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The use of natural antioxidants in ready-to-serve food

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Abstract

Research material constituted minced meat balls prepared from mechanically deboned turkey meat. The effect of natural antioxidants, which are contained in selected spices, on sensory quality and storage stability of products was investigated. Sage and a mixture of spices (sage, red pepper, black pepper, garlic and marjoram) were used as sources of antioxidants. Products were fried in a medium layer of soybean oil and then stored in a refrigerator for 4 days. The results of the experiment showed the effect of product composition on the intensity of oxidation processes in the lipid fraction of the products. Addition of sage and the mixture of spices retarded the process of oxidation. Sage proved to be more effective than the mixture of spices.

Keywords: Natural antioxidants; Ready to serve food; Storage stability

1. Introduction

Oxidation of lipids, which occurs during raw material storage, processing, heat treatment and further storage of final products, is one of the basic processes causing rancidity in food products, leading to their deterioration. Taste and aroma of a product can be the criteria for rejection of any kind of food if they differ significantly from what is expected by the consumer. Products of lipid oxidation influence other food constituents; e.g. they interfere with the absorption of protein or folic acid. It has also been found that they can cause pathological changes in the mucous membrane of the alimentary tract, inhibit activity of enzymes and increase the content of cholesterol and peroxides in blood serum, thus activating the process of atherosclerosis. According to numerous researchers they can also show carcinogenic activity (Ames, 1983; Budzyńska-Topolowska & Ziemlański, 1992; Frankel, 1991; Gardner, 1979).

Considering the possibility of undesirable influences of oxidised lipids on the human organism, it seems to be of essential importance to minimise the content of products of lipid oxidation in food. In industrial processing, mainly synthetic antioxidants are used, in order to prolong the storage stability of food. However, toxicologists and nutritionists have for long noted the noxiousness of some synthetic antioxidants, such as BHT and BHA, which are used in food processing. According to Ames (1983) and Baardseth (1989) they can show carcinogenic effects in living organisms.

Consumers generally perceive natural antioxidants as better than synthetic additives. Phenols are one of the most important groups of natural antioxidants. They occur only in material of plant origin and they are known to protect easily-oxidizable constituents of food from oxidation. Especially worthy of notice are spices and herbs which for many years have been used as additives to enhance the sensory features of food (Baardseth, 1989; Lindberg Madsen, Andersen, Christiansen, Brockhoff & Bertelsen, 1996; Pokorny, 1991; Wang, Cao & Prior, 1996).

The objective of the study was to investigate the possibility of application of selected spices as natural antioxidants in meat dishes.

2. Materials and methods

The experiment was carried out on minced meat balls prepared from turkey meat. Raw material was obtained from the poultry processing plant "Indykpol" in Olsztyn. The basic composition of products was as follows:

- turkey meat (60%)
- mechanically deboned turkey meat (20%)

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- dried rolls soaked in milk (12%)
- eggs (5%)
- modified starch (3%)
- salt (1%; in relation to the total mass of product).

In the experiment, three types of sample were prepared in 7 day intervals:

1. Reference sample (no spices added) — sample A.
2. Sample with addition of 1.0% mixture of spices (sage, red pepper, black pepper, garlic and marjoram) — sample B.
3. Sample with addition of 1.5% sage — sample C.

All components were thoroughly mixed and formed into the shape of balls. Balls were coated in breadcrumbs and egg mixture and fried in a medium layer of soybean oil at a temperature 180°C. Frying was performed until the temperature inside the product reached 80°C. Fried products were comminuted before chemical analyses. Analyses were performed in six replications on raw material before frying, then directly after frying and chilling and after 2 and 4 days of storage in a refrigerator at 4°C.

Analyses of products comprised basic chemical composition:

- content of water — by drying at temperature 105°C to constant weight (Krełowska-Kułas, 1993)
- content of protein — by the Kjeldahl method as in the Parnas–Wagner modification (Krełowska-Kułas, 1993)
- content of fat — by the Soxhlet method (Krełowska-Kułas, 1993).

Evaluation of the intensity of hydrolytic and oxidative activity in the lipid fraction was performed by:

- Iodine value — determined by treating a sample of fat with iodine monobromide BrI and potassium iodide KI, and titrating the excess amount of iodine with sodium thiosulfate $Na_2S_2O_3$, using the Hanus method (Krełowska-Kułas, 1993);
- Acid value — by dissolving a sample of fat in an ethanol/ethyl ether (1:1) mixture and titrating with potassium hydroxide (Krełowska-Kułas, 1993);
- Peroxide value — colorimetrically in reaction with ammonium thiocyanate NH_4CNS (Krełowska-Kułas, 1993);
- Content of malondialdehyde — colorimetrically in reaction with 2-thiobarbituric acid by the Ohikawa method modified by Pikul, Leszczyński and Kummerow (1983).

The lipid fraction was extracted from the product with a chloroform/methanol (2:1) mixture by the Folch method (Folch, Lees & Stanley, 1975). Changes in taste and aroma of the products were estimated by six panellists using a profiling method (Meigaard, Civille & Carr, 1991).

3. Results

The results of the experiment showed changes in chemical composition of minced meat balls as a result of heat treatment (Table 1). The process of frying caused evaporation of a certain amount of water. The water content of the product decreased by 11.9–12.4%. As a result of the lower content of water, the relative content of protein and fat increased. Simultaneously products absorbed a certain amount of oil during frying. Similar results were obtained by Pikul and Wojciechowski (1994).

In order to evaluate the content of unsaturated fatty acids in products, the iodine value was determined. The iodine values in raw products were 180, 194 and 156 gJ/100 g of fat for samples A, B and C, respectively. Such differences in iodine value could be explained by the fact, that samples A, B and C were prepared in 7 day intervals, and mechanically deboned poultry meat, even when stored in the freezer, is a very susceptible material for quality changes during storage. A slight increase of iodine value after heat treatment — by 2–5 gJ/100 g of fat — was observed, probably as a result of oil absorption during frying. The lowest iodine value of sample C indicated the smallest anticipated oxidative changes during storage of that sample.

Acid value in raw samples was observed at a level of about 2–3 mg KOH/1 g of fat (Table 2). It decreased during frying, probably as a result of free fatty acids binding by peroxides formed in the early stages of lipid oxidation or their further decomposition. Acid values in samples after frying were in the range 1.9–2.1 mg KOH/

Table 1
Chemical composition of minced meat balls raw and directly after frying[a]

Type of sample	Protein (%)		Fat (%)		Water (%)	
	$\bar{x}$	$S(x)$	$\bar{x}$	$S(x)$	$\bar{x}$	$S(x)$
A (reference sample)						
Raw	16.4	0.520	6.73	0.342	64.85	0.686
Fried	21.2	0.155	10.01	0.282	52.91	0.815
B (sample with mixture of spices)						
Raw	16.6	0.308	6.65	0.265	65.17	0.694
Fried	21.2	1.189	10.56	0.456	52.77	0.855
C (sample with sage)						
Raw	16.5	0.493	6.66	0.474	65.07	0.658
Fried	22.5	0.359	10.64	0.613	52.72	0.788

[a] $\bar{x}$, mean value; $S(x)$, standard deviation.

1 g of fat and increased during storage. The smallest hydrolytic changes were observed in samples with addition of sage.

Peroxide value characterizes the degree of oxidative lipid deterioration. In analysed products, peroxide values varied at the beginning of the experiment as well as after 4 days of storage (Table 3). The highest peroxide value, after 4 days of storage, was observed in the reference sample at a level 0.254 mg O_2/kg of fat. Products which contained sage and a mixture of spices showed lower peroxide values — 0.106 and 0.154 mg O_2/kg of fat, respectively. Thus, the presence of spices in minced meat balls retarded formation of peroxides in the lipid fraction.

Directly after frying, the content of malondialdehyde in all samples increased significantly and during storage further increases were observed (Table 4). The rate of malondialdehyde formation in the reference sample A was higher than that in samples with spices. In spite of the highest initial level of malondialdehyde in the fat

Table 2
Acid value (AV) in fat extracted from minced meat balls[a]

Type of sample	AV (mg KOH/1 g fat)	
	$\bar{x}$	$S(x)$
A (reference sample)		
Raw	3.04	0.010
Fried	1.88	0.087
Stored 2 days	1.96	0.030
Stored 4 days	2.19	0.036
B (sample with mixture of spices)		
Raw	3.17	0.02
Fried	1.98	0.021
Stored 2 days	2.27	0.061
Stored 4 days	2.30	0.138
C (sample with sage)		
Raw	2.93	0.165
Fried	2.12	0.210
Stored 2 days	2.13	0.080
Stored 4 days	2.15	0.044

[a] $\bar{x}$, mean value; $S(x)$, standard deviation.

Table 3
Peroxide value (PV) in fat extracted from minced meat balls[a]

Type of sample	PV (mg O_2/kg fat)	
	$\bar{x}$	$S(x)$
A (reference sample)		
Raw	0.067	0.001
Fried	0.124	0.006
Stored 2 days	0.176	0.019
Stored 4 days	0.254	0.015
B (sample with mixture of spices)		
Raw	0.074	0.002
Fried	0.092	0.006
Stored 2 days	0.113	0.104
Stored 4 days	0.154	0.039
C (sample with sage)		
Raw	0.085	0.016
Fried	0.090	0.014
Stored 2 days	0.102	0.003
Stored 4 days	0.106	0.016

[a] $\bar{x}$, mean value; $S(x)$, standard deviation

Table 4
Content of malondialdehyde (MDA) in minced meat balls[a]

Type of sample	MDA (mg/1 g product)	
	$\bar{x}$	$S(x)$
A (reference sample)		
Raw	0.0051	0.00027
Fried	0.0071	0.00069
Stored 2 days	0.0228	0.00800
Stored 4 days	0.0254	0.00174
B (sample with mixture of spices)		
Raw	0.0058	0.00046
Fried	0.0077	0.00036
Stored 2 days	0.0162	0.00570
Stored 4 days	0.0248	0.00511
C (sample with sage)		
Raw	0.0061	0.00020
Fried	0.0081	0.00061
Stored 2 days	0.0098	0.00164
Stored 4 days	0.0124	0.00036

[a] $\bar{x}$, mean value; $S(x)$, standard deviation.

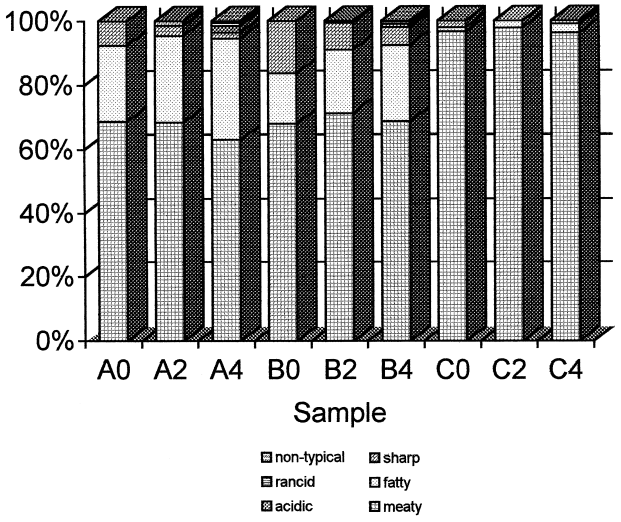

Fig. 1. Proportion of taste profiles: A, reference sample; B, sample with mixture of spices; C, sample with sage (A0, B0, C0, samples directly after frying; A2, B2, C2, samples after 2 days of storage; A4, B4, C4, samples after 4 days of storage).

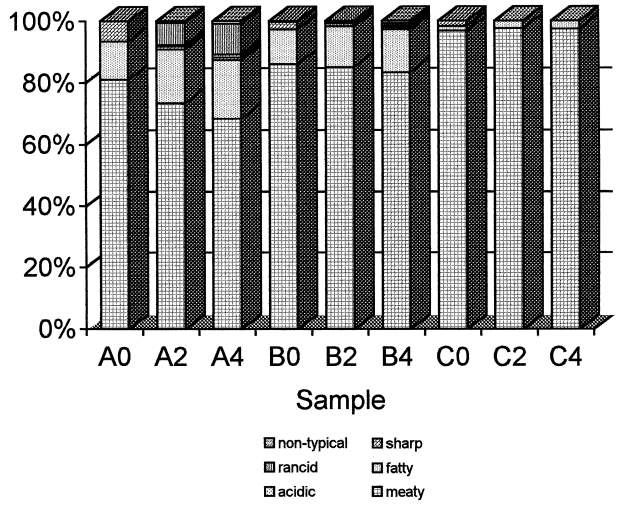

Fig. 2. Proportion of aroma profiles: A, reference sample; B, sample with mixture of spices; C, sample with sage (A0, B0, C0, samples directly after frying; A2, B2, C2, samples after 2 days of storage; A4, B4, C4, samples after 4 days of storage).

fraction from sample C with sage, after 4 days of storage the amount of malondialdehyde in that sample was significantly lower than in the reference sample and in the sample with a mixture of spices, probably as a result of the antioxidant activity of polyphenols contained in the sage. Pikul and Wojciechowski (1994) observed similar changes in fried chicken meat. According to numerous authors, polyphenol antioxidants significantly affect the rate of the oxidation process in foodstuffs (Frankel, 1991; Korczak, Flaczyk & Pazoła, 1988; Korczak, Pazoła & Gogolewski, 1990; Lindberg Madsen et al., 1996; Pokorny, 1991).

Sensory evaluation of products was performed by analysing profiles for taste (Fig. 1) and aroma (Fig. 2). Intensity of such flavours as meat, fatty, pungent, sour, rancid and non-typical was analysed. The results showed the domination of meat taste and aroma in all samples. Differences in occurrence of undesirable off-flavours depended on additives used and the time of storage. The addition of spices, which contained natural antioxidants (samples B and C) caused fewer observations of undesirable off-flavours. The biggest differences in taste and aroma profiles were found for reference sample (A) and the smallest for the sample with addition of sage (C). The sensory panellists highlighted rancid off-flavours in the reference sample, which significantly decreased the final score for this product. The intensities of undesirable off-flavours increased with prolonged time of storage.

4. Conclusions

A strong correlation between taste and aroma profiles and chemical indices of quality was observed. Sensory quality remained in agreement with intensity of hydrolytic and oxidative changes in lipid fraction of products. The process of heat treatment of minced meat balls caused changes in the chemical composition of products and, simultaneously, oxidative processes in the lipid fraction were initiated. During storage of products in a refrigerator, further hydrolytic and oxidative processes in the lipid fraction were observed. The addition of spices limited undesirable changes in products. Minced meat balls, made with addition of 1.5% sage, still showed good quality after 4 days of storage and it is advised that sage be used as an antioxidant additive in industrial processing of food. Analyses of taste and aroma profiles showed differences in occurrence of undesirable off-flavours, depending on the additives used and time of storage.

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