

EFFECTS OF SYNTHETIC ANTIOXIDANTS AND ROSEMARY EXTRACTS ON OXIDATIVE RANCIDITY AND COLOR STABILITY IN WHOLE HOG SAUSAGE

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Story in Brief

The use of extracts of rosemary and other spices to combat oxidative rancidity is generating increased interest with consumer concerns over the use of synthetic antioxidants. Spice extracts are of interest because they have the advantage of being labeled as spices or natural flavors. The objective of this study was to evaluate the rancidity inhibition and color stability properties of various antioxidants in whole hog sausage during frozen storage and retail display conditions. Sausage was prepared with four treatments: (a) control, (b) synthetic antioxidant combination, (c) rosemary extract and citric acid combination and (d) rosemary extract control. Sausage chubs were frozen, sliced into patties and stored at -20°F for 105 days. The retail study consisted of patties in frozen storage for 45 days then placed in simulated retail display conditions for five days. Synthetic antioxidants were more effective than rosemary extracts in controlling oxidative rancidity in both the frozen and retail studies. The synthetic antioxidant treatment tended to be more effective in inhibiting discoloration of sausage patties, but there was no difference between treatments in color scores from days three to five of the retail study. Although not as effective as synthetic antioxidants, rosemary extracts can be a viable alternative to synthetic antioxidants for controlling oxidative rancidity, especially when used with synergists such as citric acid. This study indicates only slightly enhanced color stability in whole hog sausage with the addition of synthetic antioxidants and rosemary extracts.

(Key Words: Rancidity, Antioxidants, Spice Extracts, Pork Sausage.)

Introduction

Oxidative rancidity greatly affects the quality of processed meat products, especially products with relatively high fat content like pork sausage. To

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combat oxidative rancidity, antioxidants are often added to these products to help improve shelf life. The most common antioxidants in use today are butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT), but consumer concerns over the health risks attributed to these two additives has prompted researchers to investigate antioxidants from other sources such as natural spices.

Spices with antioxidant properties have an advantage over synthetic antioxidants in that they can be labeled as spices or natural flavorings and thereby avoiding the consumer perceptions of food additives. Rosemary is a spice which has well known antioxidant properties, but it is often unacceptable for use in products as a whole spice due to its strong odor and bitter taste. However, rosemary oleoresin can be extracted to produce a natural antioxidant with bland characteristics that can be used in many food applications. Some of the claims of commercial rosemary antioxidants are protection against lipid oxidation and increased color stability. Therefore, the objective of this study was to evaluate the rancidity inhibition and color stability properties of various antioxidants during frozen storage and retail display conditions.

Materials and Methods

Sausage Manufacture

Whole hog sausage was prepared at the Oklahoma State University Meat Laboratory. Sows (n=3) were slaughtered and the lean and fat portions were removed from one side within one hour of slaughter. Each side represented a replication of the study and each animal was slaughtered and processed on different days. The lean and fat portions were ground (3/16 inch), formulated to 41% fat, and mixed one minute in a paddle mixer. Additional fat needed to meet the desired fat target was obtained from the opposite side of the carcass and was ground in the same manner. Whole hog sausage was then prepared from prerigor pork (25 lb.), a commercial spice mix (A.C. Legg, Birmingham, AL) and 0.75 oz of (a) dextrose which served as a control (CON), (b) a commercial BHA/BHT/citric acid additive and dextrose (BHA), (c) a commercial rosemary/citric acid mixture (ROS), and (d) a rosemary and dextrose control mixture (RCO). Each batch was mixed for 2 minutes in a paddle mixer then stuffed into 1.5 pound plastic chubs. The chubs were frozen (-20°F) overnight. Chubs were sliced into 1/8 inch thick patties on a band saw, layer packed 30 patties per box (separated by wax paper), and the boxes were held at -20°F for the appropriate storage period.

Product analysis

Oxidative rancidity was determined in both studies by measuring thiobarbituric acid reactive substances (TBARS) values (mg malonaldehyde per

kg sample). TBARS were determined in duplicate using the method of Rhee (1978). For the frozen storage study, four patties were removed from each treatment at 0, 35, 75 and 105 days for TBARS analysis.

For the retail display portion of the study, 12 patties per treatment were removed from frozen storage at 45 days, placed on Styrofoam meat trays, covered with polyvinyl chloride wrap, and placed in simulated retail display conditions for five days. The case was kept at $50\pm 2^{\circ}\text{F}$ with 85 foot-candles of light. TBARS values were determined for all samples on each day of the retail study.

The products were analyzed by a trained color panel for lean portion color on a scale from one to eight (1-very dark red, 5-bright cherry red, 8-very light red) and percent discoloration on a scale from zero to 100 percent (0- no discoloration, 100 - complete discoloration) each day of the retail study. The panel (n=8) was trained in two one-hour sessions using examples of sausage patties showing lean portion color and discoloration indicative of the entire range of both scales. Panelists were selected on repeatability.

Analysis of variance was performed using the General Linear Models procedure of the Statistical Analysis System (SAS) with main effects of day and antioxidant treatment.

Results and Discussion

Frozen Storage

All treatments increased in TBARS values over time ($P<.05$), but BHA was the only treatment with TBARS values under 1.0 for the duration of the study (Table 1). For red meat products, TBARS values of 1.0 or greater are considered indicative of rancid product. All other treatments surpassed TBARS values of 1.0 between day 35 and 75. TBARS determination for the frozen patties showed no significant difference ($P>.05$) between treatments at day 0. At day 35, all antioxidant treatments were lower in TBARS values ($P<.05$) than the control, with BHA being most effective ($P<.05$). The rosemary treatments were not significantly different from each other at this point. For the remainder of the study (days 75 and 105), all treatments were different from each other with CON displaying the highest ($P<.05$) TBARS values and BHA having the lowest ($P<.05$) values. The rosemary/citric acid treatment (ROS) showed lower ($P<.05$) TBARS values than the rosemary control treatment (RCO) at both 75 and 105 days. Rosemary and citric acid in combination have a synergistic effect, which explains the lower TBARS values for ROS when compared with RCO. The BHA treatment proved to be very effective in inhibiting the effects of oxidative rancidity during 105 days of frozen storage, while rosemary extracts showed some benefit up to 35 days of storage.

Table 1. TBARS values^a of whole hog sausage during frozen storage.

Treatment ^b	Day			
	0	35	75	105
CON	0.19 ^c	0.80 ^c	2.10 ^c	3.00 ^c
BHA	0.21 ^c	0.29 ^c	0.67 ^f	0.88 ^f
ROS	0.15 ^c	0.65 ^d	1.37 ^e	1.86 ^e
RCO	0.19 ^c	0.67 ^d	1.50 ^c	2.02 ^d

^a Thiobarbituric acid reactive substances measured in mg malonaldehyde per kg sample

^b Treatments consist of prerigor pork (25 lb.), a commercial spice mix (A.C. Legg) and 0.75 oz of (a) dextrose (CON), (b) BHA/BHT/citric acid additive and dextrose (BHA), (c) rosemary/citric acid mixture (ROS), and (d) rosemary and dextrose control mixture (RCO).

^{cdef} Means in same column bearing common superscripts are not different ($P>.05$).

Retail Study

Similar to the frozen study, the BHA treatment showed the lowest TBARS values over the duration of the retail study (Table 2). The BHA treatment held TBARS values under 1.0 until day five of the retail study, while the rosemary treatments surpassed that level on day two. The control had a TBARS value of 1.04 on day one. ROS displayed lower values than RCO and the control treatment over the duration of the retail study, but was not as effective as BHA.

Muscle color scores among treatments were not different ($P>.05$) for days 1, 3 and 5 (Table 3). On day two, BHA, ROS and RCO were not different ($P>.05$), but all three had more desirable color scores ($P<.05$) than the control. For muscle color evaluation, values close to 5 are representative of fresh sausage patties and as color deteriorates, muscle color scores decrease. Day four showed ROS to have the lowest muscle color ($P<.05$) while there was no difference ($P>.05$) between CON, BHA and RCO.

All treatments increased ($P>.05$) in discoloration over time (Table 4). In evaluating discoloration, the percentage discoloration should increase as the product deteriorates. The only difference ($P<.05$) in discoloration between treatments was that BHA had lower scores than RCO on days one and two. There were no differences ($P>.05$) between all treatments on days three through five. Numerically, BHA had the lowest discoloration values on all days except day four, but those values were not significantly different ($P>.05$) from other treatments.

Table 2. TBARS values^a of whole hog sausage during retail display.

Treatment ^b	Day				
	1	2	3	4	5
CON	1.04 ^c	1.80 ^c	1.60 ^c	1.85 ^c	2.26 ^c
BHA	0.29 ^e	0.67 ^f	0.61 ^f	0.87 ^e	1.10 ^f
ROS	0.67 ^d	1.23 ^e	1.03 ^e	1.35 ^d	1.57 ^e
RCO	0.99 ^c	1.42 ^d	1.33 ^d	1.49 ^d	1.73 ^d

^a Thiobarbituric acid reactive substances measured in mg malonaldehyde per kg sample.

^b Treatments consist of prerigor pork (25 lb.), a commercial spice mix (A.C. Legg) and 0.75 oz of (a) dextrose (CON), (b) BHA/BHT/citric acid additive and dextrose (BHA), (c) rosemary/citric acid mixture (ROS), and (d) rosemary and dextrose control mixture (RCO)

^{cdef} Means in same column bearing common superscripts are not different ($P > .05$).

Table 3. Muscle color scores^a for whole hog sausage during retail display.

Treatment ^b	Day				
	1	2	3	4	5
CON	5.56 ^c	4.05 ^d	4.29 ^c	3.33 ^c	2.98 ^c
BHA	5.35 ^c	4.62 ^c	3.99 ^c	3.38 ^c	2.88 ^c
ROS	5.61 ^c	4.98 ^c	3.98 ^c	2.99 ^c	2.75 ^c
RCO	5.47 ^c	4.71 ^c	3.06 ^c	3.06 ^c	2.82 ^c

^a Muscle color scores range from 1=very dark red, 5=bright cherry red, 8=very light red

^b Treatments consist of prerigor pork (25 lb.), a commercial spice mix (A.C. Legg) and 0.75 oz of (a) dextrose (CON), (b) BHA/BHT/citric acid additive and dextrose (BHA), (c) rosemary/citric acid mixture (ROS), and (d) rosemary and dextrose control mixture (RCO)

^{cd} Means in same column bearing common superscripts are not different ($P > .05$).

Table 4. Discoloration scores^a for whole hog sausage during retail display.

Treatment ^b	Day				
	1	2	3	4	5
CON	20.50 ^{cd}	31.67 ^{cd}	33.19 ^c	53.72 ^c	69.06 ^c
BHA	12.56 ^d	24.17 ^d	30.67 ^c	50.05 ^c	58.78 ^c
ROS	20.23 ^{cd}	26.20 ^{cd}	33.93 ^c	49.86 ^c	64.52 ^c
RCO	24.33 ^c	32.64 ^c	38.96 ^c	53.06 ^c	62.67 ^c

^a Discoloration estimated to the nearest 10%

^b Treatments consist of prerigor pork (25 lb.), a commercial spice mix (A.C. Legg) and 0.75 oz of (a) dextrose (CON), (b) BHA/BHT/citric acid additive and dextrose (BHA), (c) rosemary/citric acid mixture (ROS), and (d) rosemary and dextrose control mixture (RCO)

^{cd} Means in same column bearing common superscripts are not different ($P>.05$).

Conclusions

In this study, synthetic antioxidant combinations such as BHA/BHT/citric acid proved to be more effective in controlling oxidative rancidity than natural spice extracts. Rosemary additives were effective in frozen sausage patties for controlling rancidity (TBARS values under 1.0) for up to 35 days, while the BHA treatment held TBARS values under 1.0 the entire 105 day period. The BHA treatment tended to have less discoloration during retail display conditions, but there was no significant difference between any of the treatments in color scores from day three to day five. The natural spice extracts tended to be only slightly effective in improving discoloration. This study shows that rosemary extracts can be a viable alternative to synthetic antioxidants for controlling oxidative rancidity for up to 35 days of frozen storage. Under other processing and storage procedures, rosemary extracts may be effective in controlling rancidity and improving color stability, but more research needs to be done before using rosemary extracts in place of BHA or BHT in commercial applications.

Literature Cited

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