FLUENCE OF SEQUENCE OF TREATMENTS ON OXIDATION OF PORK MUSCLE TISSUE.

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e influence on lipid oxidation of different sequences of treatments such as sample size hole, sliced or ground samples), cooking, refrigerated storage and frozen storage was in-stigated. A modified TBA method was used to measured oxidation on porcine longissimus rsi muscle samples. Results indicate that, the sequence in which these treatments were ap-ied to muscle samples has a significant ($P<0.05$) effect on TBA values.

troduction

veral investigations have been conducted to determine the influence of tissue size reduc-on, cooking, storage conditions and their cumulative effect on oxidation and consequently rmed-over flavor (WOF) (Chang et al., 1961; Keskinel et al., 1964; Huang and Greene, 1978; ene et al., 1981; Pikul et al., 1984a). However, the effect on lipid oxidation of the quence in which these processes are conducted has not been systematically studied. The 2-iobarbituric test (TBA) has been mostly used to measure oxidation in meat, but it not ssible to determine the sequence effect by comparing studies performed in different boratories mainly because TBA number varies when different experimental conditions or difications of the method are utilized (Newburg and Cocon, 1980; Melton, 1983; Igene et ., 1985; Willemot et al., 1985; Williams et al., 1983; Pikul et al., 1984b). Considering is, the objective of the present research is to evaluate the influence that different quences of common meat industry procedures (grinding, slicing, cooking, and refrigerated nd frozen storage) have on oxidation of pork muscle tissue as measured by TBA method.

terials and Methods

mple Treatments: As it is shown in Figure 1, the samples were randomly distributed among ght preparation (prep.) treatment and thirteen time-temperature (tm-tp) treatments.

uscle Source and Sample Preparation: Pork loins from both sides of an individual pork car-ss were purchased from a local packer. At the laboratory, the loins were deboned and the ngissimus dorsi muscles (LD) were excised and trimmed. The LD's were arbitrarily divided nto eight pieces between the proximal and distal ends and randomly distributed among the rep. treatments. The sizes of the portions were calculated considering that the samples repared from them must be the necessary to be distributed among the tm-tp treatments. uplicate patties and slices were prepared for each tm-tp treatment. For the cooked samples n extra 35% more of sample was calculated to prevent cooking loss. Whole samples of .5±0.5cm thick, slices samples of 0.5±0.1cm thick and 20±0.5g patties of 5.5cm diameter and cm thick were prepared. The patties were made from meat that was cubed (4x4x4cm) and then ound through a 0.48 cm plate. The slices were sliced with an electric slicer (Hobart Model 12). After being prepared all samples were individually wrapped in aluminum foil and taped ith masking tape and then cooked or storage. The cooked samples were cooked in a convection ven (The G. S. Blodgett Company, Inc.) at 93.3°C and 1125 rpm blower speed to a final in-ernal temperature of 70±2°C. The refrigeration and freezing temperatures were 4±2°C and 20±2°C respectively. Each individual sample was weighed and its weight recorded before and fter being treated.

easurement of Lipid Oxidation: Lipid oxidation was determined by the 2- thiobarbituric acid TBA) method of Witte et al. (1970) as modified by Pensel (1990). Blanks and standard curve sing 1,1,3,3-Tetraethoxypropane (TEP) were run simultaneously. The TEP recovery was 91% and he K value was 10.64, similar to the value reported by Witte et al. (1970) considering that g of sample was used in this case. The results were expressed as TBA numbers in terms of illigrams of malonaldehyde per 1 kilogram of meat. TBA values reported are the mean of

five replicates. To consider the cooking drip and storage loss of the samples, it was necessary to correct the weight to a standard fresh weight (Pensel, 1990).

Data Analysis: The statistical analysis was completed using a two-factor (prep. and tm treatments) fixed effect model with blocking (replications). Due to the interaction betw main effects, multiple comparisons were conducted based on the "marginal" multiple co parisons (Pensel, 1990). For this reason, WU, SU, CS and 0 time treatment were not inclu in Table 1. Analysis of variance and Duncan multiple range test were performed using (1985) procedures.

Results and Discussion

It can be seen from the statistical comparison in Table 1, that TBA numbers for CG sampl were significantly higher ($P<0.05$) than the comparable TBA numbers obtained from SC, GC, and GU samples at all Tm-Tp treatments. Except at 0 time, the GU samples had significant lower ($P<0.05$) TBA numbers when compared with CG, SC, GC and WC samples. The length frozen storage did not produce significant differences whatever the size of the samples. 6F samples were not significantly different from 2F samples, neither 2R-2F or 2R-6F we significantly different from 6R-2F and 6R-6F respectively. Contrarily, TBA values of 6R- samples were higher than TBA values of 6F-6R samples. In general, refrigeration and cooki lead increases in TBA values (Dawson and Schierholz, 1976) independently of the sample siz However, the most detrimental combination of treatments was reducing the sample size aft cooking. This can be seen in Figure 2, where the TBA numbers for the samples that we cooked and then ground or sliced (CG, CS) presented always the highest values, the cook samples had intermediate values and the uncooked samples had the lowest TBA values. Thi shows the importance of the sequence in which the processes are carried out. For example, and SC samples were subjected to the same processes but in reverse sequence, however th results were significantly different with CS samples resulting in considerable more oxida tion. Despite the disruption or denaturation of the cell membrane with the concomitan liberation of phospholipids, release of iron from the heme and incorporation of oxygen coul be contributing factors for the increase of TBA numbers (Gray and Pearson, 1987; Rhee 1988), the sequence in which these processes occur also should be considered a factor.

Conclusion

Based on the results of this study, it is possible to conclude that the sequence in whic the processes were carried out had a significant influence on TBA numbers. Cooking followed by grinding and then six days of frozen storage and six additional days of refrigerated storage was the most detrimental combination of treatments. Then to predict the effect that certain treatments have on oxidation using TBA analysis, it is necessary to know the sequence and storage history of the sample.

References

CHANG P.Y., YOUNATHAN M.T., and WATTS B.M., 1961. Lipid oxidation in pre-cooked beef preserved by refrigeration, freezing and irradiation. Food Technol. 15,168-171.

DAWSON L.E. and SCHIERHOLZ K., 1976. Influence of griding, cooking and refrigerated storage on lipid stability in turkey. Poultry Sci. 55,618-622.

GRAY J.I. and PEARSON A.M., 1987. Rancidity and warmed-over flavor. In "Advances in Meat Research. Vol. 3. Restructured Meat and Poultry Products" (A.M. Pearson and T.R. Dutson eds.). Van Nostrand Reinhold Company, N. Y., 221-269pp.

KESKINEL A., AYRES J.C. and SNYDER H.E., 1964. Determination of oxidative changes in raw meats by the 2-thiobarbituric acid method. Food Technol. 18,223-226.

IGENE J.O., PEARSON A.M. and GRAY J.I., 1981. Effect of length of frozen storage, cooking and holding temperature upon component phospholipids and the fatty acid composition of meat triglycerides and phopholipids. Food Chem. 7,289-303.

NE J.O., YAMAUCHI K., PEARSON A.M., GRAY J.I., and AUST S.D., 1985. Evaluation of 2-lobarbituric acid reactive substances (TBRS) in relation to warmed-over flavor (WOF) velopment in cooken chicken. J. Agric. Food Chem. 33,364-367.

NG W.H. and GREENE B.E., 1978. Effect of cooking on TBA numbers on stored beef. J. Food . 43,1201-1209.

TON, S.L. 1983. Methodology for following lipid oxidation in muscle foods. Food Technol. 105-111.

NBURG D.S., and COCON J.M., 1980. Malonaldehyde concentrations in food are affected by oking conditions. J. Food Sci. 45,1681-1687.

NSEL N.A., 1990. Influence of experimental conditions on porcine muscle and its effect on idation. M.Sc. thesis, The Ohio State University, Columbus, OH.

TUL, J., LESZCZYNSKI D.E., NIEWIAROWICZ A., and KUMMEROW F.A., 1984a. Lipid oxidation in icken breast and leg meat after sequencial treatments of frozen storage, cooking frigerated storage and reheating. J. Food Technol. 19,575-584.

TUL, J., LESZCZYNSKI D.E., NIEWIAROWICZ A., BECHTEL P.J., and KUMMEROW F.A., 1984b. Effect frozen storage and cooking on lipid oxidation on chicken meat. J. Food Sci. 49,838-843.

E K.S., 1988. Enzymic and nonenzymic catalysis of lipid oxidation in muscle foods. Food hnol. 42,127-132.

, 1985. "SAS User's guide: statistics", 5th. edition. SAS Institute, Inc. Releigh, NC.

LEMOT C., POSTE L.M., SALVADOR, J. and WOOD D.F., 1985. Lipid degradation in pork during med-over flavour development. Can. Ins. Food Sci. Technol. 18,316-322.

LIAMS J.C., FIELD R.A., MILLER G.J. and WELKE R.A., 1983. Evaluation of TBA method for e determination of lipid oxidation in red meat from four species. J. Food Sci. 48,1776-78.

TTE V.C., KRAUSE G.F. and BAILEY M.E., 1970. A new extraction method for determining 2-lobarbituric acid values of pork and beef during storage. J. Food Sci. 35,582-585.

gure 1: Treatments Design

eparation treatments: WU= whole uncooked, WC= whole cooked, SU= sliced uncooked, SC= sliced and then oked, GU= ground uncooked, GC= ground and then cooked, CW or WC= whole cooked, CS= cooked and then ed, CG= cooked and then ground.

e-temperature treatments: R= refrigerated storage, F= frozen storage, ⟶ = indicates refrigerated rage, ⟶ = indicates frozen storage, 0= zero day, 6F-6R= 6 days F and then 6 days R, 6R-2F= 6 s R and then 2 F, 6R= 6 days R, 2F-6R= 2 days F and then 6 days R, 6R-6F= 6 days R and then 6 days F, -6F= 2 days R and then 6 days F, 6F-2R= 6 days F and 2 days R, 2F-2R= 2 days F and then 2 days R, -6F= 2 days R and then 6 days F, 2R= 2 days R, 2F= 2 days F, 6F= 6 days F.

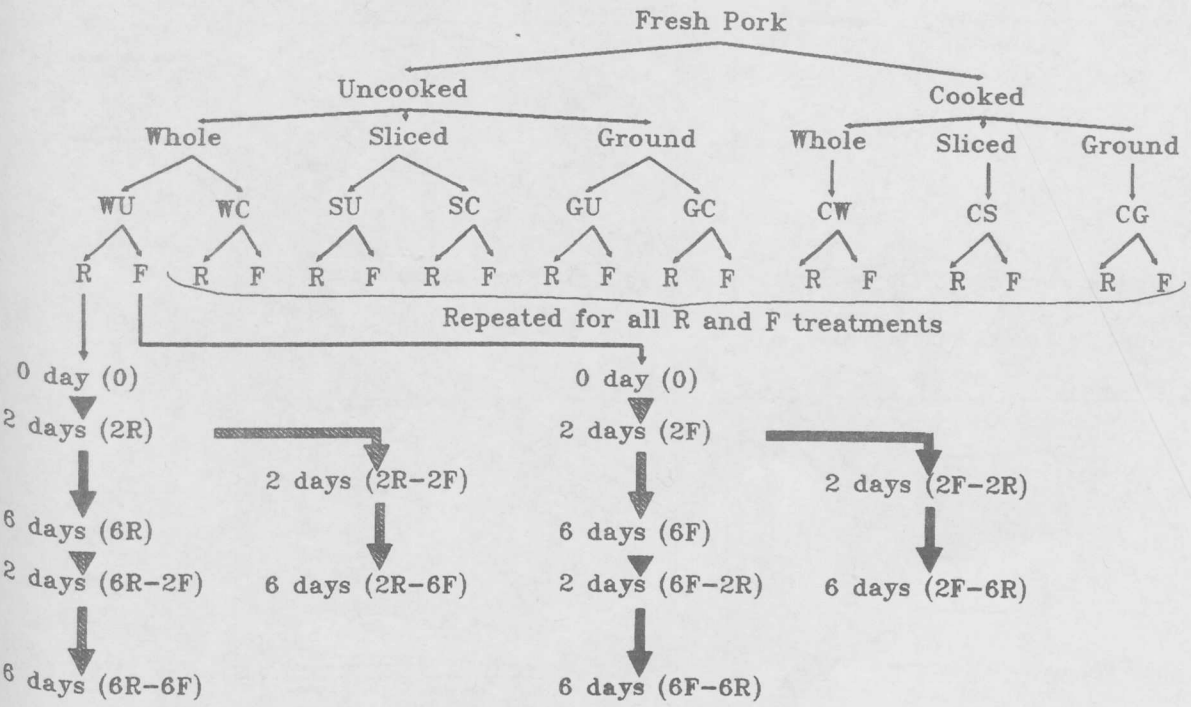

Table 1. Effect of Different Sequences of Treatments on TBA Numbers [a,b]

a: Cells in the same column or row, bearing the same letter are not significantly different ($P<0.05$)

b: TBA Number is expressed as milligrams malohaldehyde/kilogram muscle. Each value represents a mean of five replicates (±SD).

CG= cooked and then ground, SC= sliced and then cooked, GC= ground and then cooked, WC= whole cooked, GU= ground uncooked, R= refrigerated storage, F= frozen storage, 6F-6R= 6 days F and the 6 days R, 6R-2F= 6 days R and then 2 F, 6R= 6 days R, 2F-6R= 2 days Fand then 6 days F, 6R-6F= 6 days R and then 6 days frozen, 2R-6F= 2 days R and then 6 days F, 6F-2R= 6 days F and 2 days R, 2F-2R= 2 days F and then 2 days R, 2R-6F= 2 days R and then 6 days F, 2R= 2 days R, 2F= 2 days F, 6F= 6 days F.

	6F-6R	6R-2F	6R	2F-6R	6R-6F	2R-2F	6F-2R	2F-2R	2R-6F	2R	2F	6F
CG	A 1.783 ± 0.12	A B 1.779 ± 0.10	A B C 1.742 ± 0.12	A B C 1.743 ± 0.15	B C D 1.772 ± 0.15	C D E 1.707 ± 0.11	C D E 1.732 ± 0.09	D E F 1.772 ± 0.11	E F G 1.536 ± 0.07	F G 1.585 ± 0.07	G 1.480 ± 0.17	G 1.418 ± 0.10
SC	H 0.652 ± 0.25	H I 0.761 ± 0.36	H I J 0.657 ± 0.38	H I J 0.450 ± 0.23	I J K 0.471 ± 0.16	J K L 0.617 ± 0.26	J L K 0.354 ± 0.20	K L M 0.368 ± 0.22	L M N 0.274 ± 0.07	M N 0.316 ± 0.16	N 0.235 ± 0.08	N 0.227 ± 0.18
GC	H 0.577 ± 0.39	H I 0.560 ± 0.30	H I J 0.308 ± 0.05	H I J 0.641 ± 0.38	I J K 0.590 ± 0.28	J K L 0.493 ± 0.14	J K L 0.481 ± 0.18	K L M 0.351 ± 0.17	L M N 0.438 ± 0.14	M N 0.251 ± 0.08	N 0.324 ± 0.08	N 0.203 ± 0.07
WC	H 0.761 ± 0.29	H I 0.549 ± 0.34	H I J 0.623 ± 0.50	H I J 0.472 ± 0.22	I J K 0.354 ± 0.15	J K L 0.248 ± 0.09	J K L 0.462 ± 0.14	K L M 0.315 ± 0.13	L M N 0.285 ± 0.05	M N 0.213 ± 0.05	N 0.064 ± 0.05	N 0.190 ± 0.21
GU	O 0.217 ± 0.15	O P 0.225 ± 0.17	O P Q 0.299 ± 0.27	O P Q 0.154 ± 0.20	P Q R 0.187 ± 0.08	Q R S 0.116 ± 0.07	Q R S 0.079 ± 0.07	R S T 0.118 ± 0.08	S T U 0.170 ± 0.08	T U 0.120 ± 0.07	U 0.068 ± 0.06	U 0.109 ± 0.05

Figure 2: Effect of Treatment Combinations on TBA Numbers

a- 0, 2R, 6R, 6R_2F, 6R-6F Tm-Tp Treat.

b- 0, 2R, 2R-2F, 2R-6F Tm-Tp Treat.

c- 0, 2F, 6F, 6F-2R, 6F-6R Tm-Tp Treat.

d- 0, 2F, 2F-2R, 2F-6R Tm-Tp Treat.