Inhibition of Oxidation of Meat Lipids with Spices and their Oleoresins

Fereidoon Shahidi[1] and Ronald B. Pegg[2], [1]Department of Biochemistry, Memorial University of Newfoundland, St. John's, NF, A1B 3X9 Canada, and [2]Saskatchewan Food Innovation Program, Department of Applied Microbiology and Food Science, Saskatoon, SK, S7N 5A8 Canada.

Background

Spices are often added to prepared meats as condiments for colouring and seasonings. Important fractions of spices are their volatile oils and oleoresins. Volatiles of essential oils are responsible for the characteristic aroma of the spice and their content may range from less than 1% to 20% (Clark, 1970). The oleoresin, which is the non-volatile extract, is responsible for the typical taste and pungency of the spice. The spice oleoresin, usually less than 10% of the total weight of spice, is extracted by acetone or ethanol which could later be removed.

It has been reported that spices and herbs enhance the keeping quality of food lipids. Thus, the antioxidant activity of a number of spices and condiments has been reported in the literature (Al-Jalay et al., 1987; Bishov et al., 1977; Chipault et al., 1956; Chang et al., 1977; Barbut et al., 1985; Stoick et al., 1991).

Objectives

The objective of this study was to investigate the antioxidative properties of six spices, namely clove, ginger, oregano, rosemary, sage and thyme and their corresponding oleoresins in a cooked comminuted pork model system. Combined effects of spices and oleoresins was also intended

Methods

Fresh pork lions were purchased from a local supermarket, surface fat removed and ground twice using an Oster meat grinder. The comminuted samples (120g) were mixed with 20% (w/w) distilled water in Mason jars along with spices or spice oleoresins at levels specified in the table. The samples were cooked in a water bath to an internal temperature of 68 ± 2°C. The total cooking period was approximately 40 min. Samples were stirred by a glass rod every 5 min. After cooling to room temperature, the cooked samples were homogenized in a Waring blender and stored in Nasco Whirl-Pak bags and stored at 4°C. Oxidative state of samples was evaluated at specified times using the 2-thiobarbituric acid as detailed by Shahidi and Hong (1991). The absorbance of the complex between the 2-thiobarbituric acid reactive substances (TBARS) and the 2-thiobarbituric acid (TBA) reagent was read at 532 nm and the content of TBARS was calculated as μg malonaldehyde equivalents per g samples using a conversion factor of 8.1. Percent inhibition of TBARS formation over a 3 week storage period was calculated using a control devoid of any spice and/or oleoresin. Results reported are mean values of data calculated from determinations on days 1, 7, 14 and 21.

Results and Discussion

Table 1 summarizes the results for the antioxidant activity of selected spices and their oleoresins as percent inhibition of formation of TBARS after a 3 weeks storage at 4°C. The TBARS values for spice-containing samples were significantly lower ($p>0.05$) than those of the control, thus indicating protection to meat by these spices against the development of fat oxidation. Furthermore, this protection was concentration-dependent, but a saturation point might be reached after a certain amount of spice was present as in the case of clove where a 96% inhibition was achieved at 500 ppm addition level and this protection remained unchanged at higher concentration of spice. Clove, sage, rosemary and oregano appeared quite effective in retarding lipid oxidation as TBARS values remained at less than 1 μg/g sample over the entire storage period. Ginger and thyme showed the weakest antioxidant activity (Table 1).

The results for the relative effectiveness of spices from this study are in agreement with those of Cort (1974), Chipault et al. (1956) and Al-Jalay et al. (1987). Chipault et al. (1956) reported that factors such as the physical state of the fat-water system, the type of fat, the pH of the aqueous system, and the presence of catalysts and sysergists affect the solubility of lipids and may influence the antioxidant efficacy of spices in different foods. Chipault et al. (1956) found that sage and rosemary were more effective than other spices in lard, while cloves proved to be a powerful antioxidant in ground pork. Oregano has a pronounced antioxidant effect in mayonnaise and salad dressings.

The superior antioxidant activity of clove, as exhibited in the present results, may arise from its high content of eugenol (3.03%) and gallic acid (1.26%), both of which are known to possess strong antioxygenic effects at relatively lower concentrations (e.g. 1985; Al-Jalay et al., 1987). Meanwhile, the activity of rosemary is attributed mainly carnosol, reosemanol, rosemanidipherol, rosemariquinone as well as carnosic and rosemaric acids (Houlihan et al., 1984). Oregano, which also belongs to the same family as rosemary contains caffeic, rosemaric and protocatechnic acids as well as a phenyl glycoside of 2-caffeoyloxy-3-[2-(4-hydroxybenzoyl)-4,5-dihydroxy] phenylpropionic acid (Kikuzaki and Nakatani, 1989) as its active components. Curcumin was found to be the active component in thyme (Al-Jalay et al., 1987) and antioxidant activity of ginger has been reported in the literature, but its active antioxidants have not been reported (Lee et al., 1986).

The effect of spice oleoresins at 200 ppm, alone or with 1000 ppm spice, is also shown in Table 1. Spice oleorsins were found to be somewhat less effective than spices themselves, perhaps due to the presence of other active components in the ground spice (Clark, 1970). When spices were combined with their corresponding oleoresins, the antioxidant activity of the system generally increased, as expected, but this trend was not observed for rosemary and thyme.

A close scrutiny of the results shown in this work shows that spices and/or their oleoresin inhibit oxidation according to the order given below.

clove > sage > rosemary = oregano > thyme = ginger

However, despite better effectiveness of clove and sage, rosemary continues to be used widely because of its better flavor profile and ease of producing odorless oleoresins (Zagarska et al., 1998).

References

Al-Jalay, B., Blank, G., McConnell, B. and Al-Khayat, M. 1987. Antioxidant activity of selected spices used in fermented meat sausage. J. Food Protec. 50: 25-27.

Barbut, S., Josephson, D.B. and Maurer, A.J. 1985. Antioxidant properties of rosemary oleoresins in turkey sausage. J. Food Sci. 50: 1356-1359.

Bishov, S.J., Masuoka, Y. and Kapsalis, J.G. 1977. Antioxidant effects of spices, herbs and protein hydrolyzates in freeze dried model systems: synergistic action with phenolic antioxidants. J. Food Process. Preserv. 1: 153-166.

Chang, S.S., Ostric-Matijasevic, B., Hsieh, O.A.L. and Huang, C.L. 1977. Natural antioxidants from rosemary and sage. J. Food Sci. 42: 1102-1106.

Chipault, J.R., Mizuno, G.R. and Lundberg, W.O. 1956. The antioxidant properties of natural spices. Food Technol. 10: 209-211.

Clark, W.R.E. 1970. Modern trends in the application of spice. Food Manufac. 45(1): 53-54.

Cort, W.M. 1974. Hemoglobin peroxidation test screens antioxidants. Food Technol. 28: 60-66.

Houlihan, C.M., Ho, C.-T. and Chang, S.S. 1984. Elucidation of the chemical structure of novel antioxidants rosenamodiphenol isolated from rosemary. J. Am. Oil Chem. Soc. 61: 1036-1039.

Kikuzaki, H. and Nakatani, N. 1989. Structure of a new antioxidative phenolic acid from oregano. Agric. Biol. Chem. 53: 519-524.

Lee, Y.B., Kim, Y.S. and Ashmore, C.R. 1986. Antioxidant properties of ginger rhizone and its application to meat products. J. Food Sci. 51: 20-23.

Shahidi, F. and Hong, C. 1991. Evaluation of malonaldehyde as a marker of oxidative rancidity in meat products. J. Food Biochem. 15:97-105.

Shahidi, F., Pegg, R.B. and Saleemi, Z.O. 1995. Stabilization of meat lipids with ground spices. J. Food Lipids 2: 145-153.

Stoick, S.M., Gray, J.I., Booren, A.M. and Buckley, D.J. 1991. Oxidative stability of restructured beef steakes processed with oleoresin rosemary and tert-butyl hydroquinone and sodium tripolyphosphate. J. Food Sci. 56: 597-600.

Zagarska, I., Raflowski, R., Amarowicz, R., Karamac, M. and Shahidi, F. 1998. Stabilization of butter with deodorized rosemary extract. Z. Lebensm. Unless. Forsch. A 206: 99-102.

Table 1. Inhibition (%) of formation of 2-thiobarbituric acid reactive substances by spice, spice oleoresins and their combinations in a ground pork model system over a 3-week storage at 4°C.

Spice/oleoresin	Spice, ppm				Oleoresin, 200 ppm	Spice, 1000 ppm + Oleoresin, 200 ppm
	200	500	1000	2000		
Clove	56	96	96	96	79	98
Ginger	20	23	32	46	51	73
Oregano	17	35	53	85	74	88
Rosemary	6	48	60	85	48	82
Sage	14	49	74	93	69	94
Thyme	12	25	36	64	45	52