

# Quality evaluation of different types of chicken consumed in Puerto Rico<sup>1</sup>

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## ABSTRACT

A study was done to compare the general quality, microbiology and shelf-life of fresh and frozen chicken. Two brands of frozen Grade A, one brand of frozen Grade C and one brand of fresh chicken were compared for yield, texture, general acceptability, psychrotrophic bacteria contents after one, two, and three cycles of thawing and freezing, and shelf-life once it was kept at 7.2° C (45° F) after thawing. Unfrozen fresh chicken samples were analyzed for psychrotrophic bacteria and shelf-life as a control. Results indicated that there are no significant differences ( $P > 0.05$ ) in yield, texture and general acceptability among the fresh and frozen chickens studied. The size of the psychrotrophic bacteria population is generally not affected by up to three cycles of thawing and freezing. With the exception of the frozen Grade C chickens analyzed, shelf-life was not generally affected by up to three cycles of thawing and freezing as compared with samples that were unfrozen and frozen and thawed only once.

## RESUMEN

### Evaluación de la calidad de diferentes tipos de carne de pollo que se consumen en Puerto Rico

Se llevó a cabo un estudio para comparar la calidad general, microbiología y duración en almacén de pollos frescos y congelados. Se compararon dos marcas de pollo congelado Grado A, una de Grado C y una marca de pollo fresco para rendimiento, textura, aceptabilidad general, contenido de bacterias psicrófilas luego de 1, 2 y 3 ciclos de descongelación y congelación y la duración en almacén una vez los pollos se descongelaron y se mantuvieron a 7.2° C. (45° F.). A manera de testigo, se analizó también un grupo de muestras sin congelar para bacterias psicrófilas y duración en almacén. No encontramos diferencias significativas ( $P > 0.05$ ) en rendimiento, textura y aceptabilidad general entre las muestras de pollo fresco y congelado. La abundancia de bacterias psicrófilas generalmente no se afectó hasta por 3 ciclos de descongelación y congelación. Con la excepción de los pollos Grado C, la duración en almacén generalmente no se afectó por hasta 3 ciclos de descongelación y congelación al compararla con la de las muestras que nunca se congelaron o que se congelaron y descongelaron sólo una vez.

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## INTRODUCTION

Production of chicken has steadily increased in Puerto Rico in the last 25 years. Whereas in the year 1963-64 25,500,000 lb of chicken were produced, in 1986-87, this amount increased to 93,300,000 lb (2). Import of mainly frozen chicken has also increased in the last 10 years, from 125,000,000 lb in 1975-76 to 152,000,000 lb in 1985-86 (3). These figures clearly indicate that consumption of chicken in Puerto Rico has been rising, with a peak per capita consumption of 66.9 lb in 1986-87 (2).

The biggest problem encountered by the local chicken producers is competition from lower-priced imported frozen products. This has been and is being dealt with through an aggressive promotional campaign directed to exalt the higher qualities of the local fresh product. Parameters like more attractiveness, tenderness, juiciness, freshness and better taste have been used in favor of the local product against the frozen imported competitor.

Besides these general quality attributes, microbiological aspects related to product spoilage and shelf-life are important considerations in both fresh and frozen chicken. Although microbial growth does not occur in frozen foods, if these are allowed to thaw the proliferation of spoilage microorganisms could be great. Freezing may affect the structural integrity of foods, thus making them more susceptible to microbial attack by allowing surface organisms to penetrate deeper into the tissue (5, 10). Also, the surface condensation of water upon thawing and the concentration of water-soluble substances such as amino acids, minerals and vitamins in the condensates favor microbial growth. It is not advisable that a frozen food be refrozen once it has thawed. Whereas the reasons for this are more related to texture, flavor and other nutritional qualities of the frozen product, the above mentioned aspects of the microbiology of thawed frozen foods should be considered, especially if the foods are not thawed properly.

The present study was undertaken to compare the general quality of imported frozen chicken versus locally produced fresh chicken, and to compare the microbiology and shelf-life of chickens submitted to three cycles of thawing and refreezing.

## MATERIALS AND METHODS

### General quality

Fifteen whole chickens of each class (two brands of frozen Grade A, one brand of frozen Grade C and one brand of locally produced fresh) were purchased at local supermarkets. Ten chickens of each class were weighed, deboned, and the percentage of edible tissue was calculated. Both meat and skin were considered edible tissue. The edible tissue thus

obtained was subjected to texture determination using a Shear-Press<sup>5</sup> (Food Technology Corp. Rockville, Maryland). For this, duplicate 250 g portions of each chicken were analyzed and mean shear-press values obtained for each chicken.

The remaining five whole chickens of each class were cut in pieces and seasoned with a mixture of 3 g "adobo" (seasoning): 0.5 g paprika, 0.6 g garlic, 2.3 g NaCl and 18.1 g vegetable oil per pound of chicken pieces. The pieces were then deep fried in corn oil at 177° C (350° F) for 26 minutes. Each class of chicken was fried separately from the others. The fried pieces were then submitted to a taste panel for evaluation. Results were submitted to statistical analysis for significance.

#### Microbiology and Shelf-life

Forty chicken legs with thigh of each of two brands of frozen Grade A chicken, one brand of frozen Grade C chicken and one brand of local fresh chicken were purchased locally. All 120 frozen pieces were thawed overnight at 7.2° C (45° F) and initial psychrotrophic bacteria counts made by the swab method (7). Decimal dilutions were made in sterile 0.1% peptone water, pour plated with Plate Count Agar (Difco Laboratories, Detroit, Michigan)<sup>3</sup> and incubated at 20° C for 4 days (8). The 40 fresh chicken pieces were analyzed immediately upon arrival at the laboratory by the same methodology as for the thawed chicken pieces.

Ten pieces of each class of chicken were maintained at 7.2° C (45° F) until they decomposed. The time for off-odors to appear was recorded, and the corresponding psychrotrophic bacteria count determined as previously described. The rest of the pieces were frozen at -23.3° C (-10° F).

After 2 days of frozen storage, all frozen pieces were thawed overnight at 7.2° C (45° F). Psychrotrophic bacteria counts were made as before to all chicken pieces. Ten pieces of each class were maintained at 7.2° C (45° F) until they decomposed, and the time for off-odors to appear was recorded. The corresponding psychrotrophic bacteria count was determined as already described. The remaining chicken pieces of each class were refrozen, rethawed, and analyzed as before to complete 3 cycles of thawing and freezing.

All microbial counts were submitted to statistical analysis to detect significant differences.

<sup>5</sup>Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

## RESULTS AND DISCUSSION

Table 1 presents yield and relative textures of edible tissue in the four classes of chicken tested. The frozen Grade C chicken samples averaged the highest percentage of edible tissue by weight, followed by the fresh, frozen Grade A<sub>1</sub> and Grade A<sub>2</sub> brands. The fresh chickens had the softest texture of all samples tested, since their edible tissue required the least mechanical force to be cut. Following in descending order of tenderness were the frozen Grade C, Grade A<sub>1</sub> and Grade A<sub>2</sub> chickens. However, none of these differences in yield or texture were statistically significant ( $P > 0.05$ ).

At first glance it may seem odd that a Grade C chicken has a higher yield or a better texture than Grade A chickens. It must be kept in mind that Grade C is not a classification that a poultry processor works toward, but one given when the product does not meet the A classification. Usually the A classification is not met because of cosmetic defects, and this is irrelevant to chicken size (the bigger the bird the higher the meat to bone ratio) and meat tenderness.

The following tabulation shows the sensory evaluation of fried samples of the four classes of chicken. All samples were found acceptable in overall quality. The highest scores were for Grade A<sub>2</sub> and fresh chickens, whereas the lowest scores corresponded to the frozen Grade A and Grade C samples. These differences, however, were not statistically significant ( $P > 0.05$ ).

	Mean Values <sup>6,7</sup>
Frozen Grade A <sub>1</sub>	1.06
Frozen Grade A <sub>2</sub>	1.32
Frozen Grade C	1.03
Fresh	1.21

TABLE 1.—Yield and relative texture of edible tissue in four classes of chicken

	Frozen grade A <sub>1</sub>	Frozen grade A <sub>2</sub>	Frozen Grade C	Fresh
Yield <sup>1</sup>	62	60	70	64
Shear-press values <sup>2</sup>	1475	1510	1425	1393

<sup>1</sup> Average percentage of edible tissue by weight in 10 chickens of each class.

<sup>2</sup> Values are expressed as pounds of force required to shear through 250 grams of edible tissue. These lb/250 g values are the average of duplicate samples of 10 chickens of each class.

<sup>6</sup> +2, -2 scale: +2 = very acceptable; +1 = acceptable; 0 = questionable; -1 = slightly unacceptable; -2 = not acceptable.

<sup>7</sup> Average of 31 evaluations distributed in 3 replications. No significant differences ( $P > 0.05$ ) were observed among these mean values.

TABLE 2.—Microbial counts<sup>1</sup> of four classes of chicken subjected to 1, 2 and 3 cycles of thawing and freezing

	Frozen grade A <sub>1</sub>			Frozen grade A <sub>2</sub>			Frozen grade C			Fresh		
	1 cycle	2 cycles	3 cycles	1 cycle	2 cycles	3 cycles	1 cycle	2 cycles	3 cycles	1 cycle	2 cycles	3 cycles
Initial psychrotrophic count after first thaw	1.6x10 <sup>3</sup> a <sup>2</sup>	1.5x10 <sup>4</sup> I <sup>3</sup>	4.6x10 <sup>3</sup> ab I	4.6x10 <sup>3</sup> a	2.0x10 <sup>3</sup> a I	5.3x10 <sup>3</sup> a I	8.4x10 <sup>3</sup> a	5.9x10 <sup>3</sup> a I	6.5x10 <sup>3</sup> a I	9.0x10 <sup>3</sup> a	1.2x10 <sup>4</sup> a I	2.9x10 <sup>4</sup> b I
Psychrotrophic count after second thaw	—	2.2x10 <sup>4</sup> a II	1.4x10 <sup>4</sup> a II	—	1.8x10 <sup>4</sup> a I	1.9x10 <sup>4</sup> a I	—	2.1x10 <sup>4</sup> a I	6.8x10 <sup>4</sup> a I	—	8.2x10 <sup>4</sup> a I	3.0x10 <sup>5</sup> b I
Psychrotrophic count after third thaw	—	—	1.2x10 <sup>5</sup> II	—	—	9.9x10 <sup>5</sup> I	—	—	8.7x10 <sup>6</sup> I	—	—	6.3x10 <sup>6</sup> I
Average number of days for spoilage <sup>4</sup> to become evident	6.5	5.9	5.5	5.2	5.5	5.2	4.7	3	1.8	5.3	5.8	5.5
Psychrotrophic count at time of spoilage	5.5x10 <sup>8</sup>	1.7x10 <sup>9</sup>	3.0x10 <sup>8</sup>	3.6x10 <sup>8</sup>	5.1x10 <sup>8</sup>	2.5x10 <sup>9</sup>	7.4x10 <sup>8</sup>	4.6x10 <sup>9</sup>	2.3x10 <sup>8</sup>	2.0x10 <sup>8</sup>	1.1x10 <sup>9</sup>	9.2x10 <sup>9</sup>

<sup>1</sup> All counts are the average of 10 samples for each treatment and are expressed as number of Colony Forming Units (CFU) per square centimeter of chicken surface.

<sup>2</sup> Counts within the same row (for a given class of chicken) followed by the same letter are not significantly different ( $P > 0.05$ ).

<sup>3</sup> Counts within the same column (for a given cycle within a given class of chicken) followed by the same Roman numeral are not significantly different ( $P > 0.05$ ).

<sup>4</sup> Criterium of spoilage was the appearance of off-odors.

Table 2 presents the microbiology and shelf-life of the different classes of chicken subjected to three cycles of thawing and freezing. Grade A<sub>1</sub> had the lowest initial psychrotrophic bacteria count, followed by the fresh, the other frozen Grade A and the frozen Grade C chickens. In general, the initial psychrotrophic bacteria counts did not vary significantly ( $P > 0.05$ ) within a given chicken class. Exceptions to this were in frozen Grade A, and fresh chickens, which exhibited certain significant ( $P \leq 0.05$ ) variations. The 10 fresh chicken parts kept at 7.2° C (45° F) until they spoiled (without prior freezing) had an average psychrotrophic bacteria count of  $1.4 \times 10^5$  CFU/cm<sup>2</sup> of chicken surface (data not included in table 3).

After two cycles of thawing and freezing, the initial psychrotrophic bacteria counts were not significantly different ( $P > 0.05$ ) from the ones observed with the initial thaw, with the exception of the Grade A<sub>1</sub> chickens which exhibited significantly lower ( $P \leq 0.05$ ) counts at the end of the second cycle. Following a third cycle of thawing and freezing, no significant differences ( $P > 0.05$ ) were observed in the psychrotrophic bacteria counts as compared to the ones obtained after the second cycle. This held true for all classes of chicken tested.

These results indicate that the mere fact of freezing and thawing does not have an effect on the size of the population and psychrotrophic bacteria present in chickens. Even though repeated freezing and thawing destroys bacteria by disrupting cell membranes (5), microorganisms differ in their responses to freezing: some survive virtually unharmed; some resist freezing but are susceptible to damage during frozen storage or thawing; others are sensitive to freezing, storage and thawing under only some conditions, others are inactivated by freezing under nearly all conditions (10). Our observations point out that the psychrotrophic bacteria population generally is not affected by up to 3 cycles of thawing and refreezing.

Table 2 shows the psychrotrophic bacteria count at the time of spoilage and the average number of days for this to happen, once the product was thawed and kept at 7.2° C (45° F). In all cases, the referred population sized somewhere in the order of  $10^8$  to  $10^9$  CFU/cm<sup>2</sup> of chicken surface. The chickens that averaged the longest shelf-life (6.5 days) also averaged the lowest initial psychrotrophic bacteria count ( $1.6 \times 10^8$  CFU/cm<sup>2</sup>). Aside from this, no direct correlation was observed between initial psychrotrophic bacteria content and length of shelf-life, since in some instances chickens exhibiting higher initial bacterial contents also exhibited almost equal or slightly longer keeping times than others having lower initial counts. The fresh chicken pieces that were never frozen and always kept at 7.2° C (45° F) had an average shelf-life of 6.3 days before spoiling (data not included in table 3). This time was similar to

the maximum of 6.5 days observed in the frozen Grade A<sub>1</sub> chickens after 1 cycle of thawing.

It has been reported that the rate of spoilage of thawed poultry is no different from that of unfrozen poultry (4, 6, 9). In this study, we observed a difference of less than 1 day between the keeping time of fresh unfrozen chicken (6.3 days) and the average shelf-life of fresh chickens subjected to 1, 2, and 3 cycles of thawing and freezing (5.5 days). This would confirm the above mentioned previous finding.

Marked differences in shelf-life among frozen chickens subjected to 1, 2 and 3 cycles of thawing and freezing were observed only in the frozen Grade C sample. This finding correlates well with the previously described observation that in general the psychrotrophic bacteria population did not vary significantly when 1, 2 or 3 cycles of thawing and freezing were considered.

On the basis of results, we can conclude that there are no significant differences in the general quality parameters studied among the fresh and frozen chickens. This has been reported elsewhere (1). The size of the psychrotrophic bacteria population is generally not affected by up to three cycles of thawing and freezing. With the exception of the frozen Grade C chickens tested, shelf-life was not generally affected by up to three cycles of thawing and freezing, as compared with shelf life of samples that were unfrozen and frozen and thawed only once.

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