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Quality Change of Refrigerated Chicken Breast Meat Patties and Nuggets Packaged with and without Vacuum

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진공과 비진공 포장방법에 따른 닭가슴살 Patty와 Nugget의 품질변화

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Abstract

Frozen, prefried chicken breast meat patties and nuggets were obtained from a commercial plant. The samples were packaged with and without vacuum in pouches and stored at 2-4 °C. The quality of these products was measured at 4-day intervals for a period of 28 days. Vacuum packaging did not inhibit or reduce psychrotrophic microbial growth of the patty and nugget samples upon refrigerated storage. Log total fungal counts for vacuum packaged samples remained stationary after reaching a log number of 3.5, while a continuous increase was observed for non-vacuum packaged samples. Vacuum packaging did not prevent an increase of TBA values. Free fatty acid values of the samples were low and remained low throughout the observation period. A continuous darkening of the internal portions of the samples was observed.

Key words: color, patty, nugget, quality, packaging, refrigerated storage

Introduction

Americans have grown accustomed to fast foods that are engineered for least cost production, mass acceptance, speed of production and distribution, and consumer convenience. The growth of these fast foods over the past generation attests to their popularity[1]. Consumption of chicken products from fast food outlets has increased over the past few years and accounted for 3.9% of total sales at the average fast food hamburger outlet in 1984, compared with 3.7% in 1983[2].

According to a National Broiler Council Survey, there will be a decline in the number of whole birds sold, while further processed products will expand significantly because of added convenience, quality, variety and value. Further processed products, which now account for about 20% of the market, are expected to increase to an average of 31% in the early 1990s and reach as high as 39% by 1995. Statistics released by the United States Department of Commerce reports that further processed chicken inspections are up 58% in the last five years and the market now stands at approximately 2.1 billion pounds, or 20%, of the poultry market[3,4]. Health and dietary considerations and the relative consumer price of meats are the two most important factors likely to influence meat consumption patterns. Chicken, a relatively low-cost item without a "junk" food image, can be a part of many new fast food products. Further processed poultry products are likely forms for these items[5].

Traditionally, chicken patties were made either from mechanically deboned or ground poultry meat which are prone to quality deterioration upon refrigerated storage. Microbiological qualities of these products varied among sample batches. Chen *et al.*[6] showed the microbial deterio-

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ration of raw chicken patties during refrigerated storage.

In general, prefried chicken patties and nuggets are marketed in frozen forms to institutional food services and restaurants. Marketing these products in meat counters of supermarkets would further stimulate consumption by consumers. Due to differences in processing methods, the stability of products may vary. In addition, there is a need for extending the shelf life of these products in order to meet the minimum requirement of 16 days as demanded by most distributors[7]. Little or no scientific information is available concerning the quality of prefried chicken patties or nuggets held at a refrigerated temperature.

Vacuum packaging has been employed by the food industry to reduce quality deterioration of food products. Baker *et al.*[8] showed that the quality of vacuum packaged chicken frankfurters deteriorated slower than non-vacuum packaged chicken frankfurters. Shank and Lundquist[9] and Pierson *et al.*[10] reported that non-vacuum packaged meat spoiled faster than vacuum packaged products. Vacuum packaging has also been shown to cause changes in microflora of some sliced meat products[11,12].

This study was designed to investigate the microbial, chemical, and color properties of packaged chicken patties and nuggets, with and without vacuum, during refrigerated storage.

Materials and Methods

Sample Preparation

Prefried (fully cooked) chicken breast meat patties and nuggets from the same batch for each run were obtained from a Mississippi poultry processing plant immediately after manufacturing. The composition was 39.9% breast meat with skin, 26.6% ice slush, 19.9% skin, 12.3% soy protein, 1% seasonings, and 0.3% polyphosphate. All ingredients were mixed by a Bold Blendor (Western Springs Engineering, La Grange, IL). The mixture was transferred into a Formax forming machine (Formax Inc., Makena, IL), shaped, battered, breaded, and fried in fresh oil at 190.6 °C for 1 min 35 sec.

Two patties or 9 nuggets were placed in a 3.0 mil polyester/polyethylene laminated pouch (International Kenfield Distributing Co., Rosemont, IL). Twenty Pouches of each sample were vacuum packaged (10 mmHg) and heat sealed using a Maxi Pak (Rebel Butcher Supply Co., Jackson, MS). The remaining 20 pouches of each were folded without sealing. Both the vacuum packaged and folded pouches were stored at 2-4 °C. Two pouches of each vacuum and non-vacuum packaged samples were taken for the tests.

Microbial Counts

Total psychrotrophic microbial and total fungal colony forming units (CFU) of samples during refrigerated storage were determined on Day 0 and repeated every 4 days for a period of 28 days 3 times for patties and 2 times for nuggets. Thirty grams of the sample were blended with 270 m*l* of sterilized 0.1% Bacto-Peptone (Difco) solution in a sterile Waring Blendor at high speed for 1 min. Using a "pour plate technique"[13], serial dilutions of the samples were plated with Plate Count Agar (Difco) and acidified Potato Dextrose Agar (Difco), separately. The Plate Count Agar plates were incubated for 72 hr at 20 °C for the total psychrotrophic count, while the acidified Potato Dextrose Agar plates were incubated at 25 °C for 5 days for total mold and yeast counts. The average number from the duplicate plates was used for statistical analysis.

2-Thiobarbituric Acid (TBA) and Free Fatty Acid (FFA) Values

The TBA value of the sample was measured using a distillation method as described by Tarladgis *et al.*[14]. Ten grams of ground sample from each treatment were used. The FFA values of the samples were obtained by a titration method[15]. The free fatty acid content was calculated as the percentage, by weight, of oleic acid.

Color

Color of patties and nuggets was measured both externally and internally with a Hunterlab Model D-25 Color and Color Difference Meter (Hunter Associates Laboratory, Fairfax, VA). The color measurement was recorded on Day 0 and repeated every 4 days for a period of 28 days.

External color of the patties were measured by convering the aperture with the sample and flattened over a glass by applying pressure to insure proper surface illumination. For the nuggets, five to six pieces were placed in a petri dish to form a surface large enough to cover the aperture and flattened by applying pressure to prevent spaces between pieces. Standard plate number 6277, with a Hunter "L" value of 83.3, an "a" value of -4.9, and a "b" value of 25.7, was used as a reference for external color measurement, because of yellowish color of the standard plate of which color is close to the sample.

For internal color determinations, patties and nuggets were sliced in half horizontally. The sliced surfaces were exposed to the colorimeter. Standard plate number 6274, with a "L" value of 92.4, and "a" value of -0.7, and a "b" value of -0.9, was used as a reference, due to its whitish color.

Statistical Analysis

Data were analyzed statistically by analysis of variance as described by Steel and Torrie[16] using a UNIVAC 1100 model computer. Duncan's new multiple range test[17] was used to separate the means when required.

Results and Discussion

The log number of total psychrotrophic CFU of the chicken breat meast patties ranged from 2.3 to 3.1/g and varied among different sample batches. Upon refrigerated storage, control packaged patties took a mean of 17.7 days to reach 1×10^7 CFU/g of psychrotrophic counts; while 22.1 days were required to reach 1×10^8 CFU/g. The mean storage time needed to attain a log of 7.0 CFU/g for vacuum packaged patties was 19.7 days and 28.8 days to reach a log number of 8.0 CFU/g (Table 1).

The initial CFU for nuggets ranged from log number of 1.8 to 3.8/g. The days required to reach 1×10^7 CFU/g of psychrotrophic counts from control packaged nuggets were 14.4 and 16.6 days for the two tests, while 17.5 and 20.6 days for 1×10^8 CFU/g were recorded. The time required to reach a log CFU counts of 7/g for vacuum packaged nuggets were 14.8 and 26.4 days (Table 1). Results from the analysis of variance indicaed that vacuum packaging did not ($P>0.05$) inhibit or reduce the ultimate psychrotrophic microbial growth in chicken patties and nuggets upon refrigerated storage.

Shank and Lundquist[9] reported that the mere exclusion of air or oxygen did not inhibit the growth of anaerobic or facultative bacteria of cured ham. Vacuum packaging did not insure extension of storage shelf life unless the product was handled so as to insure minimum contamination

Table 1. The growth of psychrotrophic microorganisms in chicken patty and nugget products at 2-4°C under two packaging conditions[a),b)]

Treatment	Days required to reach:							
	1×10^7 CFU/g				1×10^8 CFU/g			
	Rep 1	Rep 2	Rep 3	mean	Rep 1	Rep 2	Rep 3	mean
Patties								
Control	16.8	18.0	18.4	17.7a	20.8	21.6	24.0	22.1a
Vacuum	19.2	16.0	24.0	19.7a	28.0	18.4	28.8	28.8a
Nuggets								
Control	16.6	14.4	—	15.5a	20.6	17.5	—	19.0a
Vacuum	26.4	14.8	—	20.6a	28.8	24.8	—	26.8a

a) Each number is a mean of two observations

b) Means not followed by the same letter are significantly different ($P<0.05$).

Table 2. The growth of fungal microorganisms in chicken patty and nugget products at 2-4°C under two packaging conditions[a]

Treatment	Days required to reach: 1×10^4 CFU/g		1×10^5 CFU/g	
	Rep 1	Rep 2	Rep 1	Rep 2
Patties				
Control	17.3	25.5	20.0	27.5
Vacuum	> 28.0	> 28.0	> 28.0	> 28.0
Nuggets				
Control	18.8	6.2	22.7	7.2
Vacuum	> 28.0	> 28.0	> 28.0	> 28.0

a) Each number is a mean of two observations.

before and during the packaging process. Arafa and Chen[18] also showed that vacuum packaging affected neither the psychrotrophic aerobic total counts nor the shelf life of cut-up fresh broilers, when compared with the non-vacuum packaged controls.

Initial total fungal count of prefried chicken patties and nuggets also varied among the different sample batches. Log total fungal count for vacuum packaged samples remained stationary after reaching a log number of 3.5, while a continuous increase was observed for non-vacuum packaged samples. Days required to reach 1×10^4/g and 1×10^5/g of total fungal CFU of non-vacuum and vacuum packaged samples are shown in Table 2. The statistical analysis could not be conducted because the total fungal CFU of vacuum packaged samples did not reach 1×10^4/g during the experiment. Kemp *et al.*[19] reported that vacuum packaging reduced mold growth in dry cured ham.

In general, visible mold growth on the surface of the samples occurred before the log number of total psychrotrophic count reached 6.0. Visible mold growth on the products was inhibited by vacuum packaging. Of interest to note is that little or no off-odor was detected even after the log total psychrotrophic CFU reached 7.0 or 8.0. No difference ($P>0.05$) was noticed between vacuum and control packaged chicken patties and nuggets in total psychrotrophic aerobic counts during refrigerated storage.

Table 3. Effect of vacuum packaging on TBA values of chicken breast meat patties and unggets stored at 2-4°C[a),b)]

Day	Patties		Nuggets	
	Vacuum	Non-vacuum	Vacuum	Non-vacuum
0	0.83f	0.83f	0.58a	0.58a
4	1.05ef	0.92f	0.55a	0.65a
8	1.25de	1.07ef	0.58a	0.86a
12	1.37d	0.96f	0.82a	0.86a
16	1.42cd	1.36d	0.67a	0.77a
20	1.47cd	1.39cd	0.86a	0.87a
24	1.78ab	1.63bc	0.85a	0.90a
28	1.78ab	1.97a	0.94a	1.09a

a) Mean of 4 observations.

b) Means within a row or column in each product group not followed by the same letter are significantly different ($P<0.05$)

Table 4. Effect of vacuum packaging on free fatty acid values of chicken breast meat patties and nuggets stored at 2-4°C[a),b)]

Day	Patties		Nuggets	
	Vacuum	Non-vacuum	Vacuum	Non-vacuum
0	1.60bc	1.60bc	1.61a	1.61a
4	1.37efg	1.40defg	1.50a	1.66a
8	1.35efg	1.56cd	1.37a	1.57a
12	1.35efg	1.51cde	1.41a	1.32a
16	1.24g	1.73b	1.48a	1.61a
20	1.32fg	1.46cdef	1.62a	1.71a
24	1.24g	1.22g	1.38a	1.46a
28	1.22g	1.98a	1.52a	1.35a

a) Mean of 4 observations.

b) Means within a row or column in each product group not followed by the same letter are significantly different ($P<0.05$)

Regardless of the packaging method, TBA values of samples increased as storage time progressed (Table 3). Analysis of variance shows a significant ($P<0.05$) packaging method-storage time interaction indicating that vacuum packaging is not effective in delaying or preventing the rancidity development of chicken patties and nuggets. Baker *et al.*[8] reported that TBA values of both vacuum and non-vacuum packaged chicken frankfurters increased very little over 24 days of stor-

age at 2 °C. Arafa and Chen[20] reported that vacuum packaged frozen precooked and frozen prefried chicken parts maintained lower TBA values than non-vacuum packaged chicken parts throughout 6 months of frozen storage.

Free fatty acid values of the patty and nugget samples were low and remained low throughout the experiment (Table 4). Results indicate that the free fatty acid value does not play a major role in the quality deterioration of chicken patties and nuggets during refrigerated storage.

Regardless of packaging method, a continuous darkening of the internal portions of the chicken patties and nuggets was observed while in refrigerated storage. Darkening of internal portions was also indicated by decreasing Hunter "L" values. No apparent increasing or decreasing trend in the external Hunter "L" value was noticed for products in both packaging treatments throughout the refrigerated storage (Tables 5 and 6). Redness and yellowness of all samples, both externally and internally showed tendency of decrease as length of storage time increased in general. Frequently, visible black spots were noticed after the sample was refrigerated for 16 days. The mechanism for the formation of these black spots warrants further investigation.

In summary, vacuum packaging did not delay or prevent the increase in total psychrotrophic aerobic counts, rancidity development, and color change, but did retard the growth of mold on prefried chicken patties and nuggets during refrigerated storage at 2-4 °C.

요 약

가열조리 냉동된 닭 가슴살 patty 와 nugget 을 계육가공공장으로부터 얻어서 진공과 비진공으로 포장한 뒤 2-4℃로 냉장저장하였다. 이 제품의 품질을 28일간 4일 간격으로 측정하였다. 진공포장방법으로는 냉장저장된 제품의 미생물 총균수는 줄이지 못하였으며 비진공 포장된 제품의 총곰팡이 수는 실험기간 동안 증가한 반면 진공포장된 제품은 log 값 3.5부터 정체기에 들어갔다. 진공포장은 TBA 값의 증가를 막지 못했으며 유지방산 값은 실험기간 동안 낮은 일정한 값을 보였다. 진공 및 비진공포장 방법 그 어느 경우에도 제품색깔은 현저하게 변했다.

Table 5. External Hunter color values of chicken breast meat patties and nuggets stored at 2-4 °C[a),b)]

Type of Product	Storage Days	"L"		"a"		"b"	
		Vacuum	Non-vacuum	Vacuum	Non-vacuum	Vacuum	Non-vacuum
Patties	0	43.3a	43.3a	8.62a	8.62a	17.4a	17.4a
	4	44.1a	46.0a	6.56bc	6.94b	16.0bc	17.5a
	8	44.8a	45.7a	5.77cdef	6.00bcde	15.2de	16.5b
	12	43.8a	43.6a	5.98bcde	5.46defg	15.0de	15.5cd
	16	43.4a	42.5a	5.24efg	4.82fg	14.6ef	14.7def
	20	43.0a	44.4a	6.29bcd	5.16efg	15.1de	15.0de
	24	44.4a	48.7a	5.38defg	4.47g	14.5ef	15.1de
	28	43.8a	46.5a	5.08efg	3.43h	14.6ef	14.0f
Nuggets	0	46.4bcd	46.4bcd	7.98a	7.98a	17.9a	17.9a
	4	45.9bcde	46.8ab	6.41a	6.52a	16.6a	17.4a
	8	45.4cdef	48.0a	5.86a	6.64a	15.8a	17.5a
	12	45.0def	45.8bcde	6.12a	6.26a	15.5a	16.4a
	16	44.7ef	46.7abc	5.28a	4.87a	15.2a	16.0a
	20	44.7ef	46.7abc	5.78a	5.10a	15.2a	16.4a
	24	44.1f	46.3bcd	5.98a	4.74a	14.9a	15.5a
	28	44.8ef	44.1f	5.42a	5.00a	15.1a	15.7a

a) Mean of 4 observations

b) Means within a row or column for each color value and product type not followed by the same letter are significantly different ($P<0.05$).

Table 6. Internal Hunter color values of chicken breast meat patties and nuggets stored at 2-4°C[a),b)]

Type of Product	Storage Days	"L"		"a"		"b"	
		Vacuum	Non-vacuum	Vacuum	Non-vacuum	Vacuum	Non-vacuum
Patties	0	64.8ab	64.8ab	2.76a	2.76a	15.2a	15.2a
	4	64.1abc	66.0a	0.86cdef	0.89cdef	14.9ab	15.1ab
	8	62.9bcde	64.6a	1.45def	0.74bcde	15.0ab	15.0ab
	12	61.6cdef	62.6bcde	1.42g	-0.23bcde	15.0ab	13.6ef
	16	60.6def	59.9fg	1.64ef	0.65bc	14.4bcd	13.2f
	20	63.9abcd	62.3bcdef	1.56fg	0.18bcd	14.6abc	13.8def
	24	61.8cdef	58.8g	1.52bc	1.72bcd	14.0cde	13.9cdef
	28	61.6def	55.1h	0.95ab	1.99cdef	13.8def	14.0cdef
Nuggets	0	65.6a	65.6a	3.10a	3.10a	13.6a	13.6a
	4	65.1a	65.2a	2.44b	2.16bc	14.0a	13.8a
	8	62.3a	64.1a	1.92bc	1.86bc	13.9a	14.0a
	12	62.5a	64.3a	2.09bc	1.13de	13.8a	13.7a
	16	61.9a	63.2a	2.03bc	1.55cd	13.6a	14.0a
	20	61.3a	64.7a	1.90bc	0.92e	13.4a	13.4a
	24	60.4a	62.8a	1.94bc	0.68e	13.2a	13.0a
	28	62.2a	62.0a	1.62cd	-0.26f	13.6a	12.9a

a) Mean of 4 observations.

b) Means within a row or column for each color value and product type not followed by the same letter are significantly different ($P<0.05$).

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Mention of trademark names does not constitute a guarantee or warranty of the products by the authors nor does it imply their approval to the exclusion of other products that may also be suitable.

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