LIPID OXIDATION, PH VALUE AND LACTIC ACID BACTERIA OF CHINESE SAUSAGES MADE FROM NORMAL AND PSE PORK AS AFFECTED BY STORAGE TIME

Kuo, J. C. [1],Chu, C. U.[1]
[1]Department of Food Science, Tunghai University, Taichung, Taiwan 407

Background

The PSE (pale, soft and exudative) condition is associated with lower processing yields, increased cooking losses and reduced juiciness (Hedrick et al., 1994), which has caused economic and processing losses to the meat industry. The possibility and feasibility of using PSE pork in processed meat products was proposed. Redden & Chen (1995) used PSE pork for the manufacture of Chinese meatballs and dried meat floss (shred meat), and found that PSE pork was not suitable for meatballs production, even with the inclusion of potato or corn starch as a binding agent. However, the pale color of PSE pork used for manufacturing dried meat floss was highly favored by the taste panel. Huang et al. (1997) studied the effect of carrageenan on the quality of restructured PSE hams and found that carrageenan would increase the texture and overall acceptability scores in PSE hams. Motzer et al. (1998) studied restructured hams made with PSE pork and binders, and reported that modified food starch could enhance the water retention of PSE pork in a restructured ham. Li & Wick (2001) indicated the addition of mechanically deboned turkey meat to processed meat made with PSE pork has the potential to enhance the economic value to both of these low value raw materials.

Objectives

The objectives of this study were to evaluate the semi-dried Chinese sausages made with different levels of PSE pork loins for lipid oxidation, pH value and lactic acid bacteria during storage at 4°C.

Methods

Percent moisture, fat and protein were determined according to AOAC (1995) procedure. The pH value and 2-thiobarbituric acid (TBA) values of meat samples were determined according to Ockerman (1989). TBA values were expressed as mg malonaldehyde/Kg. Appropriate serial dilutions were made in sterile peptone water and 0.1 ml of each dilution were spread onto Lactobacilli MRS agar (Difco Laboratories, Detroit, MI). Plates were incubated at 37°C for 48 hr, and the lactic acid bacterial colonies were counted and reported as CFU/g meat. This experiment was replicated three times with duplicate samples in each replication.

Results and discussion

Lipid oxidation, expressed as the TBA value, is shown in Table 1. At zero time, the 100 % Normal treatment showed higher ($p<0.05$) TBA values than the 100 % PSE and 50 % Normal + 50 % PSE treatments due to its higher lipid content. Lipid content of the 100 % PSE treatment (20.8) was the lowest, compared to the 100 % Normal (22.1) and 50 % Normal + 50 % PSE (21.4) treatments, thus, its TBA value was lower than the other two treatments. On days 15, 30 and 45, the 100 % Normal treatment consistently had the highest TBA values among these treatments, followed by the 50 % Normal + 50 % PSE and 100 % PSE treatments.

Mean TBA values of all meat products increased as the storage time increased, indicating that lipid oxidation had occurred in vacuum-packed Chinese sausages. TBA values of all products throughout storage time were in the range of 0.09-0.32, which were well below the threshhold value (1.0 mg malonaldehyde/Kg) for detection of warmed-over flavor (Boles & Parrish, 1990). Gary & Pearson (1987) indicated that rancid flavor was initially detected between TBA 0.5 and 2.0. From this result, it suggested that vacuum-packed Chinese sausages had no serious rancid problem during storage for up to 45 days at 4°C. The relatively low extent of lipid oxidation could be attributed to the vacuum packaging and low storage temperature. Kuo et al. (1986) studied the quality of Chinese sausages and found that the use of vacuum packaging could be a means of reducing lipid oxidation in meat products.

During storage, the increase rate of TBA values for each treatment was different due to its different lipid oxidation rate. On day 15, TBA values of the 100 % Normal, 50 % Normal + 50 % PSE, and 100 % PSE treatments were 29, 54 and 67 % higher than those at zero time, respectively (Table 1). After 45 days of storage, the trend in TBA changes among these treatments was similar. TBA values of the 100 % Normal, 50 % Normal + 50 PSE blend, and 100 % PSE treatments were 1.88, 2.15 and 2.56 times higher than those at zero time, respectively. These results demonstrated that the lipid oxidation rate was faster in the Chinese sausages made from 100 % PSE meat, even their initial TBA values were very low. The higher proportions of PSE pork used for manufacturing sausages, the higher lipid oxidation rate of the meat products. The rate of oxidative reaction was probably due to the pH effect. Yasosky et al. (1984) reported that TBA values of ground pork decreased as the pH values increased. Inhibition of oxidation occurred at higher pH.

The pH values of Chinese sausages made from different levels of PSE meat were different at day 0 (Table 2). As expected, sausages made from PSE pork (the 100 % PSE and 50 % Normal + 50 % PSE treatments) had lower ($p<0.05$) pH values (6.08 and 6.16, respectively) than the 100 % Normal treatment (6.21). This was due to the lower pH value of the raw PSE muscle (5.60), compared to the normal muscle (5.96). The pH value of the 100 % PSE treatment was lower than that of the 50 % Normal + 50 % PSE treatment; however, the differences were not significant. Motzer et al. (1998) manufactured hams with PSE pork and also found the 100% PSE meat treatment had lower pH values than the 50 % Normal + 50 % PSE blend and 100 % Normal treatments. Petrovic et al. (1995) studied the properties of normal and PSE cooked hams and found the pH value of PSE hams was lower than that of normal muscle. At each storage time (15, 30 or 45 days), the 100 % PSE treatment consistently had the highest pH value, followed by the 50 % Normal + 50 % PSE and 100 % Normal treatments.

The pH value of all sausage samples decreased as the storage time increased. This was probably due to the accumulation of lactic acid produced by the growth of lactic acid bacteria in vacuum-packed sausages. The Chinese sausages were added with 10 % of sugar, which could be used by the lactic acid bacteria during storage.

No differences ($p>0.05$) in lactic acid bacteria were found between treatments at any given storage time, but during the storage period, counts increased logarithmically (Table 3). The lactic acid bacteria of all treatments increased to 5.2-5.4, 6.2-6.4 and 7.3-7.4 log CFU/g at 15, 30 and 45 days of storage, respectively. Gill (1982) reported that the flora of vacuum packaged meat is usually dominated by species of *Lactobacillus*. The normal spoilage of cured meat products is one of a souring nature due to the growth of *Lactobacilliace*, but other organisms may also be found. During storage, the growth of lactic acid bacteria caused the accumulation of lactic acid and decrease of pH value in all Chinese sausages (Table 2).

Conclusions

As the storage time increased, pH values of Chinese sausages decreased, TBA values and lactic acid bacteria increased. TBA values were below 0.4 throughout storage time, suggesting that the vacuum-packed Chinese sausages could be stored for ≧ 45 days at 4°C without any serious lipid oxidation.

References

Boles, J. A., & Parrish, F. C. Jr. (1990). Sensory and chemical characteristics of precooked microwave-reheatable pork roasts. *Journal of Food Science, 55*, 618-620.

Gill, C. O. (1982) *Microbial interaction with meats*. In M. H. Brown, *Meat microbiology* (p.246). London/New York: Applied Science Publishers.

Gray, J. I. , & Pearson, A. M. (1987). Rancidity and warmed-over flavor. *Advanced Meat Research, 3*, 221-269.

Hedrick, H. B., Aberle, E. D., Forrest, J. C., Judge, M. D., & Merkel, R. A. (1994). *Princles of Meat Science* (pp. 108, 116). Iowa: Kendall / Hunt Publishing Company.

Huang, C. Y., Mikel, W. B., & Jones, W. R. (1997). Carrageenan influences on the characteristic of restructured normal and pale, soft and exudative hams. Journal of *Muscle Foods, 8*, 85-93.

Kuo, J. C., Yuan, C. K. R., Lee, F. L., & Shin, C. H. (1986). Vacuum packaged Chinese sausage as influenced by different fat and nitrite levels. *Chinese Food Science, 13*, 21-31.

Li, C. T., & Wick, M. (2001). Improvement of the physicochemical properties of pale soft and exudative (PSE) pork meat products with an extract from mechanically deboned turkey meat (MDTM). *Meat Science, 58*, 189-195.

Motzer, E. A., Carpenter, J. A., Reynolds, A. E., & Lyon, C. E. (1998). Quality of restructured hams manufactured with PSE pork as affected by water binders. *Journal of Food Science, 63*, 1007-1011.

Petrovic, L., Okanovic, D., & Rede, R. (1995) Film-packed cooked hams from PSE meat. *Fleischwirtschft, 75*, 480-481.

Redden, V. R., & Chen, T. (1995). The potential of Chinese meatballs and dried meat as value added PSE pork products. *Food Australia, 47*, 323-326.

Yasosky, J. J., Aberle, E. D., Peng, I. C., Mills, E. W., & Judge, M. D. (1984). Effects of pH and time of grinding on lipid oxidation of fresh ground pork. *Journal of Food Science, 49*,1510-1512.

Table 1. TBA value of Chinese sausages made from normal and/or PSE pork as affected by storage time

Days	Meat type		
	100 % Normal	50 % Normal + 50 % PSE	100 % PSE
0	0.17 $^{a, w}$	0.13 $^{a, w}$	0.09 $^{a, w}$
	(100)	(100)	(100)
15	0.22 $^{a, w, x}$	0.20 $^{a, w, x}$	0.15 $^{a, w, x}$
	(129)*	(154)	(167)
30	0.27 $^{a, x, y}$	0.23 $^{a, x, y}$	0.20 $^{a, x, y}$
	(159)	(177)	(222)
45	0.32 $^{a, y}$	0.28 $^{a, b, y}$	0.23 $^{b, y}$
	(188)	(215)	(256)

$^{a, b}$ Means in the same raw with different letters are significantly different (P < 0.05).
$^{w-y}$ Means in the same column with different letters are significantly different (P< 0.05).
* Value in brackets is the % of initial TBA value within each meat type.

Table 2. pH value of Chinese sausages made from normal and/or PSE pork as affected by storage time

Days	Meat type		
	100 % Normal	50 % Normal + 50 % PSE	100 % PSE
0	6.21^{a,w}	6.16^{a,b,w}	6.08^{b,w}
15	5.81^{a,x}	5.71^{b,x}	5.55^{c,x}
30	5.61^{a,y}	5.54^{a,y}	5.32^{b,y}
45	5.45^{a,z}	5.36^{b,z}	5.13^{c,z}

$^{a-c}$ Means in the same raw with different letters are significantly different (P<0.05).
$^{w-z}$ Means in the same column with different letters are significantly different (P<0.05).

*Table 3. Lactic acid bacteria (log CFU/g) of Chinese sausages made from normal and/or PSE pork as affected by storage time

Days	Meat type		
	100 % Normal	50 % Normal + 50 % PSE	100 % PSE
0	4.3 $^{a, w}$	4.3 $^{a, w}$	4.2 $^{a, w}$
15	5.5 $^{a, x}$	5.4 $^{a, x}$	5.2 $^{a, x}$
30	6.4 $^{a, y}$	6.3 $^{a, y}$	6.2 $^{a, y}$
45	7.4 $^{a, z}$	7.4 $^{a, z}$	7.3 $^{a, z}$

^{a} Means in the same raw with the same letter are not significantly different (P>0.05).
$^{w-z}$ Means in the same column with different letters are significantly different (P<0.05).