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Cooking Yields and Quality Characteristics of Grilled Chicken Breast Fillets as Affected by pH of Vinegar-phosphate Marinades

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Abstract: Grilled poultry products have become more and more popular. Chicken breast fillets were either marinated for five minutes in vinegar-phosphate buffers with pH ranging from 5.0 to 8.5 or with marinades prepared with a commercial polyphosphate mixture (Kena) and vinegar with the same pH ranges. The marinated fillets were then grilled at 149°C to an internal temperature of 73.9°C. Marinating chicken fillets in a vinegar-phosphate buffer with pH of 5.5 resulted in lowest ($P<0.05$) grilling yields and highest ($P<0.05$) Warner-Bratzler (WB) shear readings for the products. As the pH of phosphate buffer marinades decreased or increased, a trend in decreasing WB shear readings and increasing in grilling yields was observed. For fillets marinate with either vinegar or polyphosphate mixture, the buffer with pH 5.5 resulted in the highest ($P>0.05$) shear values. Adjusting marinade pH to 7.5 with polyphosphate mixture resulted in the highest ($P<0.05$) grilling yields as compared with those of marinades with other pH values. Results demonstrated that the marinade pH should be considered for marinating chicken fillets. Regardless of the ingredients, pH of 5.5 marinades should be avoided by the processors and pH of 7 marinades might be the good choice for marinades.

Key words: Chicken breast fillet, marinade pH, grilling yield, WB shear reading

Introduction

Poultry meat is most popular muscle foods in the U.S. Value-added processing and development of new products has assisted to increase the consumption of chicken (Baker and Bruce, 1989). In 1965, only 4% of U.S. broilers were marketed as further-processed products. However, further-processed products occupied more than 36% of the U.S. broiler market in 1995 (Roenigk, 1995).

Baking, broiling, roasting, deep-frying, microwaving, grilling, and barbecuing are cooking methods that are often used for cooking poultry meat. According to a survey conducted by Food Research Institute, Inc., in 1998, the common chicken cooking methods were recorded as follows: 41% grilled, 34% fried, 14% baked, and 11% others. Hence, the grilling method has become more and more popular recently; however, the juiciness and tenderness of grilled products have been a serious concern to the processors.

Inorganic phosphates are well-known for their role in the enhancement of water-holding capacity of meat products (Sofos, 1986). Hargett *et al.* (1980) reported that the improvement on water retention and subsequent higher cooking yields, increased binding, and improved palatability scores were obtained in the formation of frankfurters. Injected various polyphosphate compounds into the pork loins prior to hot processing can result in juicier, more tender, and heavier pork chops (Hoes *et al.*, 1980). As mentioned by Barbut *et al.* (1998), higher cooking yields were observed by adding sodium tripolyphosphate (STPP) in turkey frankfurters.

Wilding *et al.* (1986) and Wismer-Pedersen (1987) indicated water-retention in myofibrillar protein is lowest at its isoelectric point (pI). In our study, Yang (1992) reported that lowering the pH near its pI had the poor water retention capacities of citric acid treated samples. Ang and Hamm (1986) reported that hot-stripped breast meat treated with sodium tripolyphosphate (STPP), either a single ingredient or as a mixture with NaCl, significantly reduced toughness of the meat. However, when acetic acid was included in the marinade solution, it increased in tenderness (Post and Health, 1983). The objective of this research was to investigate the cooking yields and textural changes of grilled breast fillet as affected by various pH marinades.

Materials and Methods

Broiler Fillet and Marinating: Frozen broiler carcasses were obtained from the Mississippi State University Poultry Research Center and thawed in a refrigerator at 4-5°C overnight prior to use. Skinless breast fillets were hand-deboned and cut into pieces approximately 1.5 cm thickness. Before each study, the weight of each broiler breast fillet was measured. Eight vinegar- phosphate buffers ranged from pH 5.0 to 8.5 were prepared with a commercial polyphosphate mixture (Kena) and vinegar with the same pH ranges. For each 100 grams of raw meat, 200 grams of marinade was used. Broiler breast fillets were marinated for 5 min prior to grilling.

Grilling: The marinated broiler breast fillets were grilled on a preheated grill/griddle at 149°C (Model 069001, National Presto IND., Inc. Eau Claire, WI) to an internal temperature of 73.9°C without spraying cooking oil on the grill/griddle, as determined by inserting thermocouples into the center location of breast fillets. These

thermocouples were connected to a Speedomax M. Multipoint Recording Potentiometer (Leeds and Northrup Co., North Wales, PA.). After grilling, fillets were cooled for 3 min before measurement.

Analyses

Cooking Yield: Percentage of cooking yield was determined by calculating weights for fillets before marinating and after cooking. Cooking yield (%) = (Cooked wt/ raw wt) x 100

Shear Value Measurement: A Warner-Bratzler coring tool was used to remove 1.27 cm diameter cores from each cooked broiler breast fillet. Shear values of cores were measured by using a Warner-Bratzler apparatus (G-R Electric Mfg. Co., Manhattan, KS; with 50 × 0.1 lb capacity). The readings were converted into kg force required to shear cross-section areas.

Statistical Analysis: The experiment was conducted using a completely random design (Steel and Torrie, 1980). Data were analyzed using analysis of variance (ANOVA) (SAS Institute, Inc., 1993). When significant differences ($P<0.05$) were detected, the least significant difference (LSD) test was used to separate different mean values (Freud and Wilson, 1997).

Results and Discussion

pH Value and Grilled Fillet Yields: Marinating broiler breast fillets in a vinegar-phosphate buffer with pH of 5.5 resulted in the lowest ($P<0.05$) cooking yields for the products (Fig .1). Adjusting marinade pH to 7.5 with polyphosphate mixture (Kena) resulted in the higheset ($P<0.05$) grilling yields when compared with those of marinades with the other range pH values (Fig. 1). Hence, the buffer marinade with the pH of 7.0 was suggested as an optimum level.

Molins *et al.* (1987) reported that addition of phosphates significantly increased pH and improved cooking yields, as affected by phosphate treatmnet, agree with data from Sofos (1986) and Barbut *et al.* (1988). It is generally postulated that denaturation of sacoplasmic and myofibrillar proteins occurs near the isoelectric point (PI), and reduces solubility (Wismer-Pedersen, 1987). Consequently, heating will increase the cooking loss when adjusting marinade pH to 5.5. According to the economic advantage, a higher cooking yield means a higher profit for the company. Therefore, pH 7.5 was chosen for an optimal pH value for marinades.

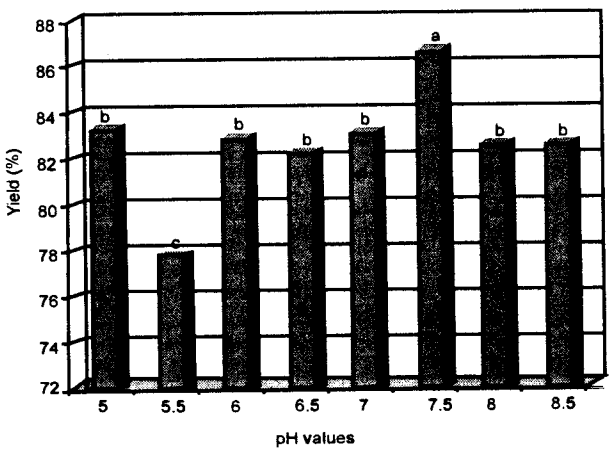

Fig. 1: Cooking yield of grilled chicken breast fillets as affected by different marinade pH

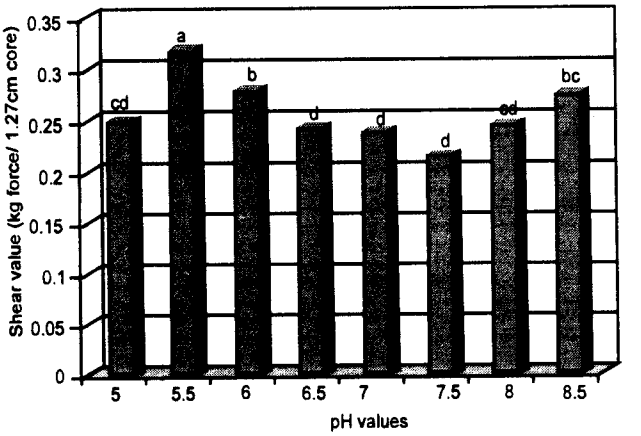

Fig. 2: WB shear values of grilled chicken breast fillets as affected by different marinade pH

PH Value and Grilled Fillet Texture: Marinade pH changed WB shear values of grilled fillets (Fig.2). The grilled fillet marinated with pH of 5.5 resulted in the highest ($P<0.05$) WB shear values (Fig. 2). When marinade pH decreased from pH 5.5 to 5.0, and increased from pH 5.5 to 6.5, WB shear values were decreased ($P<0.05$); however no further decreases in shear values were observed when marinade pH was increased beyond 6.5 (Fig. 2).

Zhao and Sebranek (1996) indicated that dipping fresh pork chops with sodium tripolyphosphate (550 ppm) resulted in better tenderness and juiciness scores than undipped ones. The same observation was reported in hot-processed pork loins injected to 110% of weight with a 5% solution of sodium polyphosphate glassy and tetrasodium pyrophosphate (Hoes *et al.*, 1980). The action of commercial polyphosphate mixture (Kena) is to

increase protein hydration, which results in more moisture and simultaneously increase tenderness. However, Forrest *et al.* (1975) reported that lowed muscle pH caused the release of cathepsins that degrade protein structure. Therefore, connective tissue of breast fillets might be denatured by the acid and, consequently, contributes to the tenderness.

Tenderness is one of the primary sensory factors to meat products (Price and Schweigert, 1987). Hence, marinade pH 5.5 should be avoided by increasing the toughness of grilled meat.

Conclusion

The marinade pH ranges have the significant influence to the grilling yields and tenderness of grilled breast fillet. When broiler fillets were marinated with either vinegar or commercial polyphosphate mixture (Kena), marinade pH of 7.5 was an optimal level for grilled chicken breast fillets. Regardless of the ingredients in the marinades, the marinade pH of 5.5 should be avoided by the processing.

References

Ang, C.Y.W. and D. Hamm, 1986. Effect of salt and sodium phosphate on shear, triobarbituric acid, sodium, and phosphorus values of hot-stripped broiler breast meat. Poul. Sci., 65:1532-1538.

Baker, R. C., 1989. Effect of washing on turkey dark meat. Proc. Poul. 4:42.

Baker R.C. and C.A. Bruce, 1989. Further processing of poultry In: Processing of Poultry. Elsevier Applied Science. London and New York pp: 251-283.

Barbut, S., A. J. Mauer and R. C. Lindsay, 1998. Effects of reduced sodium chloride and added phosphates on physical and sensory properties of turkey frankfurters. J. Food Sci., 53:62-66.

Forrest, J. C., E. D. Aberle, H. B. Hedrick, M. D. Judge and R. A. Merkel, 1975. Principle of Meat Sci. W. H. Freeman and Company, San Francisco, CA.

Freud, R. J. and W. J. Wilson, 1997. Academic Press. San Diego, CA. pp: 464.

Hamm, R., 1960. Biochemistry of meat hydration. Adv. Food res. 10:356-362.

Hargett, S.M., T.N. Blumer, D.D. Hamann, J.T. Keeton and R. J. Monore, 1980. Effect of sodium acid pyrophosphat on sensory, chemical, and physical properties of frankfurters. J. Food Sci., 45: 905.

Hoes, T. L., C. B. Ramsey, R. C. Hines and J. D. Tatum, 1980. Yield and palatability of hot-processed, phosphate-injected pork. J. Food Sci., 45:773.

Molins, R. A., A. A. kraft, H. W. Walker, R. E. Rust, D. G. Olson and K. Merkenich, 1987. Effect of inorganic polyphosphates on ground beef characteristics: some chemical, physical and sensory effects on frozen beef patties. J. Food Sci., 52:50-52.

Morre, S.L., D. M. Theno, C. R. Anderson and G.R. Schmidt, 1976. Effect of salt, phosphate and some nonmeat proteins on binding strength and cooking yield of beef roll. J. Food Sci., 41:424-426.

Post, R. C. and J. L. Health, 1983. Marinating broiler parts: the use of a viscous type marinade. Poul. Sci., 62:977-984.

Price, J. F. and B. S. Schweigert, 1987. The Science of Meat Products. 3rd ed. Food and Nutrition Press., Inc., Westport, CT.

Richardson, R.I. and J.M. Jones, 1987. The effects of salt concentration and pH upon water-binding, water-holding and protein extractability of turkey meat. Int. J. Food Sci. and Tech., 22:683-692.

Roenigk, P. W., 1995. Consumer attitudes about and usage of chicken 1995 update. Presented at the Food Editor's Semiar 41st National Chicken Cooking Contest, Atlanta, Gerogia. National Broiler Concil, Washington, D. C.

SAS Institute, Inc. 1993. SAS User's Guide: Statistics, Version 6 Edition. SAS Institute, Inc. Cary, NC.

Sofos, J.N., 1986. Use of phosphates in low-sodium meat products. Food Tech., 40:52-57.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of Statistics: A Biometrical Approach. 2nd ed. McGraw-Hill Book Co., New York, NY.

Wilding, P. N. Hedges and P. J. Lillford, 1986. Slat-induced swelling of meat: the effect of storage time, pH, ion-type and concentration. Meat Sci., 18:55-57.

Wismer-Pedersen, J., 1987. Chemistry of animal tissues: part 5. Water. Ch. 3. In "The Sci. of Meat and Meat Products," 3rd ed., pp.141-154. (Eds.) J. F. Prices and B. S. Schweigert. Food and nutrition Press. Wastport, C.T.

Yang, C.C., 1992. Chemical and functional characteristics of chicken dark meat as affected by additives, storage, and pH adjustment. Department of Food Science and Technology. Dissertation, Mississippi St, MS.

Zhao, Y. and J. G. Sebranek, 1996. Physicochemical and sensory qualities of fresh pork chops as affected by phosphate, ascorbate or sorbate dipping prior to irradiation. J. Food Sci., 62:1281-1284.