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Cooking Yields and Quality Characteristics of Grilled Chicken Breast Fillets as Affected by Marinades Containing Starches

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Abstract: Marinating chicken breast fillets in 5%(W/W) native corn starch, potato starch, or modified waxy maize corn starch at room temperature prior to grilling improved ($P<0.05$) cooking yields, reduced ($P<0.05$) Warner-Bratzler (WB) shear values, and yielded longer ($P<0.05$) sacromere lengths compared to those of the tap-water marinated control. Among the tested starch treatments, modified waxy maize corn starch had the highest yield readings followed by corn starch and potato starch. Marinating fillets with 5% tested starches prior to grilling was also observed to yield lower ($P<0.05$) TBA values for grilled products than those of tap-water controls.

Key Words: chicken breast fillet, starch, grilling, cooking yield, TBA

Introduction

The per capita poultry meat consumption has increased from 56.1 lb in 1985 to 95.8 lb in 1999 (USDA, 2000). Baking, broiling, roasting, deep-frying, microwaving, grilling, and barbecuing are cooking methods that are often used for cooking poultry meat. In recent years, grilling method is getting more popular in the U.S.; however, there have been concerns involving the juiciness and tenderness of grilled products.

Approximately 70% of fatty acids in chicken and turkey meats are unsaturated (Mecchi *et al.*, 1956). Hence, another serious problem is the oxidative rancidity in cooked chicken meat. The 2-thiobarbituric acid (TBA) has been used as an indicator to determine the level of lipid oxidation (Wilson *et al* ., 1976; Basker , 1986; Ang 1988).

Xiong *et al.* (1993) investigated the compositional differences between breast and thigh muscles, and reported that breast muscle contains more total protein and moisture, and less fat than thigh meat. Low-fat meat products had lower cooking yields and were not as juicy as high-fat products (Troutt and others 1992a; Berry 1994; Bigner and Berry 1997). In addition, cooking yields of grilled breast fillets are matters of economic interest to poultry product processors.

Tenderness can vary from different species of animals and different parts of muscles (Bourne and Comstock, 1981). Tenderness is further affected by processing treatments applied to meats. Warner-Bratzler (WB) shear is one of methods that has been developed, and is still widely used today for textural measurements of cooked meat (Arafa and Chen 1978; Yang and Chen 1980; Harris *et al.*, 1992). Sarcomere length is also used in the evaluation of meat tenderness (Yang and Chen 1980; Morgan *et al.*,1991; Nurmahmudi and Sams, 1997). Arafa and Chen (1978) reported a significant correlation between WB shear value and sarcomere length and a shorter sarcomere length resulted in tougher meat.

Starch has been applied in ground meat products to improved textural characteristics (Claus and Hunt 1991; Carballo *et al.*, 1995; Bigner and Berry, 1997). Bater, (1992) injected a brine containing 1% starch into turkey breasts prior to roasting and reported a significant decrease in chewiness values.

Starch can be modified to enhance its functionalities to withstand the conditions of heat, shear, and acid associated with particular processing conditions (Whistler and others 1984; Wurzburg 1986; BeMiller 1993). Because of some chemical changes in modification, i.e. solubility, viscosity, gelation temperature, ability to form a semirigid gel, etc. (Luallen, 1985; 1988), the application of modified starch has increased. Hachmeister and Herald (1998) indicated that cross-linked dent corn and modified tapioca, or modified potato starch added to turkey patties significantly increased cooking yield and reduced reheating losses. Sodium alginate with modified tapioca starch improved the cooking yield, tenderness, and juiciness, regardless of the fat content of the meat (Berry, 1997). Although starch has been used in meat product processing, little or no report relating to thin starch coating on cooking yields and texture of grilled chicken fillets is available. The purpose of the current study was to investigate the cooking yields, textural changes and TBA measurements of grilled breast fillets as affected by marinades containing selected -starches.

Materials and Methods

Sample Preparation: Broiler Fillet: Frozen broiler carcasses were obtained and thawed in a refrigerator at 4-5? overnight prior to using. The breast fillets were separated from carcasses by hand, and skin and external fat removed. The prepared broiler breast fillets

were cut into pieces approximately 1.5-cm thickness. Before each study, the weight of each broiler breast fillet was measured.

Marinating: The following starches and tap water mixtures were used: native corn starch (Best Foods Division, CPS Internal Inc. Englewood Cliffs, NJ), modified waxy maize corn starch (Mira-Sperse 623, A. E. Staley Manufacturing Co., Decatur, IL), and potato starch (ICN Biomedicals Inc., Aurora, OH). For each 50 grams of raw meat, 100 grams of marinade was used. Prior to grilling, broiler breast fillets were marinated for 5 min at room temperature.

Grilling: Marinated broiler breast fillets were grilled on a 149? preheated grill/griddle (Model 069001, National Presto IND., Inc. Eau Claire, WI) to an internal temperature of 73.8? (165?) (USDA, 2001). In general, broiler breast fillets were cooked on one side 2.5 min; turned over and cooked for additional 2.5 min approximately. After cooking, fillets were cooled for 3 min before measurements.

Measurements: 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 with parallel muscle fiber orientations 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). The readings were converted into kg force required to shear cross-section areas.

Sarcomere Length Determinations: Muscle fibers from grilled breast fillets were incised and placed on a microscope slide by using a dissecting needle. Sarcomere readings were determined by using the filar micrometer eyepiece (American Optical Co., Buffalo, N.Y.) under a microscope (1000X). Sarcomere number per 0.01mm was counted, and the average sarcomere length was calculated by dividing 0.01mm (10m) by the total numbers of sarcomeres counted.

2-Thiobabituric Acid (TBA) Values: TBA values of the samples were measured using a distillation method (Tarladgis *et al.*, 1960). The TBA value was obtained by multiplying the O.D. value with a constant of 7.8.

Statistical Analysis: The experiment was conducted using a completely random design (Steel and Torrie, 1980) with at least four replications. 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 (Steel and Torrie, 1980).

Results and Discussion

Starch and Grilled Fillet Yield: Marinating broiler breast fillets with marinades containing either native corn starch, modified waxy maize corn starch, or potato starch prior to grilling improved cooking yields. As the content of starch in marinades increased, the cooking yield also increased (Fig. 1). In general, grilling yields were lower when the fillets were smaller and the effect of starch on yield appeared to be greater for the smaller fillet than the larger fillet (Fig. 1B vs. 1A). The possible formation of a thin starch gel coating on fillets might retard the exudates formation during grilling and retain juice in the products.

When starch contents increased from 0 to 1.25% (W/W), or from 3.75% (W/W) to 5% (W/W), greater increases in grilling yields were observed (Fig 1B). Therefore, 5% (W/W) of starch content in marinades was chosen as an optimum level. Among tested starch treatments, modified waxy maize corn starch had the highest yield readings followed by corn starch and potato starch (Fig, 1B).

Bater *et al.* (1992) indicated that turkey breasts injected with brine containing 1% starch prior to roasting increased cooking yield 15% more than control. However, few or no reports concerning the application of starch on the grilled products were available. Yield is one of the most important factors in processing. A higher cooking yield means a higher profit for the processor.

Starch and Grilled Fillet Texture: Marinades containing native corn starch, modified waxy maize corn starch, or potato starch improved ($P<0.05$) the texture of grilled chicken breast fillets. The presence of 1.25% (W/W) of starch, regardless of tested starch types, significantly decreased ($P<0.05$) the WB shear value of the grilled products; however, no further decreases in the shear readings were observed when the marinade content was increased beyond 1.25% (W/W) (Fig. 2). No differences ($P>0.05$) were observed on WB shear values among native corn starch, modified waxy maize corn starch, or potato starch on grilled fillets.

Troutt *et al.* (1992b) indicated that the texture of the low-fat ground beef was improved by adding 0.5% of potato starch. Berry and Wergin (1993) reported that by adding modified potato starch to low-fat beef patties, tenderness can be greatly improved. This lower shear force effect was also observed in low-fat pork nuggets containing modified tapioca starch (Berry, 1994).

Tenderness is the most important palatability factor regarding meat acceptance by consumers (Miller *et al.*, 1995). Hence, marinating broiler breast fillets with starch added prior to grilling can improve the

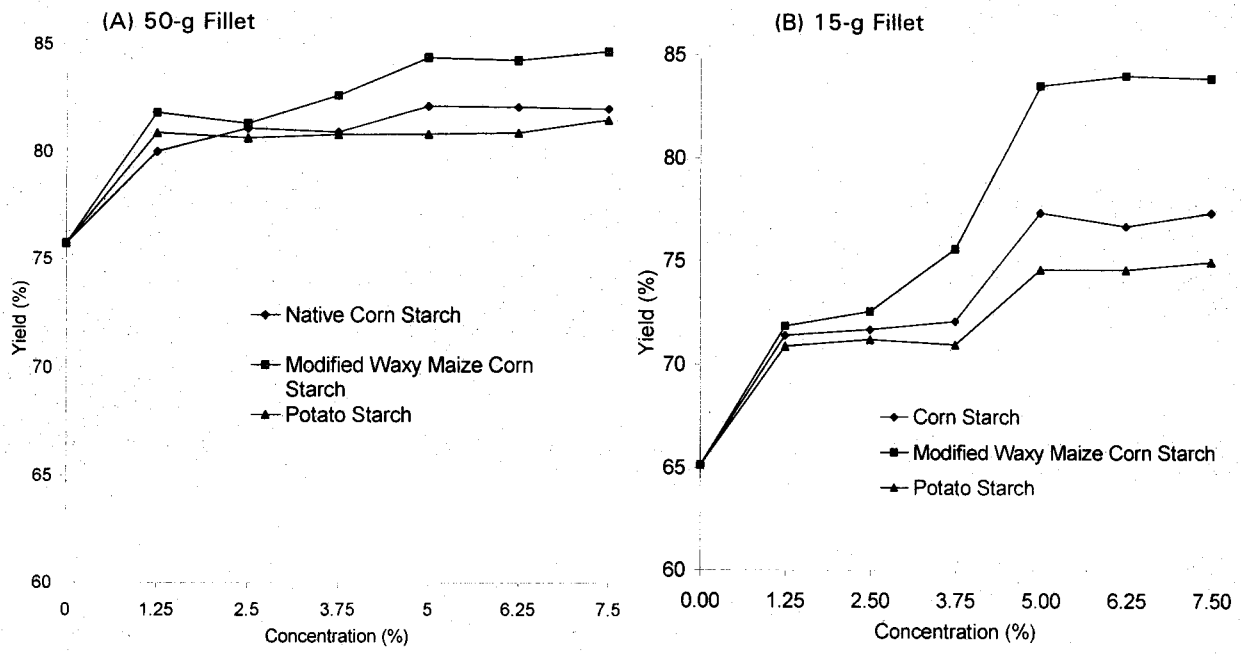

Fig. 1: Cooking yields (%) of grilled chicken breast fillets as affected by marinades containing different concentrations of starches

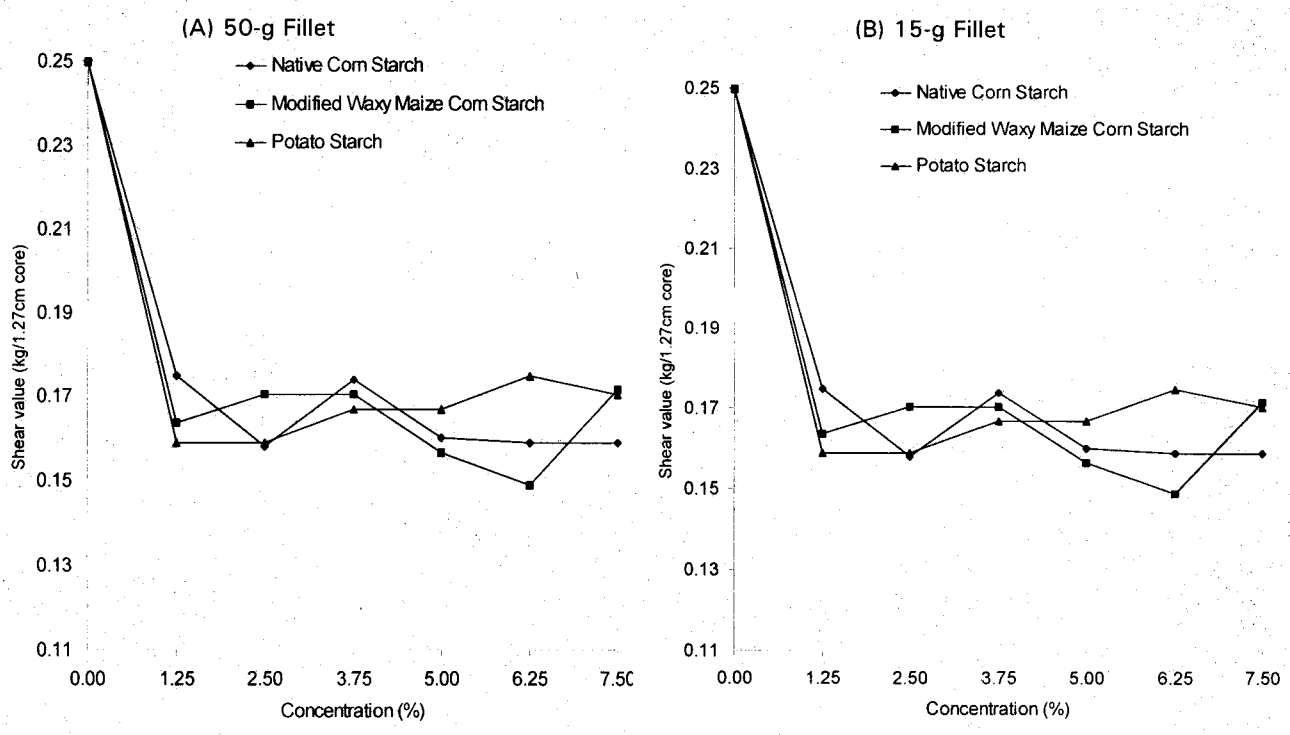

Fig. 2: WB shear values (kg/1.27cm core) of grilled chicken breast fillets as affected by marinades containing different concentrations of starches

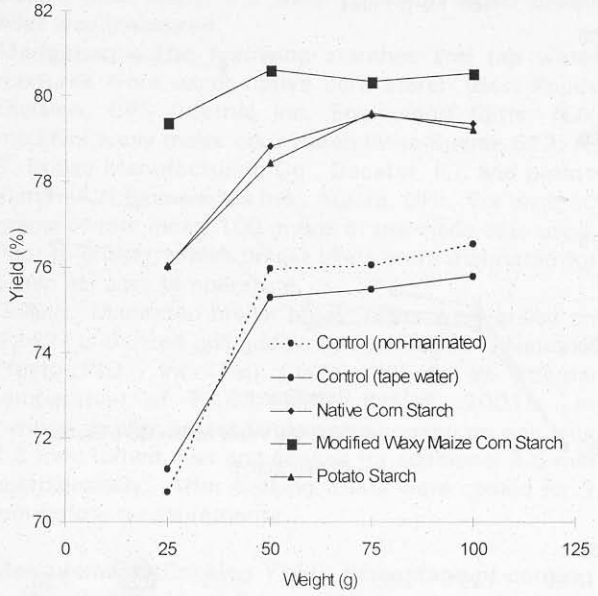

Fig. 3: Cooking yields (%) of grilled chicken breast fillets as affected by raw rillet weights and starch types

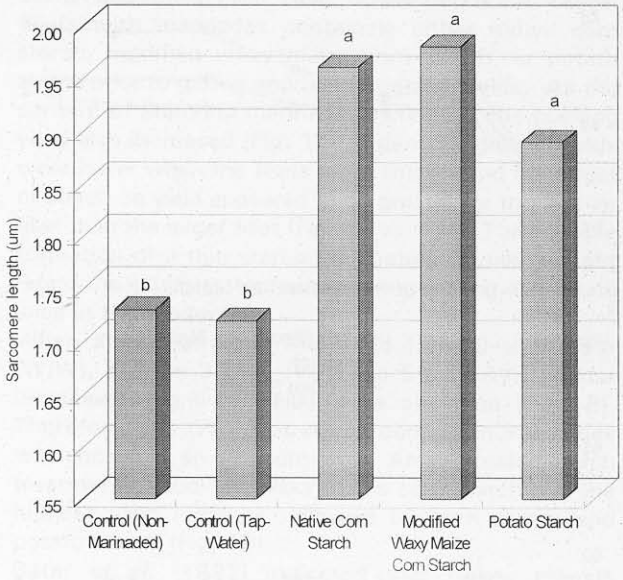

Fig. 5: Sarcomere lengths (μm) of grilled chicken breast fillets as affected by marinades containing different starches

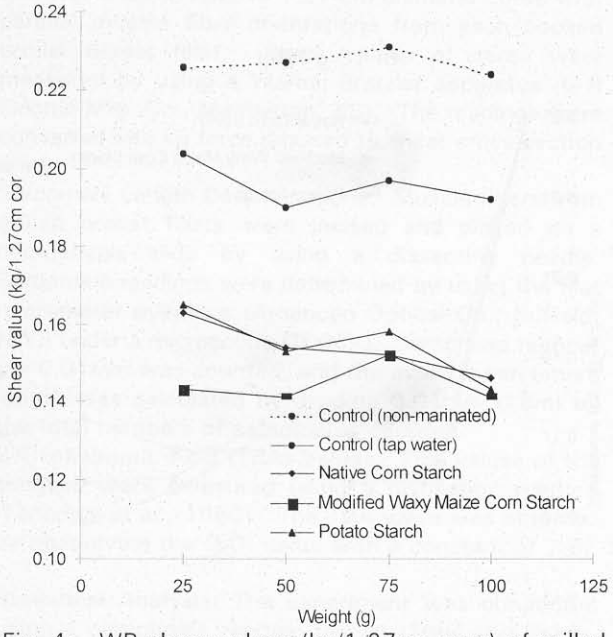

Fig. 4: WB shear values (kg/1.27cm core) of grilled chicken breast fillets as affected by raw fillet weights and starch types

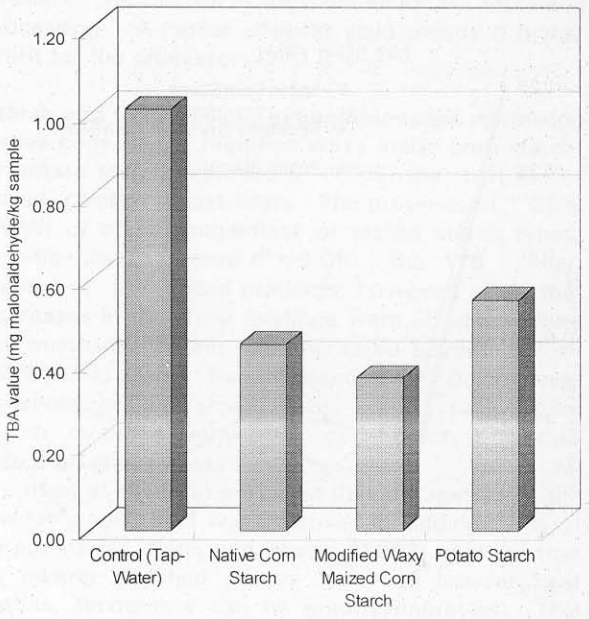

Fig. 6: TBA values of grilled chicken fillets as affected by marinades containing different starches

tenderness of grilled products.

Yield and WB Shear Values of Grilled Fillets as Affected by Fillet Sizes and Starch Types As the weight of fillets increased, the percentages of grilling yield increased. When the fillet was 50 grams or heavier, there was no significant increase ($P>0.05$) in the percentages of grilling yield (Fig. 3). Regardless of fillet sizes, marinating fillets with marinades containing modified waxy maize corn starch prior to grilling had higher ($P<0.05$) yield percentages as compared with yields of the other treatments (Fig. 3).

Bigner and Berry (1997) reported 1.90 cm-diameter low fat pork crumbles had a higher reheating yield than 0.95 cm-diameter ones. The greater surface-to-volume ratio of smaller fillets coupled with exudates of fillets evaporated easily and quickly during the grilling process. A thin starch gel coating might have the capability of holding the exudates of fillets, especially when modified waxy maize corn starch was used.

No differences ($P>0.05$) in WB shear values were observed in the different weight sizes of grilled breast fillets within the same marinated treatment (Fig. 4). Regardless of tested starch types, lower ($P<0.05$) WB shear values were observed when compared with those of non-marinated controls or tap-water marinated controls. Unlike the grilling yield percentages, regardless of weight size, the WB shear values of tap-water marinated controls were lower ($P<0.05$) than those of non-marinated controls (Fig. 4). Results of this study further indicated that weight sizes might not be related to the tenderness of grilled fillets.

Sarcomere Lengths of Grilled Fillets as Affected by Starch Marinades. The sarcomere lengths of the grilled products marinated in marinades containing starches before grilling were longer ($P<0.05$) than those from the non-marinated and tap-water controls (Fig. 5). Sarcomere length has long been associated with meat tenderness (Locker and Hagyard 1963; Marsh and Leet 1966; Arafa and Chen 1978; Bilgili *et al.*, 1989; Owens and Sams, 1997). Shorter sarcomere lengths result in tougher meat.

Longer sarcomere lengths is probably due to the protection of the thin starch gel coating against loss of exudates and moisture evaporation from muscle fibers to reduce fillet shrinkage. Again, results suggest that marinating breast fillets with starch prior to grilling could improve the texture of grilled products.

TBA Values of Grilled Fillets as Affected by Starch Marinades Lipid oxidation is a critical problem in the cooked chicken meat. Cooking chicken meat has been reported to result in increased TBA values (Pikul *et al.*, 1985; Ang, 1988). Marinating breast fillets with 5%(W/W) of tested starches prior to grilling was observed to yield lower ($P<0.05$) TBA values for the cooked product as compared to those of the controls (Fig. 6).

Various natural or synthetic antioxidants have been used to retard the development of rancidity in foods (Pearson *et al.*, 1983; Pearson and Gray 1983; Nawar, 1985). It is of interest to note that there are few or no reports available related to the application of starch coating to retard oxidation development. The starch gel coating on the surface of meats might cut off the contact of between air and fillets during grilling.

Chicken breast fillets marinated with selected starches had higher ($P<0.05$) cooking yields and improved ($P<0.05$) textural characteristics. In general, higher percentages of cooking yields were obtained when the sizes of fillets were larger; however, little or no increases in yield readings of grilled fillets were observed when the fillets were 50 grams or more. TBA values of grilled fillets with starch coating before grilling were lower ($P<0.05$) when compared to tap-water marinated controls.

Marinated fillets with marinades containing starch or modified starch had longer ($P<0.05$) sarcomere lengths than non-marinated and tap-water marinated controls. Overall, data showed that modified waxy maize corn starch was the prime ingredient in marinades and 5% of starch was an optimum level for marinating breast fillets.

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