SES AND SOLUTIONS OF IRIDESCENCE IN PRECOOKED MEAT

KROPF, H. WANG, M. HUNT and C. KASTNER

partment of Animal Sciences and Industry, Weber Hall, Kansas State University, Manhattan, Kansas 66506-0201, USA

SUMMARY

Meat iridescence research included 2 phases. In phase 1, drying and adding water to dried samples affected iridescence. escence was eliminated by dehydration or freezing but reoccurred upon rehydration or thawing. Removing lipid by ethyl ether n meat surfaces had no effect on iridescence. Soaking iridescent meat samples in formaldehyde, formamide, methanol, hexane, ethyl alcohol had no apparent influence on iridescence. Slicing at an angle 40° or less to the muscle fiber direction of beef itendinosus eliminated iridescence. Rotation angle of iridescent samples, and both viewing angle and angle of lighting enced ($P<0.05$) intensity of iridescence as evaluated by 8 panelists. A lighting angle of 70° resulted in more intensive escence than 90°, while a viewing angle of 35° resulted in more iridescence than 55°. Iridescence occurred in about one-half e 360° rotation with a most intensive point in the middle 20° region.

Phase 2 included the effect of processing variables. Beef semitendinosus (ST) and Biceps femoris (BF) muscles were ted with 3% or 10% water and 0.3% phosphate versus non-injected controls and precooked in smokehouse to final internal peratures of 54.4°C (held for 121 min.), 60°C (held for 12 min.), 62.8°C, or 68.3°C; sliced at -1.1°C, 7.2°C, 48.8°C, 54.4°C, 2.8°C by either a dull or a sharp slicer. Less added water (3% compared to 10%) resulted in less visual iridescence with 0.3% sphate. More iridescence occurred at cooking to 62.8°C final internal temperature or slicing at 48.8°C, or with a sharp slicer de. Less iridescence appeared at low cooking (54.4°C held for 121 min.) or low slicing temperature (-1.1°C). In most eriments, 0.3% added phosphate reduced iridescence compared with control. BF muscles showed much less iridescence than muscle.

We believe that meat iridescence results from optical diffraction and speculate that varying intensity and colors are a result istances between diffracting microstructural units. These distances can be increased by water/phosphate additions or decreased ooking and cooling shrink. Each could cause more or less iridescence.

INTRODUCTION

Iridescence, a shiny, mother-of-pearl, or rainbow-like color widely found in nature has been attributed to a physical nomenon caused by optic diffraction or multiple thin film interference (Holland, 1980; Swatland, 1984). Meat iridescence, nd in raw, cured and precooked meat, frequently causes consumer rejection and is mistakenly attributed to chemical additives nicrobial by-products. Very little work is available about the nature of this condition in meat products or the influences of ooking, chilling and slicing variables. This study has objectives of determining the effect of viewing conditions and of chemical physical treatments on iridescent products and finally on evaluating effects of cooking, chilling and slicing variations on dence and intensity of iridescence in precooked beef.

MATERIALS AND METHODS

Phase 1. Physical and chemical treatments included dehydration, freezing, adding water, adding or removing lipid, and other nical treatments. Commercial beef pastrami and dried beef with iridescence was cut transverse to fibers into 10x10x2 mm

slices. For dehydration, 5 iridescent samples each were dried at 50°C for 1 hour or at 100°C for half hour. Five other samples each were soaked in 50% or 100% acetone for 1 hour. The change of iridescence in these samples was visually evaluated immediately after treatment. Other iridescent samples were frozen at -18°C, then thawed.

Distilled water was added drop by drop to the surface of freshly cut iridescent samples. Other samples were soaked in water for 24 hours. In addition, water was similarly added to samples which had been exposed to air for 30 minutes or dried at 50°C for 1 hour or at 100°C for half hour. Iridescent samples (n=5) were treated with vegetable oil in a similar way as added water. Surfaces of 5 samples were washed, drop by drop, by 100 ml of ethyl ether, a lipid solvent. Also, 5 dried samples were soaked in ethyl ether for 24 hrs. Similar iridescent samples were treated with formaldehyde, formamide, methanol, ethyl alcohol and hexane in the same way as for added water, also slices with iridescence were soaked in 30% hydrogen peroxide solution for 3 hours and iridescence was evaluated.

Cooked beef samples with iridescence were sliced at different angles to the longitudinal direction of semitendinosus muscle fibers, ranging from 0 to 90° at about 15° increments, and iridescence was visually evaluated.

Orientation and intensity characteristics of iridescence were determined by visual evaluation by 8 panelists using a special sample-viewing unit with an auxiliary incandescent light source. Tested optic variables were light incident angle (70 and 90°) and observation angle (35 and 55°) measured from the sample surface and sample rotation angle measured around a center point. Visual scores from 0 = no iridescence to 5 = the most intensive iridescence in that sample were used. The increment of rotation angles was 30 degrees for each evaluation point for a complete sample rotation.

Phase 2. Semitendinosus (ST) and biceps femoris (BF) muscles (external fat removed) from Select and Choice grade beef carcasses were cooked. Study 1 used five pairs of ST muscles, one muscle in each pair injected with 3% water and 0.3% phosphate (Curafos 11-2, 90% sodium tripolyphosphate and 10% sodium hexametaphosphate, pH 8.9-9.8) based on the raw weight of muscle and the other muscle as control. In study II, using 4 pairs of ST muscle, the injection level of water and phosphate were 10% and 0.3%. Samples were stored at 4-5°C for 3 days after injection to allow equilibration of added water and phosphate. Four pairs of BF muscle were also used with 3% water and 0.3% phosphate added.

Before cooking, each muscle was cut transversely into 4 pieces and each piece randomly assigned to one of four final internal cooking temperatures. Muscle samples were cooked in a microprocessor controlled smoke house, humidity at 80%, to final internal cooking temperatures of samples at 54.4°C (held for 121 min.), 60°C (held for 12 min.), 62.8°C, or 68.3°C.

Cooked meat was sliced at one of five temperatures: 62.8°C, 54.4°C, 48.8°C, 7.2°C, and -1.1°C, as soon as the required temperature was attained. Cooked meat samples were chilled at 25°C, 4°C and finally -15°C as needed prior to slicing. Cooked samples were not sliced at a higher temperature than their assigned final internal temperature. Two slicers were used, one with a "sharp" blade and another one with a "dull" blade with cooked meat pieces randomly assigned to the sharp or dull blade. Each sample slice was individually vacuum packaged in an oxygen barrier bag to hold iridescence at the level found after slicing.

Each sample was visually evaluated individually by 8 experienced panelists for intensity and area of iridescence at the rotational orientation which resulted in most intensive iridescence. Two five-point evaluation scores (higher score = more intense and larger area of iridescence) were averaged.

The cooking experiment was designed as a split-split-plot model, and evaluation results were analyzed by SAS General Linear Model or Analysis of Variance program (1985).

RESULTS AND DISCUSSION

Phase 1. Iridescence disappeared after commercial pastrami and corned beef samples were frozen. After thawing, escence reappeared. Perhaps ice crystals changed the dimensions of muscle microstructure. Adding drops of distilled water esh-cut iridescent sample surfaces or soaking samples in water for 24 hours had no apparent effect on iridescence. Exposing ples to air for 30 minutes or longer resulted in a semi-dried surface and reduced iridescence, but iridescence was regenerated adding one drop of water. After oven drying, meat color changed to dark red or brown and iridescence disappeared.

Regeneration of iridescence with water in the samples dried at 100°C for half hour took at least fifty minutes and erated iridescent spots were less intense than samples dried at 50°C. Iridescence was not due to surface water film because ing samples in water should have changed the water film but iridescence still was evident. However, water had an important t on iridescence. Apparently, hydration or dehydration changed structure by swelling or shrinking so as to influence escence.

Adding drops of vegetable oil on the new cut surface of iridescent samples or soaking samples in vegetable oil for 24 hours not remove or intensify the iridescence. Soaking samples dried at 50°C for 1 hour and at 100°C for half hour in vegetable id not recover the iridescence. Ethyl ether washing did not eliminate iridescence. Iridescent spots were not due to an oil film t because ethyl ether treatment did not remove iridescent spots. Soaking for 24 hours in formaldehyde, formamide, methanol, l alcohol, and hexane had no apparent effect. Soaking samples in 100% acetone for 1 hour eliminated iridescence. After ment with 30% hydrogen peroxide, iridescent precooked beef slices lost their original color and became white, iridescence still found in the bleached samples at certain view angles.

If iridescence was found in one section of whole cooked beef semitendinosus muscle, it appeared in all or most transverse ions of a given muscle bundle. Iridescence was not found on the cut surface when an iridescent muscle was cut at an angle than approximately 40 degrees to the muscle fiber orientation of the semitendinosus muscle.

Panel evaluation showed that the rotation angle of samples, the observation angle, and the lighting angle each influenced <0.05) the intensity of iridescence. We found strongest iridescence at one rotation angle, less as the rotation angle differed more n this point in either direction. Lighting angle 70° resulted in more intensive iridescence than 90°. Observation angle 35° erated more iridescence than 55°.

Added phosphate at 0.3% with 3% (Study I) or 10% added water resulted in less ($P<0.05$) visually scored iridescence (Study (Figure 1). Cooking to 54.4°C final internal temperature (held 121 min) resulted in less ($P<0.05$) iridescence compared with C (held 12 min), 62.8°C, and 68.3°C among which no differences ($P<0.05$) were detected (Figure 2).

Iridescence in beef ST muscles was somewhat affected by slicing temperature as slicing at -1.1°C resulted in less iridescence n at 7.2, 48.9 and 54.4°C (Figure 3). A slicing temperature of 48.9°C resulted in more ($P<0.05$) visually scored iridescence n -1.1°C, or 62.8°C. A sharp slicer blade resulted in more intensive and/or larger ($P<0.05$) area of iridescence in beef ST eles.

Beef biceps femoris (BF) muscles had much less iridescence than ST muscles,possibly because slicing of BF was less pendicular to the muscle fiber direction.

CONCLUSIONS

Added phosphate effects plus higher levels of added water may increase distances between microstructural units that affect light refraction and may increase or decrease iridescence. Cooking and chilling reduce hydration and influence iridescence by changing microstructural differences to those that increase or decrease iridescence. A dull slicer blade may break up the meat surface enough to reduce light diffraction. Slicing obliquely to the muscle fiber direction might influence the surface or sub-surface arrangement of important microstructural units and diminish iridescence.

REFERENCES

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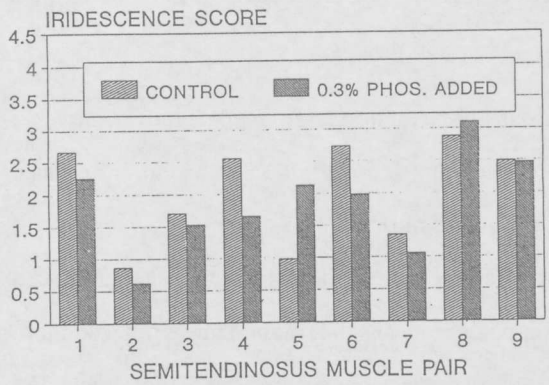

Figure 1. Phosphate effect on iridescence score of semitendinosus. Muscle pairs 1-5 had 3% added H_2O and 6-9 had 10% added H_2O.

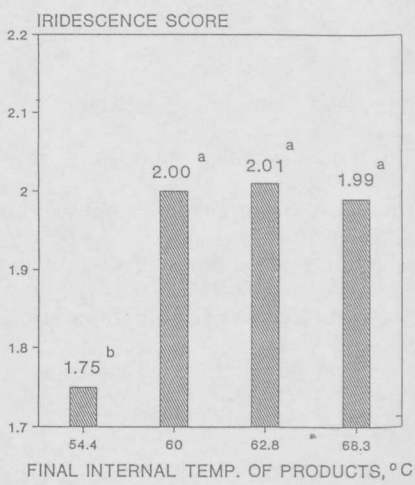

Figure 2. Final internal cooking temperature effect on iridescence score.

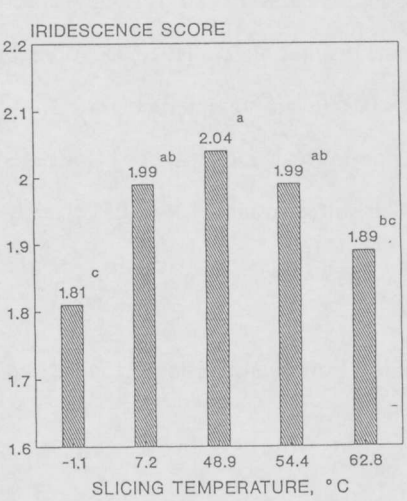

Figure 3. Slicing temperature effects.

All Figures. All semitendinosus. Iridescence score is average of intensity score (0 = none to 5 = most intense) and % of area iridescent (0 = 0% to 5 = 81-100%).