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RELATIVE FRESHNESS OF TURKEY SAUSAGE WITH ROSEMARY EXTRACT

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Introduction

Meat products typically spoil due to one of two major causes: microbial growth or chemical deterioration. The most common form of chemical deterioration is oxidative rancidity (Kanner, 1994). Oxidative rancidity in meat can vary greatly, ranging from extensive flavor changes, color losses and structural damage to proteins (Xiong, 1996) to a more subtle "loss of freshness" that discourages repeat purchases by consumers. The latter is probably the most important to food processors because it is not obvious, yet results in consumer dissatisfaction.

Several processed meat products are particularly susceptible to oxidative rancidity because of exposure to oxygen and/or elevated temperatures during processing. Meat sources with a high proportion of unsaturated fats, such as pork and poultry are particularly susceptible. Processed meats utilize antioxidants to control oxidative changes. Uncured meats typically depend on the synthetic phenolic antioxidants, BHA (butylated hydroxyanisole) and BHT (butylated hydroxytoluene). BHA and BHT are very effective, but are a source of concern to some human health professionals and some consumers (Decker and Mei, 1996). The FDA regulations specify the GRAS limit for direct addition of total phenolic antioxidants to food to be 0.02% (200ppm), based on the fat content of the food. The Food Safety and Inspection Service of the USDA further restricts this for sausage to a total of 0.02% (based on fat content) of BHA/BHT specifically (FSIS Directive 7120.1, 2002)

Because of concerns about synthetic antioxidants, many consumers and, consequently, meat processors have been seeking natural alternatives to promote freshness. Rosemary (*Rosmarinus officinalis)* extracts have been used in meat systems (Lai et al., 1991, Offord et al., 1997, Güntensperger, et al., 1998, Yu, et al., 2002) but are generally considered to be less effective than BHA and BHT. However, rosemary extract is a natural compound and enjoys a highly positive consumer image. Consequently, rosemary extracts are of very significant interest to the meat industry and expanded applications are very likely if effectiveness in meat systems can be demonstrated.

Objectives

The overall objective of the experiments reported here was to establish the ability of a liquid rosemary extract (RE) to maintain the natural freshness of turkey sausage. Turkey sausage is a lower-fat alternative to pork sausage; however, it is more susceptible to deterioration due to the higher proportion of unsaturated fats. The effectiveness of RE was assessed relative to the synthetic phenolics, butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT). The results indicate that rosemary extracts offer a commercially viable alternative to the synthetic additives (BHA, BHT) currently used by the meat industry.

Methodology

Meat Processing. The shelf life of the sausage was tested under two conditions: (1) raw-frozen and (2) precooked-frozen. Five treatments were formulated as follows: (1) control; (2) 200 ppm BHA/BHT (BHA/BHT); (3) RE at 500 ppm (RE 500); (4) RE at 1000 ppm (RE 1000); (5) RE at 1500 ppm (RE 1500). Rosemary extract (Fortium™ natural rosemary extract, Kemin Food Ingredients, Des Moines, IA) inclusion was calculated on the basis of the total product weight; however, in compliance with USDA regulations, BHA/BHT (Danisco, Aubervilliers Cedex, France; Merisol, Houston, TX) inclusion was limited to 0.2 g/kg fat, with a fat content of 11.6%. The batch formulations were as described in Table 1.

Ground turkey (containing light meat, dark meat, and skin) and seasoning components were purchased from a local grocery store. The additives were mixed with spices to insure proper dispersion. Next, the ground turkey and seasonings were mixed for 2 minutes using a stand mixer (KitchenAid, St. Joseph, MI), with a paddle attachment. Each treatment was formulated and prepared as one batch. Two distinct batches of each treatment were prepared (n=2). Patties, 5.5 cm in diameter, were formed using a plastic petri dish. After preparation, patties were subdivided into groups according to their intended storage method. For cooked-frozen storage, patties were cooked to 71 ºC (160 ºF) internal temperature, and then set on wire racks to cool before packaging. All patties were wrapped individually in plastic film, placed into resealable plastic freezer storage bags and stored at –20 ºC.

Table 1. Recipes for each of the treatments

Ingredient (g)	Treatment				
	Control	**BHA/BHT**	**500 ppm RE[1]**	**1000 ppm RE**	**1500 ppm RE**
Ground Turkey	454	454	454	454	454
Sucrose	6.9	6.9	6.9	6.9	6.9
Black Pepper	1.05	1.05	1.05	1.05	1.05
Salt	6.0	6.0	6.0	6.0	6.0
Sage	0.7	0.7	0.7	0.7	0.7
Test Additive	0	0.00526 each	0.227	0.454	0.681

[1]RE: rosemary extract

Chemical Analyses. Malonaldehyde (MA) level and alkenal level were measured at each time interval using the SafTest™ System from SafTest, Inc. (Tempe, AZ).

Statistical Analysis. Statistical analysis of the data used the GLM procedures of STATGRAPHICS® Plus software (V5.1) to assess significance of treatment and time effects in two-way Analysis of Variance (ANOVA). When treatment or time effects were significant (P<0.05), the means were separated using Duncan's Multiple Range Test. In addition, one-way ANOVA was used to assess significant difference between the negative control, positive control (BHA/BHT) and RE (using the three levels as replicates (n=6) for the RE treatment). Finally, multiple linear regression analysis was used to assess differences in rate of change of malonaldehyde and alkenal levels over time between the respective controls and RE via comparison of slopes. Data are presented graphically as outputs from the regression analyses.

Results & Discussion

Frozen, Raw Turkey Sausage. The results of the SafTest analyses are shown in Figures 1 and 2. Malonaldehyde concentration increased (P<0.001) over the 16-week sampling period. However, the respective treatments impacted (P<0.001) MA levels as well as the change in MA over time (time x treatment interaction, P=0.051). SafTest suggests that MA greater than 0.4 mg/kg represent a cause for concern, whereas MA above 1.0 mg/kg indicates that substantial quality loss has occurred.

Turkey sausage patties containing RE had lower (P<0.05) levels of MA when compared to the control and BHA/BHT sausage from 10 weeks onward. No dose response was observed for RE above 500 ppm. MA levels for untreated and BHA/BHT patties were above the level of concern from weeks 5–7 and 10–16. These results suggest that RE is more effective than BHA/BHT in raw-frozen turkey sausage patties. This is also confirmed by the regression analysis results displayed in Figure 1. BHA/BHT appeared to merely reduce the initial concentration of MA, but not the rate of formation of additional MA over time. A previous study in raw-frozen pork sausage patties also indicated that RE was more effective than BHA/BHT (Sebranek et al., 2005).

After 16 weeks, the control and BHA/BHT MA had increased substantially, however, turkey sausage containing RE remained virtually unchanged. The data also indicates the lack of a dose response beyond 500 ppm, thus offering meat processors flexibility in determining the appropriate inclusion rates for their required shelf life.

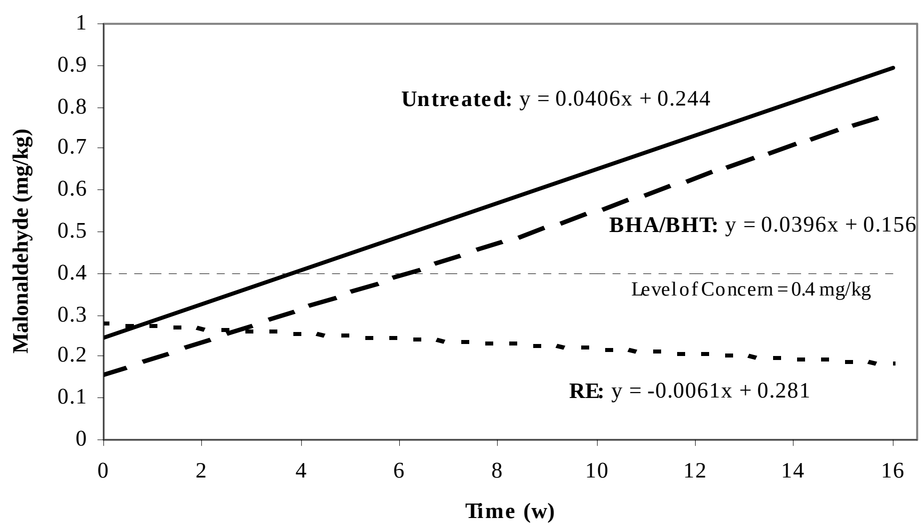

Figure 1. **Regression lines representing change in malonaldehyde levels during frozen storage of raw turkey sausage as affected by synthetic (BHA/BHT) and natural (RE) additives. The RE regression line represents the average of all treatment levels (500, 1000, 1500 ppm). The slope (increase in MA over time) for both controls was steeper (P<0.001) than that of RE.**

Alkenals increased (P<0.0001) in raw-frozen turkey sausage over the 16-week sampling period. Again, the respective treatments impacted (P<0.001) alkenal levels as well as the change in alkenals over time (time x treatment interaction, P<0.001). SafTest suggests that alkenals greater than 100 nmol/ml indicate that substantial quality loss has occurred. Alkenal levels for both the untreated and BHA/BHT patties were above the level of concern from weeks 12–16. From week 12 onwards, the turkey sausage with RE was lower in alkenals than sausage containing BHA/BHT (P<0.05). These results suggest that RE is more effective than BHA/BHT in raw-frozen turkey sausage patties, a conclusion that was also supported by multiple regression analysis (difference in slopes, P<0.001; see Figure 2).

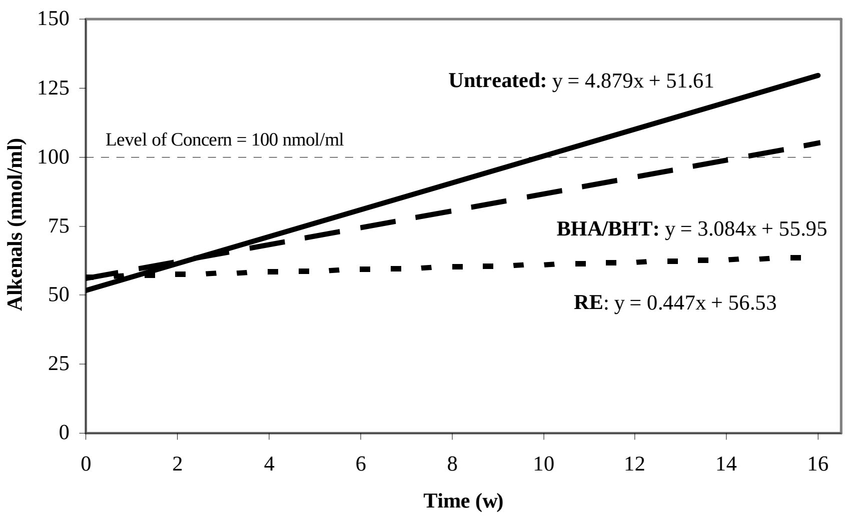

Figure 2. **Regression lines representing change in alkenal levels during frozen storage of raw turkey sausage as affected by synthetic (BHA/BHT) and natural (RE) additives. The RE regression line represents the average of all treatment levels (500, 1000, 1500 ppm). The slope (increase in MA over time) for both controls was steeper (P<0.001) than that of RE.**

Frozen, Cooked Turkey Sausage. The results of the SafTest analyses are shown in Figures 3 and 4. Similar to the raw-frozen sausage, both MA and alkenals increased (P<0.001) over the 16-week sampling period, and the treatments had a significant (P<0.001) impact on the malonaldehyde and alkenal levels. However, only a weak trend for treatment x time interaction was detected (P=0.18). The MA and alkenal levels for turkey sausage containing RE were significantly (P<0.05) lower than the untreated control and were similar to sausage containing BHA/BHT. However, by week 12, 14, and 16, turkey sausage containing RE tended to have lower MA levels than sausage with BHA/BHT (P<0.10). The high week-to-week variation in the MA data (not shown) made it challenging to distinguish trends among treatments; however, the untreated control was above the level of concern from 4 weeks onwards. Multiple regression analysis of time on MA was able to more clearly differentiate RE from positive and negative controls, each one of which had steeper slopes than RE treated sausage (P<0.01 and P<0.001, respectively, see Figure 3). In addition, contrasting the RE MA against the untreated control revealed significantly (P<0.05) lower MA on weeks 4, 5, and 8 to 16.

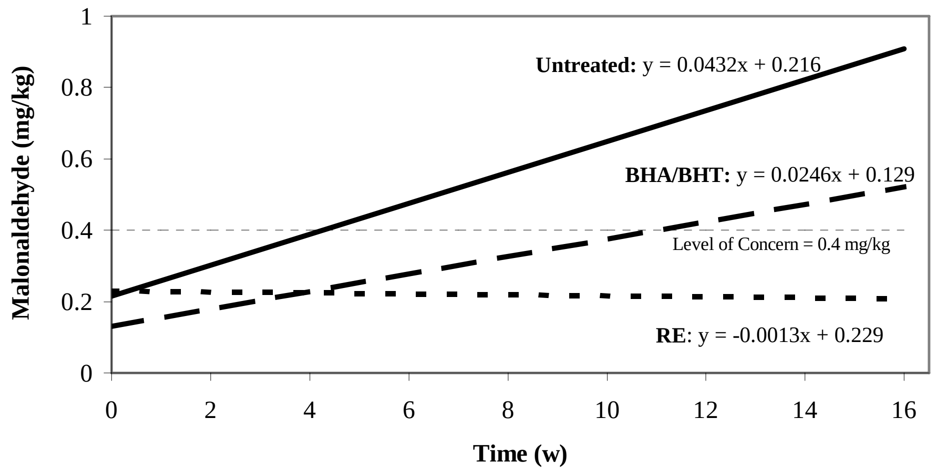

Figure 3. **Regression lines representing change in malonaldehyde levels during frozen storage of cooked turkey sausage as affected by synthetic (BHA/BHT) and natural (RE) additives. The RE regression line represents the average of all treatment levels (500, 1000, 1500 ppm). The slope (increase in MA over time) for both controls was steeper (P<0.01) than that of RE.**

After 10 weeks of frozen storage, MA of the untreated control was well above the level of concern, but the turkey sausage with either BHA/BHT or RE had MA levels within the acceptable limit. By week 16, however, sausage containing BHA/BHT was not improved over the untreated control, yet the sausage containing RE was still within the acceptable limit. This suggests that RE is more effective than BHA/BHT in cooked sausage intended for long-term (greater than 3 months) frozen storage.

Alkenals showed little increase until week 10 when especially the negative control increased, but they remained below the level of concern until week 14. Although turkey sausage with either BHA/BHT or RE tended to maintain lower alkenal levels than the negative control (P<0.001), neither analysis of variance nor regression analysis (Figure 4) detected a difference between RE and the positive control. Contrasting alkenals for the untreated control against the RE treatments confirmed that the RE treated sausage maintained lower alkenals (P<0.05, weeks 8–16) than the negative control during long-term frozen storage.

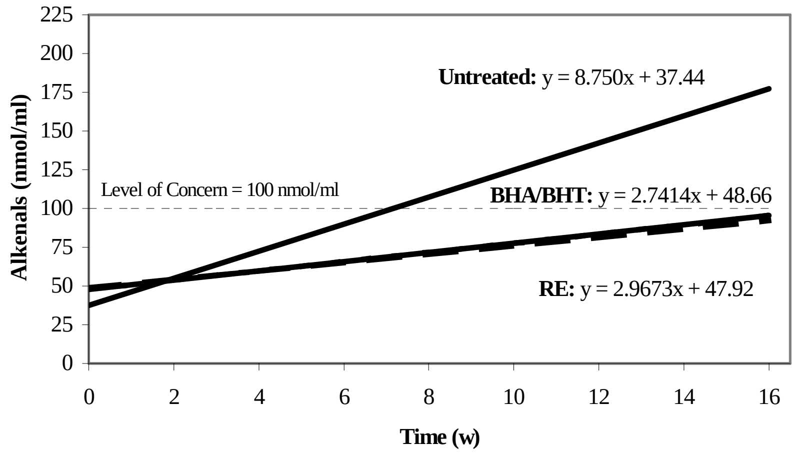

Figure 4. **Regression lines representing change in alkenal levels during frozen storage of cooked turkey sausage as affected by synthetic (BHA/BHT) and natural (RE) additives. The RE regression line represents the average of all treatment levels (500, 1000, 1500 ppm). The slope (increase in MA over time) for the negative control was steeper ($P<0.001$) than that of RE.**

Conclusions

The addition of natural rosemary extract clearly provided significant protection of freshness for turkey sausage products. RE was superior to BHA/BHT in maintaining low malonaldehyde and alkenal levels in raw-frozen turkey sausage and in delaying the formation of malonaldehyde during prolonged storage of cooked-frozen turkey sausage. The results of these experiments are in agreement with the previously demonstrated capacity of rosemary extract to suppress oxidative rancidity in pork sausage (Sebranek et al., 2005).

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