XXIX Sesji Naukowej KT i ChŻ PAN, Olsztyn, 1998, 255 (in Polish).
26. Szymandera-Buszka K, Janitz W., Udział naturalnych antyoksydantów w kształtowaniu zawartości tiaminy w sterylizowanym mięsie wieprzowym. Mat. z Symp. Jakość Zdrowotna Żywności i Żywienia, Białystok, 1999, 34 (in Polish).
27. Ziemlański Ś., Budzyńska-Topolowska J., Ocena żywieniowa tłuszczów utlenionych. Przem. Spoż., 1991, 45, 98 (in Polish).
28. Zwierzykowski W., Ochrona lipidów przed autooksydacją. Mat. Symp. Kontrola procesów oksydacji lipidów w żywności w świetle postępów chemii i techniki analitycznej, Gdańsk, 1976, 52 (in Polish).

Received December 2002. Revision received February 2003 and accepted August 2003.

ZMIANY ILOŚCIOWE I JAKOŚCIOWE TIAMINY W STERYLIZOWANYM MIĘSIE WIEPRZOWYM W OBECNOŚCI WYBRANYCH DODATKÓW TECHNOLOGICZNYCH

Krystyna Szymandera-Buszka

Katedra Technologii Żywienia Człowieka, Akademia Rolnicza im. Augusta Cieszkowskiego, Poznań

Celem pracy było określenie wpływu zabiegu sterylizacji mięsa wieprzowego w obecności utlenionego smalcu i wybranych przeciwutleniaczy na zmiany ilościowe i jakościowe tiaminy w mięsie wieprzowym. Jako przeciwutleniacze wykorzystano hydrolizat kazeiny i ekstrakt rozmarynu.

Stwierdzono, że sam zabieg sterylizacji spowodował największe straty obu form tiaminy. W przypadku dodania do mięsa smalcu świeżego straty tiaminy ogólnej wynosiły 58%, a wprowadzenie utlenionego tłuszczu przyczyniło się do pogłębienia ubytków tiaminy ogólnej do 63%. Na wielkość tych strat w przeważającej mierze miała wpływ tiamina związana. Zastosowanie ekstraktu rozmarynu z dodatkiem świeżego tłuszczu, podczas obróbki cieplnej, obniżyło straty tiaminy związanej o 5%, a hydrolizat kazeiny przyczynił się do zmniejszenia ubytków tiaminy związanej o 4,5%. W środowisku z dodatkiem utlenionego tłuszczu stwierdzono podobne działanie ochronne wobec tiaminy obu przeciwutleniaczy przy bardziej ochronnym działaniu hydrolizatu kazeiny (tab. 1, rys. 1).