

SPICES AS ANTIOXIDANTS IN COOKED, MINCED PORK MEAT.

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Summary.

Spices added to cooked, minced pork meat were found to retard the formation of Warmed-Over Flavour (WOF). With the purpose of testing different spices, an assay consisting of a meat slurry (5.00 g, boiled at 80 °C for 5 min.) with Fe(II):EDTA-complex (6.0 µmol) as prooxidant was developed. In the assay oxygen consumption rate was measured in a closed, thermostated (25 °C) cell by a Clark electrode. The addition of spices (rosemary, *Rosmarinus officinalis*, sage, *Salvia officinalis* or oregano, *Majorana onites*) to the meat slurry was found to have an antioxidative effect as indicated by a reduced oxygen consumption rate. In a storage experiment, the spices were added to meat balls in an amount acceptable by a sensory panel (0.02% of total weight). After cooking and storage in dark at 5 °C, the meat balls were evaluated by a trained sensory panel and lipid oxidation was followed by measuring the thiobarbituric acid reactive substances (TBARS) at day 0, 1, 2 and 4. Samples containing sage or rosemary had significant ($p < 0.05$) lower amount of TBARS and significant ($p < 0.05$) better sensory score, sage being the most effective. Very little or no antioxidative effect was found for oregano in the sensory evaluation.

Introduction.

The antioxidative effect of spices has long been known. Since ancient time it has been customary for instance to add garlic and red chilies, ghee (clarified butter fat) in India not only with the purpose of improving the taste but also for prolonging the storage life of the product (Sehti & Aggarwal, 1950). The most extensive and systematic studies concerning the antioxidative effect of spices have been conducted by Chipault and his colleagues (Chipault et al., 1952; Chipault et al., 1955 and Chipault et al., 1956). They showed that spices in general possess antioxidative properties, but they found that the antioxidative effect of the actual spice is dependent on the nature of the product. Most investigations have used an oil-based medium for determination of antioxidative effect of different spices (Chipault et al., 1952; Bishov et al., 1977 and Gerhardt & Schröter, 1983) or lard (Chipault et al., 1952; Palitzsch et al., 1974; Chang et al., 1977 and Gerhardt and Schröter, 1983). Only a few investigations have been conducted concerning antioxidative effect of spices in raw and in cooked meat products (Lee et al., 1986; Korczak et al., 1988 and St. Angelo et al., 1990). Cooked meat products are very susceptible to oxidation, and Tims & Watts (1958) used the term Warmed-Over Flavour (WOF) to describe the typical off-flavour developed as a result of lipid oxidation in cooked meat product. By consumers the off-flavour is recognized as 'left-over' taste or rancid taste. WOF is a serious problem for the meat-industry, since it often is a limiting factor for the self-life of precooked or ready-to-eat meat products. In cooked meat products and in other processed meat products it seems obvious to exploit the antioxidative effect of spices as the taste of the spice is desirable or acceptable in the product.

In the light hereof, we have developed an assay, where spices are screened for antioxidative activity in a cooked-meat-based-medium. The spices belonging to the Labiatae family, all found active in the assay, were investigated further in a storage experiment with meat

Materials and Methods.

Spices were obtained from SFK, Copenhagen, and pork meat (*Longissimus dorsi*) from a local slaughterhouse.

Assay.

A cube of pork meat app. 9 gram without visible fat was packed under vacuum and heat treated at 80 °C in 5 min. in a waterbath. 5.00 gram was homogenized in 15.0 ml air-saturated phosphate buffer (pH 5.6, 5.0 mmol L⁻¹, 25 °C) using an Ultra Turrax. The buffer was added just before comminution. The meat slurry was transferred to a special designed thermostated cell equipped with a platinum electrode (Radiometer, Copenhagen, Denmark) in conjunction with a multichannel analyzer and a personal-computer based data collecting system with locally written software. Additional air-saturated phosphate buffer was added (app. 60 ml) leaving no headspace and the electrode calibrated with this solution. Just before closing the cell, 0.5 ml of the Fe(II)EDTA-solution was added. The Fe(II)EDTA-complex, was made in solution (12.0 mmol L⁻¹) by dissolving FeSO₄ 7H₂O and Na₂H₂EDTA, and was prepared immediately before use. All chemicals used were of analytical grade. Relative oxygen concentration was recorded at time intervals of 30 seconds.

Storage experiment.

Product, packaging and storage. The meat was grounded through a 0.3 cm plate. Salt 0.5%, black pepper 0.02% and spices (*Rosmarinus officinalis*), sage (*Salvia officinalis*) or oregano (*Majorana onites*) in an amount of 0.02% were added to the minced meat. Meat balls of 30.0±0.5 gram were heated (100 °C in 9 min.) in polyethylene bags to avoid diffusion into the boiling water. After cooling the meat balls were placed in polyethylene bags and stored in a chill cabinet at 5 °C with continuous temperature registration (data-logger, U.K.)

Lipid oxidation. Thiobarbituric acid reactive substances (TBARS) were determined by the distillation method of Tarladgis (Tarladgis 1960). Samples were analyzed in duplicate and results were expressed as 'equivalent μmol malondialdehyde / kg meat'.

Sensory evaluation. The meat balls were evaluated by a trained sensory panel consisting of 10-11 judges. The parameters 'WOF-smell' and 'WOF-taste' were evaluated separately. For each parameter, the score was marked on a 15 cm line scale ranging from not detected to extreme. Along with the samples, four fresh references, containing either rosemary, sage, oregano or no spice were served. The meat balls were reheated in polyethylene bags in a waterbath just before serving (5 min. at 100 °C).

Results and Discussion.

Assay. Screening of rosemary, oregano, and sage demonstrated, that these spices, added to the meat slurry in an amount of 1.0% of the meat content, reduced the oxygen consumption in the closed cell. As seen from Figure 1, a marked drop in the relative oxygen concentration is observed immediately after addition of the Fe:EDTA-complex. For the sample without addition of spices a continuous reduction of the oxygen concentration during the following 45 min. is registered, while the oxygen consumption nearly stops for samples containing one of the spices, indicating an antioxidative activity. Gradually reducing the concentration of rosemary (Figure 2) or sage (data not shown) to 0.02% in the assay demonstrated, that the spices even in a concentration acceptable in ready-to-eat dishes, had a perceptible effect on the oxygen consumption.

Storage experiment. At the organoleptic evaluation, meat balls without spice (control) were found to have a more pronounced 'WOF-smell' and 'WOF-taste' than samples containing one of the spices. As may be seen in Figure 3, the scores concerning 'WOF-smell' were higher values for the control sample, than for samples added one of the spices. The values for rosemary and sage being significantly ($p < 0.05$) lower all days (lowest scores for samples added sage), except the sample containing rosemary at day 2. For the sample with oregano the difference in sensory score compared to the control were not significant ($p > 0.05$). The results of the TBA-analysis supported these findings.

findings of the sensory evaluation. The control had significantly ($p < 0.05$) higher amount of TBARS in the beginning of the storage (day 0 to day 2; Figure 4). At day 4, the amount of TBARS in samples containing one of the three spices were not significant from TBARS in the control. Among the samples containing spices, the one added sage had the lowest level of TBARS indicating antioxidant activity. The findings indicate that each of these three spices, as shown in the assay, were able to retard the initiation of oxidation in the product. The results are in agreement with earlier investigations, where the addition of rosemary or sage in an amount of 1.0% of total weight to pork meat balls (Korczak et al., 1988) or rosemary oleosin to ground beef patties (St. Angelo et al., 1990) were able to retard WOF development during chill storage. For a few spices (rosemary, sage and oregano) some of the compounds responsible for the antioxidative activity have been isolated, and the majority of the antioxidative effect is caused by different phenolic compounds, which are able to quench free radicals. Examples of these compounds are rosmannol and carnosol which both have been isolated from rosemary (Inatani et al., 1983), and carnosol which also is found in sage (Brieskorn et al., 1964). Compounds showing antioxidative activities have also been isolated from oregano (Kikuzaki & Nakatani, 1989), and in the assay in the present investigation a significant reduction in oxygen consumption was found for samples containing 1.0% oregano. However, in the storage experiment no significant differences were found in development of WOF between meat balls with 0.02% oregano added and the control. Oregano is taxonomically closely related to merian, and in investigation by Korczak et al., (1988) even a prooxidative effect was demonstrated of merian in meat balls during chill storage.

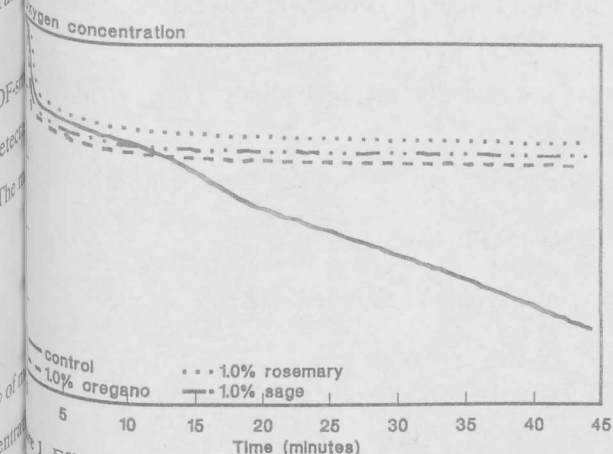


Figure 1. Effect on oxygen concentration of adding spices (rosemary, sage and oregano) to a meat slurry containing Fe(II)EDTA at pH 5.6, 25 °C.

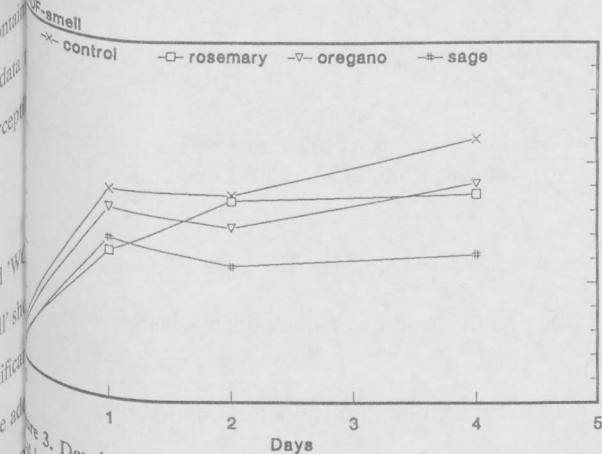


Figure 3. Development of the sensory score 'WOF-smell' of boiled, pork meat balls added spices during chill storage 5 °C.

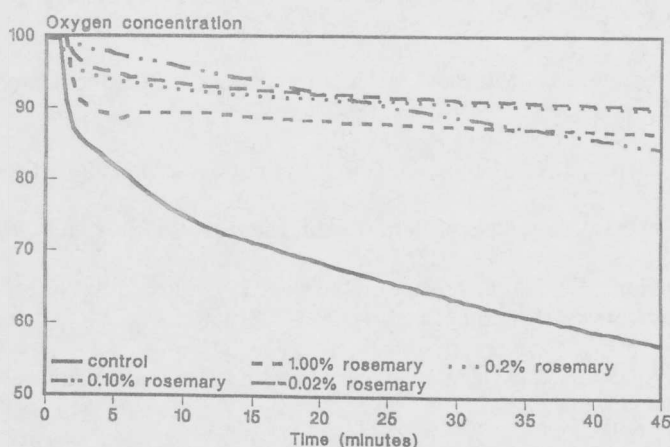


Figure 2. Effect on oxygen concentration of adding rosemary in different amounts to a meat slurry containing Fe(II)EDTA at pH 5.6, 25 °C.

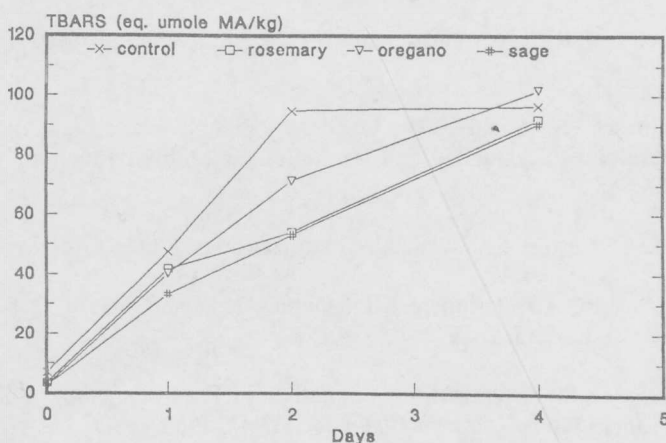


Figure 4. TBARS development during chill storage, same samples as Figure 3.

Conclusion.

The developed assay was useful for screening the antioxidative activity of spices in cooked meat products. Rosemary, sage and oregano did reduce the oxygen consumption of the meat slurry when added in an amount of 1.00%. For sage and rosemary an antioxidative effect was seen even at low level of addition (0.02%). In a chill storage experiment rosemary and sage in an amount of 0.02% were able to inhibit the development of WOF in cooked, minced meat balls, while no effect of oregano was found by a sensory evaluation.

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