ADDITION OF HONEY AND CAFFEIC ACID PHENETHYL ESTER (CAPE) TO ENHANCE COLOR AND LIPID STABILITY DURING CHILLED STORAGE IN COOKED OR RAW PORK SAUSAGES

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Introduction

Lipid oxidation is one of the mayor causes of quality loss of processed meat, imposing an adverse effect on flavor, color and texture as well as nutritional value (Byrne, 2000). Efficient protection of meat products against such oxidative deterioration depends on composition, meat handling, processing, use of antioxidants, and optimization of packaging and storage conditions (Skibsted *et al*., 1998). Addition of natural antioxidants, like honey, to meat products can effectively stabilize color and odor, and show antioxidant activity. Previous works demonstrates that the honey has a high antioxidant activity due to its high total phenolic contents (Al-Mamary *et al*., 2002). Propolis, a natural honey by-product, has been used for thousands of years in folk medicine for several purposes. It contains amino acids, phenolic acids, phenolic acid esters, and others, and one of these is CAPE (caffeic acid phenethyl ester). Some studies suggest that CAPE has antioxidant properties (Son and Lewis, 2002; Chen and Ho, 1997), but it not commonly used in food products.

The objective of the present study was to determine the effects of honey and CAPE on the oxidative stability and color of pork sausages stored aerobically at refrigeration temperatures under darkness.

Materials and Methods

Pork sausages containing sodium chloride (1.5%) and fat (30%) were prepared and stored at 2°C up to 16 days under darkness. The effect of addition of CAPE in two concentrations (100 ppm and 200 ppm) and honey (5 and 10%) on pH, color and lipid stability in raw pork sausages during refrigerated storage were studied. Cooked sausages were analyzed for pH and lipid stability. The sausages were packaged in a foam tray and over-wrapped. Lipid oxidation during storage was analyzed by measuring the concentration of thiobarbituric acid reactive substances (TBARS). CIE color L*, a* and hue values, thus metmyoglobin percentage were also evaluated each 4 days. Sausages with CAPE and honey were compared with a control (without CAPE) and with sausages formulated with BHT.

Data were analyzed as a 6 (treatment) by 5 (storage times) factorial design using the NCSS program. The ANOVA tables obtained were analyzed for comparison of means by Tukey Multiple Comparison test ($p<0.05$).

Results and Discussion

Color and pigment on raw sausages. CAPE did not changed CIE color L* and a* values of raw pork sausages ($P>0.05$). However these values were affected by the storage time. **a*** values of raw sausages presented significant changes ($P<0.05$) during storage time (Table 1), having obtained itself lower values at end of storage. This same effect observed Sebranek et al. (2005) who elaborated fresh pork sausages with 35% of fat and stored during 14 days (2-4°C). They obtained initial values of a* around 9.0 and end of 4.0. Comparing these values with the obtained ones in our experiment we observed that our sausages were redder. In addition, (Table 1) is observed that there was no significant difference ($P>0.05$) between treatments until day 16, in which the sausages with 10% of honey presented higher values of a*. Therefore 10% of honey conserves the red color of sausages during the 16 days of storage, whereas the sausages with CAPE conserve the red color until day 8 like the sausages control.

Lipid oxidation. TBARS values of raw sausages are shown in Figure 1, where observe the effect that has the time on the lipid oxidation, conforms advances the time increases the oxidation. Also it is observed that CAPE and honey delay oxidation of lipids in comparison to sausages control ($p<0.05$) in all day of storage time. In addition, statistical analysis was not significant difference ($p>0.05$) between using 100 ppm and 200 ppm of CAPE during storage, obtaining values of TBARS in day 16 of 1.32 and 1.02 mg MA/kg, respectively. With respect to antioxidant effect of the honey it is observed that 10% of honey has an antioxidant effect similar ($p>0.05$) to the one of the BHT until day 12, whereas 5% of honey until day 4. At the end of the storage there was no difference ($p>0.05$) between using 10% and 5% of honey obtaining 3.03 values of 3.15 mg MA/kg of sample, respectively. Comparing TBARS values of raw sausages it is observed that CAPE is better antioxidant ($p<0.05$) in comparison to the honey and the BHT. Because this is the first study where the antioxidant capacity is evaluated of CAPE in a meat product, there were no TBARS data to compare them with our results. Nevertheless, Chen and Ho (1997) evaluated the antioxidant index of CAPE using pork fat and found that CAPE had a lower antioxidant index in comparison to caffeic acid and α-tocoferol, but greater to BHT. CAPE is a polyphelonic compound and has the capacity to donate its hydroxyls groups to stabilize to the hydroperoxides and to inhibit the lipid oxidation. Chen and Ho (1997), mention that the presence of a second group hydroxyl in the position *orto* or for increases the

antioxidant activity due to the stabilization by resonance. This explains because CAPE is a better antioxidant for pork fat that BHT.

Table 1. Color (a* value) of raw pork sausages stored at 2°C under darkness.

Sample	Parameter	Storage Time (d)				
		0	4	8	12	16
Control	**a***	**13.02^{Ax}**	**13.97^{Cx}**	**12.72^{Axy}**	**9.57^{ABy}**	**4.73^{Az}**
CAPE 100 ppm	**a***	**13.61^{Ax}**	**13.78^{BCx}**	**12.61^{Ax}**	**10.22^{ABy}**	**6.43^{ABz}**
CAPE 200 ppm	**a***	**10.42^{Ax}**	**11.67^{Ax}**	**11.11^{Ax}**	**8.53^{Ay}**	**5.40^{ABz}**
Honey 5%	**a***	**11.66^{Ax}**	**13.56^{BCx}**	**12.06^{Ax}**	**11.28^{Bx}**	**7.20^{By}**
Honey 10%	**a***	**12.87^{Ax}**	**12.70^{ABx}**	**11.79^{Axy}**	**11.58^{Bxy}**	**10.23^{Cy}**
BHT	**a***	**13.08^{Ax}**	**13.18^{BCx}**	**11.50^{Axy}**	**10.31^{ABy}**	**5.75^{ABz}**

^{ABC} Means of a* within the same column with different superscript are significantly different (P<0.05).
^{xyz} Different letters in rows indicated differences (P<0.05).

Quality of cooked sausages. At day 0, oxidation of cooked sausages gave TBARS values for CAPE and honey sausages were lower (p<0.05) in comparison to control. Lipid oxidation proceeded during time as TBARS value increased. Sausages cooked with CAPE 200 ppm kept TBARS values around 2 mg of MA/kg until day 12 and at end of storage was not significant differences (p>0.05) between use 100 and 200 ppm of CAPE to decrease lipid oxidation. Like in fresh sausages, antioxidant effect of CAPE was better (p<0.05) in comparison to BHT. The effect of 10% of honey was similar to BHT until the last day of storage, whereas sausages with 5% of honey were similar until day 12. In day 16 it was observed that TBARS values in 10% of honey were smaller (p<0.05). This same antioxidant effect was observed by Johnston et al. (2005) and McKibben and Engeseth (2005), who evaluated the antioxidant effect of the honey in beef and turkey, respectively. The difference between the antioxidant action of 5% and 10% of honey in cooked sausages may be due to the formation of Maillard reaction products (MRP) considering that Antony et al. (2000) found that addition of honey to turkey breast had an antioxidant effect and it was attributed to the MRP formed during cooking. Vasavada and Cornforth (2006) proposed that the antioxidant activity of the hydroperoxides of MRP must to the reduction of inactivation of formed free radicals during the oxidative degradation of unsaturated fatty acids, oxygen scavenging and quelation of heavy metal ions.

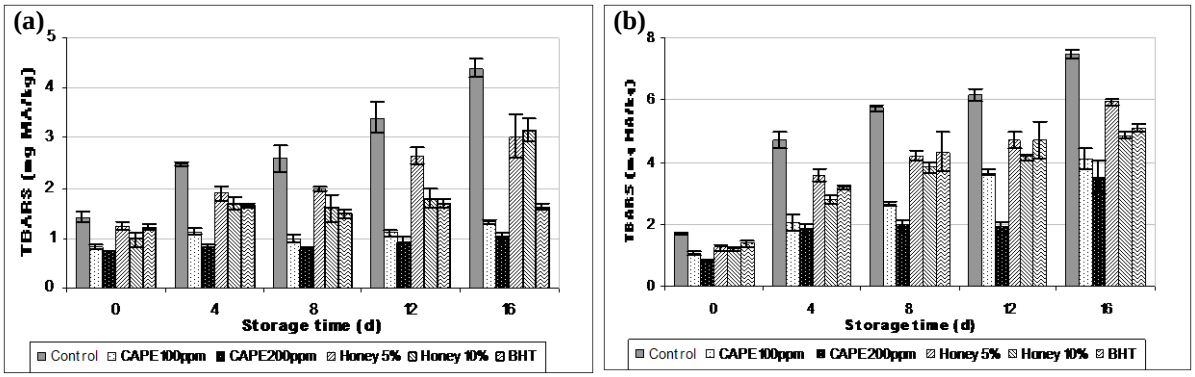

Figure 1. TBARS content in raw (a) and cooked (b) pork sausages stored at 2°C under darkness.

Conclusions

These results indicate that CAPE and honey are potent natural antioxidants and exhibit greater antioxidant efficacy and could be very effective in inhibiting lipid oxidation of cooked and raw meat products during chill-storage, can be used like strategies to maximize the quality and marketability of beef.

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