

Antioxidant type, heating method and sausage lipid quality and preference

Tipo de antioxidante, método de aquecimento e qualidade lipídica e preferência de salsichas

ABSTRACT

TORRES, E.A.F.S.; PINTO E SILVA, M.E.M.; ROCCO, S.C.; FERRARI, C.K.B.; SIQUEIRA, J. O. Antioxidant type, heating method and sausage lipid quality and preference. *Nutr. Soc. Bras. Alim. Nutr.* = J. Brazilian Soc. Food Nutr., São Paulo, SP. v.26, p. 37-49, dez., 2003.

The purpose of this study was to compare the influence of two heating methods on the lipid quality of hot dogs. Four different sausage formulations were manufactured using three different types of antioxidants and one control. Each antioxidant was evaluated for storage during 1, 7, 15, 21, 30, 45, and 60 days at -20°C. Each formulation was boiled for 5 minutes or heated in a 700-Watt microwave oven for 1 minute at half power and then submitted to an untrained panel of 30 tasters. The paired preference and acceptance tests were used to compare sensory preferences between the two heating methods. A 9 point hedonic scale was employed to evaluate the acceptability of the hot dogs that presented the highest scores in the previous test. Results indicated that the boiling method was preferred at a significance level of 0.05 for antioxidants in treatments 2, 3 and 4. Only one antioxidant did not present a significant difference ($\alpha = 0.05$) in regard to the heating method. Such antioxidant probably offers good protection against lipid oxidation induced by both heating methods, while the others are effective only for the boiling one. Two antioxidants exhibited the best performance regarding both sensory acceptance and TBA values, indicating that they offer a better protection against lipid oxidation and its consequences. Part of the negative evaluations of the microwave oven-heating method can possibly be related to lipid oxidation rather than to only appearance or texture.

Keywords: sausage; food preference; microwave oven; TBARS

ELIZABETH APARECIDA FERRAZ DA SILVA TORRES¹; MARIA ELISABETH MACHADO PINTO E SILVA²; SYLVIO CÉSAR ROCCO³; CARLOS KUSANO BUCALEN FERRARI⁴; JOSÉ OLIVEIRA SIQUEIRA⁵
^{1,2,3,4}University of São Paulo-USP/Faculty of Public Health. Department of Nutrition
⁵School of Economics, Business, and Accountancy. Department of Business
Corresponding author: University of São Paulo-USP. Faculty of Public Health. Av. Dr. Arnaldo, 715 CEP 01246-904 São Paulo, SP, Brazil + 55 11 30667705 r.230 eatorres@usp.br
Acknowledgments To CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico for grants and FAPESP - Fundação de Amparo à Pesquisa do Estado de São Paulo for financial support. 94/4428-2 and 95/5757-2

RESUMEN

El objetivo del trabajo fue evaluar la influencia de los métodos de cocción en la calidad de la fracción lipídica de salchichas. Fueron elaboradas cuatro formulaciones con tres antioxidantes diferentes y un control. Se evaluó el tipo de antioxidante durante el almacenamiento a temperatura de -20°C por períodos de 1, 7, 15, 21, 30, 45 y 60 días. Cada formulación fue hervida durante 5 minutos, o calentada en horno de microondas de 700W durante 1 minuto en potencia media y a seguir, sometida a análisis sensorial con un panel de 30 probadores no entrenados. Fueron utilizadas la prueba de preferencia pareada y la prueba hedónica con 9 puntos para aquellas con mayor aceptabilidad. Los resultados mostraron que el método de cocción fue el preferido con un nivel de significación de 0.05 para los tratamientos 2, 3 y 4. Sólo un antioxidante no presentó una preferencia significativa ($\alpha = 0.05$) con relación al método de cocción. Es posible que ese antioxidante haya actuado como protector contra la oxidación lipídica en los dos métodos de calentamiento. De los antioxidantes usados, dos proporcionaron una mejor aceptación en el análisis sensorial y en los valores de TBA indicando que pueden ofrecer mayor protección contra la oxidación lipídica y sus consecuencias. Posiblemente, parte de las características negativas que se atribuyen al calentamiento en horno microonda están relacionadas no solamente a la apariencia o textura, sino también a la oxidación lipídica.

Palavras chave: salchicha; análise sensorial; horno de microonda; TBARS

RESUMO

O objetivo desta pesquisa foi avaliar a influência do método de cocção na qualidade lipídica de salsichas. Foram elaboradas quatro formulações usando três diferentes antioxidantes e um controle. O tipo de antioxidante foi avaliado durante o armazenamento a -20°C durante 1, 7, 15, 21, 30, 45 e 60 dias. Cada salsicha foi cozida por 5 minutos em água fervente, ou aquecida em forno de microondas (700W) por um minuto na potência média, e oferecida a 30 degustadores não treinados. Foram utilizados os métodos de preferência (teste pareado) e aceitação (escala hedônica de 9 pontos) para aquelas que apresentaram maior aceitação. Os resultados indicaram que o método de cocção (cozimento em água) foi mais bem aceito para os tratamentos 2, 3 e 4. Apenas um antioxidante não apresentou diferença significativa em relação ao método de cocção. Provavelmente, este antioxidante apresentou efeito protetor na oxidação lipídica. Dois antioxidantes usados apresentaram melhor aceitação na análise sensorial e nos valores de TBA. É possível que parte das atribuições negativas dadas ao método de microondas esteja relacionada mais com a oxidação lipídica do que com a aparência, textura ou outros atributos.

Palavras-chave: salsicha; análise sensorial; microondas; TBARS

INTRODUCTION

Sausages are the most consumed processed meat product in Brazil. Its production has been growing since 1986. In the State of São Paulo, for instance, it increased by 45% between 1994 and 1995. Sausage are broadly consumed due to their easiness of preparation and low price, and they are currently part of everyday meals of different age groups (ABIA, 1997).

Kitchen appliances for the preparation of quick meals, such as microwave ovens, are now very common in Brazilian middle-class households. Many people dislike the appearance and taste of microwave oven-prepared food, not only in Brazil, but also in some other countries (GORDON, 1991), although people do not mention the reasons for such rejection. A study carried out in São Paulo with microwave oven owners showed that this appliance is used mostly to heat food rather than to prepare it (GAMBARDELLA et al., 1993).

Lipid oxidation is one of the major causes of meat and meat product spoilage (GRAY, 1978). The causes for such lipid oxidation are related to Warmed-Over Flavor (WOF), Mechanically Deboned Poultry Meat (MDPM), lipid classes, lack of antioxidants, presence of salts and unsuitable packages, lack of correlation with sensory evaluation, objective data, poor preparation, inadequate heating method and many other causes, according to several authors (PEARSON et al, 1977, RHEE et al., 1983, TORRES et al., 1989; MÍKOVÁ et al., 1991). In this study TBARS were determined and sensory evaluation was performed in order to compare two methods of cooking sausage prepared with 3 different types of antioxidants, and the TBARS values were correlated with the sensory scores.

METHODS

SAUSAGE FORMULATIONS

The samples consisted of sausage with the same formulation used by meat processors in Brazil. The samples were prepared in the pilot plant of a sausage processor. In order to evaluate lipid oxidation, a control and three different antioxidant treatments were employed, using MDPM with or without skin. Therefore, there were four formulations.

T1 - Control - Regular formula

T2 - T4B - Salt + 20% BHA + 80% in vegetable oil

T3 - T20 - Salt + 20% TBHQ + 10% citric acid + 70% propylene glycol

T4 - T20B - Salt + 20% TBHQ + 3% citric acid ± 77% propylene glycol

TBARS (2-THIO-BARBITURIC ACID REACTIVE SUBSTANCES) ANALYSIS

TBARS analysis was performed in samples heated by two methods (boiled and microwave oven-heated). The distillation method (TARLADGIS et al., 1964), as modified

in 1988 by CRACKEL et al., was used as reported by TORRES and SHIMOKOMAKI (1994). Sulfanilamide was added as recommended by SHAHIDI et al. (1985).

The samples were analyzed at 0, 7, 14, 21, 30, 45, and 60 days.

SENSORY EVALUATION

The eight different sausages, with 14 days, weighting approximately 50 g each, were boiled for five minutes in a sauce pan or heated in a 700W *Sharp*[®] microwave oven at medium power inside a shallow Pyrex pan, for 1 minute. Cooking times were chosen based on preliminary trials. Following the cooking, each sample was divided in 3 parts. Then submitted to an untrained panel of at least 30 tasters, recruited among professors, students and administrative employers from the School of Public Health, USP, Brazil. The tasters were, in average, 20 to 40 years-old (60%).

A paired preference test was used to detect sensory preferences between heating methods, according to MORAES (1990) and MEILGARD et al., (1987). The panelists received four coded samples at random (antioxidant versus with or without skin). Each antioxidant sample type was submitted to two kinds of cooking. In each evaluation session, the panelist performed four (cooking versus with or without skin) comparisons being necessary four sessions to complete all tests.

In addition, affective test, using a 9 point hedonic scale (1=extreme dislike; 9=extremely likable), was conducted to evaluate the acceptance of the sausage prepared by the method that presented the best acceptance (boiling). It was necessary two sections for the panelists to evaluate 4 samples with or without skin. The samples were also distributed in codes, at random to each person.

The tests were performed in individual booths with fluorescent light, odors and noise free, during the morning. The panelists received coded samples, on blank plates, and a glass of water to rinse the mouth between each sample and the scale (9 points, mentioned above).

SENSORY DATA ANALYSIS

Results obtained by pair-compared tests were analyzed by χ^2 tests.

The hedonic data were analyzed according to General Linear Model - GLM (Multivariate Analysis of Variance - MANOVA) using SPSS for Windows 7.5.1. MANOVA was performed to determine significant difference against treatment (alpha = 0.05). First, it was verified the significance (alpha = 0.05) of the following effects: type of antioxidant and presence of skin. The Test of Tukey was performed to detect significant differences against heating method, antioxidant types (alpha = 0.05).

RESULTS AND DISCUSSION

TBARS DATA

Table 1 TBARS values expressed in mg MA/kg of sausage without skin, boiled, during storage of 60 days in refrigerator

TREATMENT	TIME (DAYS)						
Without skin	0	7	14	21	30	45	60
Control	0,10 ^{a*}	0,10 ^a	0,11 ^a	0,12 ^a	0,15 ^a	0,22 ^a	0,23 ^a
T4B	0,10 ^b	0,08 ^b	0,10 ^b	0,11 ^c	0,12 ^b	0,14 ^c	0,15 ^c
T20	0,09 ^b	0,09 ^b	0,10 ^b	0,11 ^b	0,12 ^a	0,18 ^b	0,20 ^b
T20B	0,08 ^b	0,08 ^b	0,08 ^b	0,09 ^c	0,10 ^b	0,17 ^b	0,17 ^b

* Same letters, in the column, do not present significant differences (alpha = 0.05). Each value represents an experiment in duplicate

Table 1 shows that the antioxidants behaved similarly in regard to lipid oxidation until 14 days. After 21 days, the antioxidants differed in their ability to prevent lipid oxidation. It was possible to see differences in the results of control and treatment samples. TBARS values increased at least from 10 % (T20B) to 50% (control).

Table 2 TBARS values expressed in mg MA/kg of sausage with skin, boiled, during storage of 60 days in refrigerator

TREATMENT	TIME (DAYS)						
With skin	0	7	14	21	30	45	60
Control	0,17 ^a	0,14 ^a	0,16 ^a	0,15 ^a	0,16 ^a	0,23 ^a	0,23 ^a
T4B	0,09 ^b	0,10 ^b	0,11 ^b	0,10 ^c	0,12 ^b	0,15 ^c	0,15 ^c
T20	0,10 ^b	0,11 ^b	0,13 ^b	0,14 ^b	0,18 ^a	0,20 ^b	0,21 ^b
T20B	0,10 ^b	0,10 ^b	0,11 ^b	0,12 ^c	0,14 ^b	0,21 ^b	0,19 ^b

* Same letters, in the column, do not present significant differences alpha = 0.05. Each value represents an experiment in duplicate

The data presented a similar profile to the previous one (Table 2). As can be observed, sausage prepared with skin always presented higher TBARS scores than those without skin (Figure 1). T4B was the antioxidant that had a better performance in both treatments

(with or without skin) (Figure 2). Phospholipids from the skin are likely to play a special role in the development of lipid oxidation. Therefore, they contributed to increased lipid oxidation, measured by the TBARS test, as has been reported before by ASGHAR et al. (1988) and GOKALP et al. (1983).

After the 21st day, statistically significant differences were revealed. Moreover, after the 45th day, TBARS values increased by 70%.

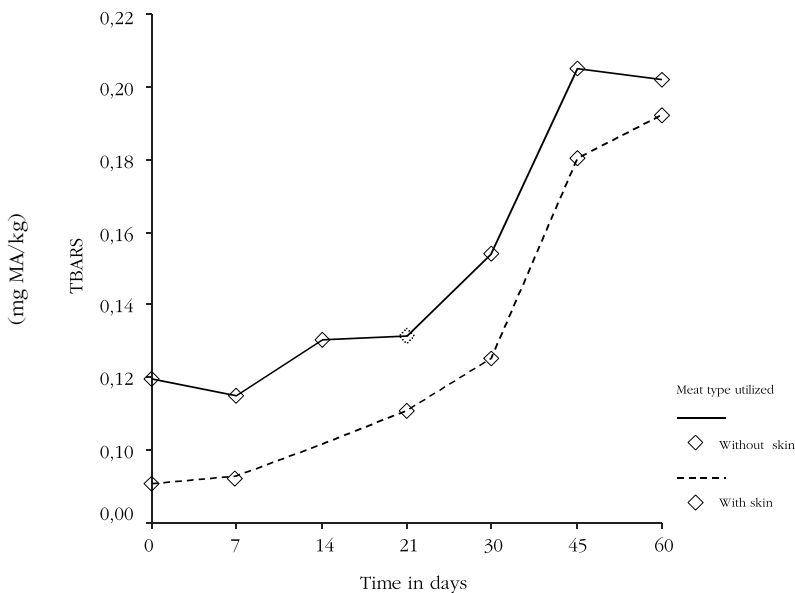


Figure 1 Mean marginal estimated TBARS

It is noticeable that in spite of the presence of the skin in the samples, they follow a similar pattern having both a higher increase in TBARS. Similar results were also reported by MÍKOVÁ et al. (1991), who evaluated oxidative changes in MDPM during storage.

The antioxidant T4B with BHA had a better performance in both types of MDPM. The other 3 treatments showed a greater dispersion, although the samples with skin had shown lower TBARS, indicating again that the presence of phospholipids could have played a special role in lipid oxidation. HUFFMAN et al. (1991) mentioned the importance of low fat content in ground beef when preparing more stable meat products.

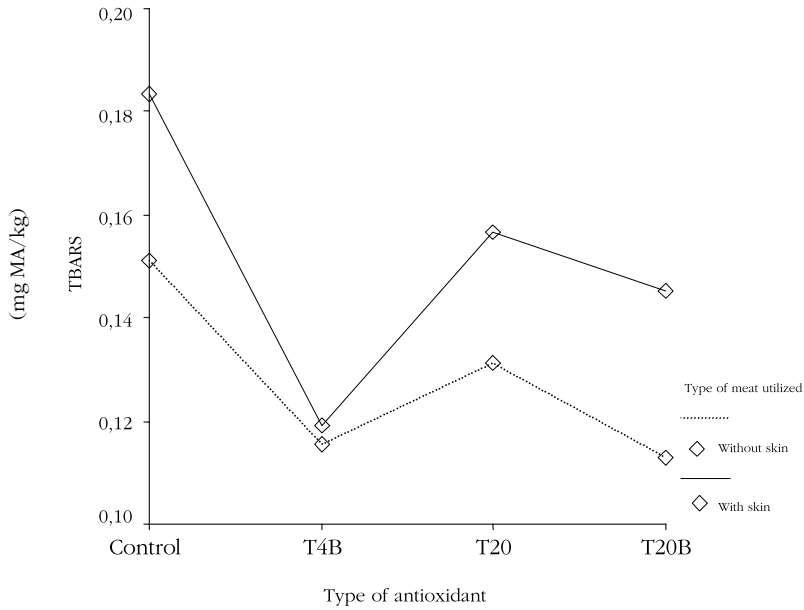


Figure 2 Mean marginal estimated TBARS

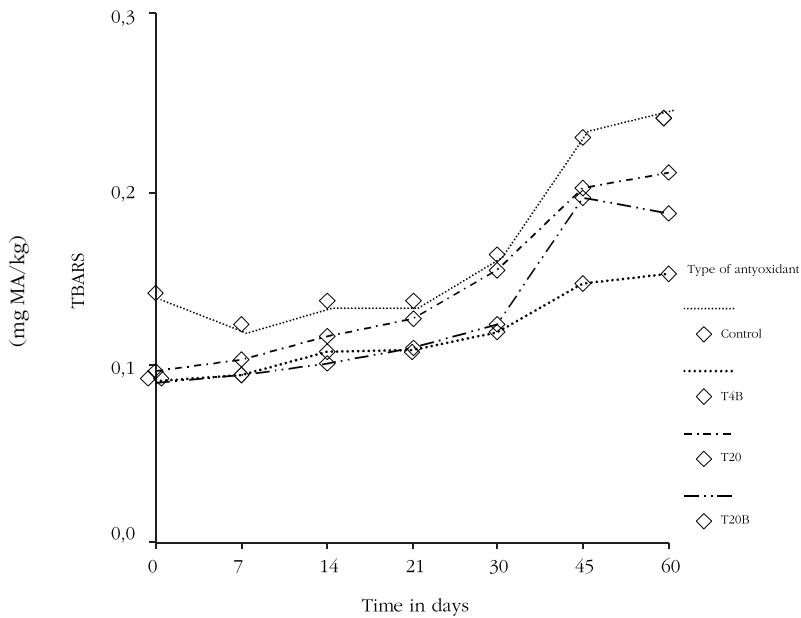


Figure 3 Mean marginal estimated TBARS

These data, figure 3, showed that the samples prepared with T4B4 (BHA) presented a better performance as an antioxidant. It can be argued that BHA can hold the lipid oxidation better than the other mixtures or even the control. However, all antioxidant treatments followed a similar pattern, increasing gradually after the 21st day and reaching the greater values at the 60th day. In Brazil, sausage are sold under vacuum packages of 500g being kept under refrigeration. It has an expiration date of 45 days. In these experiments we could see that even the valid date could be change to 60 days without any problem concerning lipid stability, although no microbiological probe was performed.

SAUSAGE SENSORY EVALUATION

According to the statistical analysis, we could observe (Table 3) that only the sample with antioxidant T20B (with or without skin) did not present statistical significance at the 5% level for cooking method, suggesting that the cooking type did not affect antioxidant performance. The panelists refereed their preference for boiling as the cooking method for the other three types of sausage without skin. On the other hand, only the control sausage with skin, cooked on the microwave was preferred by the panelists. Most of the panelists are used to microwave oven preparations, but they mentioned differences in the heating method. Some panelists pointed out that their preference was based on the texture profile or lack of lipid oxidation flavor, for the microwave oven.

Table 3 Score from preference test for sausages prepared with 4 formulations with or without skin, boiled or cooked on the microwave oven

Type of antioxidant	Without skin		With skin	
	Boiling	Microwave	Boiling	Microwave
Control	22	8	10	20
T4B	21	9	23	7
T20	24	6	24	6
T20B	13*	17*	17*	13*

* Do not differ statistically at alpha = 0.05 for pr esence of skin and type of heating

Data from the hedonic test, evaluated by 30 panelists on sausage prepared with or without skin that were boiled, are presented at Table 4. T20 with or without skin presented the lowest average, and the samples without skin did not present statistical differences (alpha = 0.05), in regard to acceptability.

According to the statistical analysis of sausage with skin, it can be seen that two groups were assembled, according to similarity. The first one included control, T4B, T20B and the second, control, T20 and T20B, since they did not present significant differences in regard to acceptance ($\alpha = 0.05$).

Table 4 The effect of skin and type of antioxidant in the acceptability of sausages

Treatment	Measures of acceptability (% acceptability)	
	With skin	Without skin
Control	6.3 ^{A,B*} (67)	6.5 (77)
T4B	6.6 ^A (77)	6.5 (80)
T20	5.2 ^B (57)	5.9 (60)
T20B	6.2 ^{A,B} (73)	6.5 (80)

* Same letters, in the column, do not present significant differences
 $\alpha = 0.05$

The samples with skin were considered acceptable because the score higher than 6 (slightly liked) was above 50%: 67% for the control, 77% for T4B, 57% for T20 and 73% for T20B. The results revealed that the less acceptable sample was the T20. These findings suggest that T4B and T20B had a better performance as an antioxidant for this type of cooking. Figure 4 shows the distribution of panelists in the hedonic scale: sausage T20 concentrated in score 7, whereas T4B was similar in scores 7, 8 and 9, and T20B scored 6. In addition, the sample with T20 was more rejected (scores 1 and 2), confirming the best results with these antioxidants.

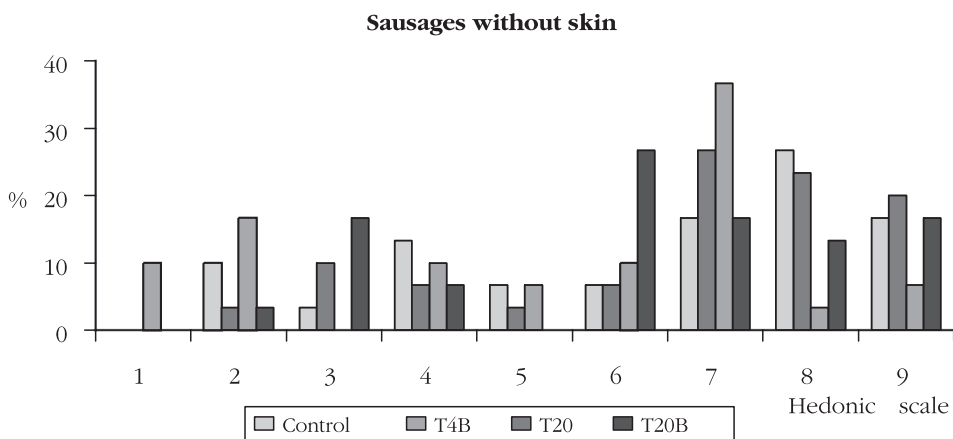


Figure 4 Distribution of panelists (%) x hedonic scale for sausage with skin

The highest acceptance of sausage without skin (Figure 5) was for T4B (80%); and for T20B (80%) even though they did not present significant differences ($\alpha=0,05$). All of the 4 sausage were considered acceptable because more than 50% of the panelists scored them 6 or above.

The use of antioxidants to prevent, or even to avoid, lipid oxidation has been extensively reviewed or experimented. Many authors have found the beneficial effects of using them in some products, such as chicken nuggets (LAI et al., 1991) and in charqui (salted and dried beef) (TORRES et al., 1989).



Figure 5 Distribution of panelists (%) x hedonic scale for sausage without skin

Another interesting finding was that the skin might not affect the sausage flavor, being, at the same time, very useful for the processors that can use any part of the carcass to prepare the MDPM. In Brazil, there is a limit on the use of MDPM in sausage. The maximum level permitted used to be 20%, according to CIA (1983), but currently, due to MERCOSUL trading, there is standardized to 40% as the maximum level of this ingredient. This fact can even lower the price of the sausage.

Unfortunately, we did not evaluate the effects of salt concentration, as it may influence the rate of lipid oxidation as reported by TORRES et al., (1989) and HUFFMAN et al., (1981).

Analysis of the skin revealed that sausage prepared with MDPM without skin presented a slightly higher acceptance. We believe that this factor, together with the antioxidant, contributed to the remarks made by the panel regarding the color and texture of the cooked sausage.

The T4B antioxidant in the samples with or without skin did not show statistically significant differences.

TBARS VERSUS SENSORY EVALUATION

The boiling method was preferred at a significant level of 0.05 in three of the four formulations studied (control and 3 treatments with antioxidants). Only one treatment did not present a significant difference regarding the heating method. The flavor response to cooked meat is a very complex sensation and intriguing physiological reaction (HERZ and CHANG, 1970). Although the notes and intensity of meat flavor are important to both consumers and manufacturers of meat products, meat flavor is not well defined or characterized. It has been shown that not only do sensory differences exist between meat cooked by conventional and microwaves ovens, but also there are quantitative differences in the volatile components involved. BODRERO et al. (1980) reported optimum cooking times for flavor development and also the evaluation of flavor quality of beef cooked by microwave and conventional methods working with beef roasts.

In the present study, sausage presented a behavior which suggest that the lower the TBARS (T4 and T20) the higher the acceptability (T4 and T20), at 14 days (Table 5). Based on these findings we suggest further studies on the role of the heating method and time, as well as flavor development and lipid oxidation stability in meat prepared foods.

Table 5 TBARS versus acceptability rates of sausages at 14 days

TREATMENT at 14 days	TBARS (mg/MA/kg sample)	Acceptability (% , ≥ 6)
Without skin		
Control	0,11	77
T4B	0,1	80
T20	0,1	60
T20B	0,08	80
With skin		
Control	0,16	67
T4B	0,11	77
T20	0,13	57
T20B	0,11	73

SIGNIFICANCE

For the microwave oven preparation of quick meals, lipid oxidation may play an important role in acceptability of food, and antioxidants may help to avoid or delay the lipid oxidation.

CONCLUSION

It was observed that BHA+80% vegetable oil presented a better performance in both sensory and chemical scores. The presence of skin in the sausage formulation slightly aggravated the increase of lipid oxidation in sausage.

There was an irrefutable preference for the boiling method. The treatment with a specific antioxidant showed that, most likely, the reason why sometimes people complain about their dislike of microwave-oven food is not only related to appearance or texture, but can also be due to lipid oxidation. The antioxidant that did not show a significant difference probably did not influence the heating method.

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Recebido para publicação em 24/6/02.

Aprovado em 30/8/03.