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Quality and safety assessment of locally produced marinated chicken shish

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Abstract

The objective of this study was to assess some quality and safety parameters of marinated chicken shish in Cairo markets. A total of 33 marinated chicken shish (15 raw chilled marinated chicken shish "", 10 raw frozen marinated chicken shish "RFCS" and 8 half cooked frozen chicken shish "HCFCS") were examined for their sensory attributes, deterioration criteria (pH, Thiobarbituric acid value "TBA" and Total volatile basic nitrogen "TVBN") and bacterial load. The results revealed that all marketed chicken shish samples were of low sensorial scores. The odor (raw samples) and flavor (cooked samples) scores were lower than the acceptable scores (3.5).The TBA values of all examined samples were higher than the acceptable values for meat products (0.9 mg/ kg). The pH values of RCCH and the TVBN values of all samples were borderline. The bacterial examination revealed that the count of aerobic bacterial, psychrotrophic, enterobacteriaceae, total staphylococci and coliforms of chilled marinated chicken shish were significantly (P<0.05) higher than those of raw and half cooked marinated chicken shish.

Key words: marinated chicken shish – RCCS- HCFCS- TVBN- TBA.
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Introduction

Marination is a traditional process originated in the Mediterranean region, where, meat is immersed in a solution that extends its shelf life, imparts a specific flavor characteristic and reduces aging time required for meat tenderization ***((Lemos et al., 1999;Guerrero-Legarreta and Hui, 2010).*** Consumers primarily marinate meat by immersing them in a liquid marinade and allowing it to penetrate the meat through diffusion over time ***(Yusop et al.,2010).*** Commercial marinating usually involves a more complex solution of water, salt, polyphosphate, flavorings and other ingredients ***(Smith and Acton, 2001 ;Lemos et al., 1999; Guerrero- Legarreta and Hui, 2010).*** Soaking, injection or vacuum tumbling are from the various methods used for marination. Meanwhile, the time required from 2-8 hours according to requested flavor intensity ***(Tarantino, 2006; Smith and Young, 2007).*** Marination is commonly used to enhance yield by increasing water content and water retention, to change the flavor profile of products and to improve meat tenderness and juiciness ***(Sen et al., 2005; Alvarado and Mckee, 2007).*** In addition to sensory improvement marination has been considered to increase microbiological safety of meat products, however it may not necessarily have an effect on some pathogen ***(Bjorkroth, 2005).***

Lipid oxidation and growth of undesirable microorganisms in chicken products result in the development of spoilage, off flavor, rancidity and deterioration, rendering such products unacceptable for human consumption ***(Bozin et al., 2007; Ibrahim et al., 2010),).*** It is worthy to mention that different raw materials, additives with various processing techniques could be reflected upon the final product. Recently, mass production of marinated chicken products has become a common trend for Egyptian markets, as a result of changing consumers eating habits and shifting towards chicken products instead of whole chicken. However, limited data are available on the quality and safety of locally produced marinated chicken products. Therefore, the current study was designed to assess the quality and safety (sensory, chemical and bacteriological,) of some marinated chicken shish present in the Cairo markets. This study will help the meat industry to improve the quality and safety of marinated chicken products through enhancing the marinating techniques and components used for marinating process.

Material and Methods

Sample collection:

A total of thirty three marinated chicken products (fifteen raw chilled chicken shish "RCCS", ten raw frozen chicken shish "RFCS" and eight half cooked frozen chicken shish "HCFS") were collected from different retail markets in Cairo, Egypt. Samples were transferred immediately in cooling ice box to the laboratory of Food Hygiene and Control Department, Faculty of Veterinary Medicine, Cairo University. In the lab, samples were investigated for their sensory attributes, deterioration criteria and bacteriological load.

Sensory evaluation:

Marinated chicken products were subjected to sensory evaluation immediately after arrival to the Lab. Sensory evaluation was performed in raw marinated chicken shish or chicken shish cooked in a forced draught oven at 230 °C for core temperature 75 °C according to the schemes of **Sumarmono et al. (2008), Baston and Barna, (2010) and Kenawi, (2005).**

For sensory evaluation of treated chicken shish, five experienced panelists (from both sexes in the age range of 25 to 45 years) were chosen from the staff members of the Department of Food Hygiene and Control at Faculty of Veterinary Medicine, Cairo University, Egypt. Panelists were selected on the basis of previous experience in consuming chicken products. Moreover, they received a preparatory session prior to testing so that each panelist could thoroughly discuss and clarify each attribute to be evaluated.

The panelists were asked to evaluate raw chicken shish in a randomized order and asked to assign a numerical value between 1 and 7 for following attributes color, odor, slimness and texture where 1 is very poor (I dislike it very much), 2 and 3 is poor, 4 is border line, 5 and 6 are good and 7 is excellent (I like it very much). After cooking, the panelists were asked to assign the same numerical values for the following attributes: Color 1 (very poor) – 7 (excellent); Flavor 1 (imperceptible) -7 (extremely intense); tenderness 0 (extremely soft) - 7 (extremely tough) and juiciness 1 (extremely dry) - 7 (extremely moist). Tap water was provided between samples to cleanse the palate. At the end of evaluation of each cooked chicken shish, each panelist was asked to give a score for overall acceptability from 1 (dislike very much) to 7 (like very much).

Deterioration criteria:

Measurement of pH value:

Five grams from each of the prepared samples were homogenized with 20 ml distilled water for 10-15 seconds. The pH was measured using pH meter (LovibondSenso Direct) with a probe type electrode (Senso Direct Type, 330), where 3 constant readings were obtained and the mean was recorded ***(Honikel et al., 1981).***

Thiobarbituric Acid Reactive Substances:

Five grams from each muscle sample were homogenized with 15 ml deionized distilled water using a stomacher (Lab blender 400) for 10 seconds at the highest speed. One milliliter of the homogenate was mixed with 50µl butylatedhydroxyanisole (7.2%) and one ml each of 15mM 2-thiobarbituric acid and 15% trichloroacetic acid. The mixture was vortexed, incubated in a boiling water bath for 15 minutes to develop color, then cooled under running water for 10 minutes, vortexed again, and centrifuged for 15 min at 2500 rpm. The absorbance of the resulting supernatant was measured at 531 nm using Unico 1200 (USA) series spectrophotometer against a blank containing one ml of deionized water and 2 ml of 2-thiobarbituric acid-trichloroacetic acid solution. The reading was multiplied by 7.8 to obtain the value of TBARS expressed as milligrams of malonaldehyde per kilogram of sample ***(Du et al 2002).***

Measurement of Total Volatile Basic Nitrogen:

Ten grams of sample were macerated with 100 ml tap water and washed into a distilling flask with 200 ml tap water, then 2 grams of magnesium oxide were added. A macro-Kjeldahl distillation apparatus was connected to the distillation flask containing 25 ml of 2% boric acid solution and few drops of methyl-red indicator (0.016 g methyl red, 0.083 g bromocresol green per 100ml ethanol) with the receiving tube was dipped below the liquid, with distillation continued till collection of 200 ml. The condenser was then washed with distilled water and the distillate was titrated with 0.05 M (0.1N) sulphuric acid. The Total Volatile Base Nitrogen (mg/100 gram sample) was calculated as the titration multiply by 14 ***(Kearsley et al., 1983).***

Bacteriological examination:

Ten grams from each sample were removed aseptically and homogenized with 90 ml max recovery solution in a stomacher (Lab-blender 400, seward, UAC house friars Road, London SE 19 UG. (Model No.6021) for 2 minutes to prepare the initial 1/10 dilution. From the resulting dilution, appropriate serial dilutions were prepared using the same diluent ***(ICMSF, 1978).*** Dilutions were spread plated (oxoid), and incubated at 35°C for 24 hours and 7°C for 7-10 days for total aerobic and psychrophilic bacterial count. ***(Harrigan, 1998).*** Enterobacteriacae counts were obtained by inoculation onto violet red bile decstrose agar plates and incubation at 37°c for 24-48 hours, Staphylococci on Barid Parker agar at 37°cfor 24-48 hours and Coliform count on Lauryl sulfate tryptose broth at 37°c for 24-48 hours by MPN method ***(APHA, 1992).***

Isolation of *Salmonellae*:

Twenty five grams from each examined sample were inoculated into 225 ml flask containing buffered peptone water and incubated at 37°C for 24 hours then 1ml from each buffered peptone water flask was inoculated into a test tube containing 9ml of Rapaport Vasiliadis broth which were incubated at 43°C for 24 hours. Finally streaked onto of Xylose-Lysine Desoxycholate (XLD) and Macconkey agar and incubated at 37°C for 24 hours ***(APHA, 1992).***

Isolation of *E. coli*:

A loopful from the positive *E. coli* broth tubes was streaked over plates of Eosin Methylene blue (EMB) and incubated at 35°C for 24 hours. Typical colonies are greenish metallic with dark purple center with or without sheen ***(APHA, 1992).***

Statistical analysis:

Analysis of variance was performed by ANOVA procedure using SPSS 17.0 for windows. Differences between the mean values of different marinated samples were determined by least square difference test (LSD) procedure.

Results and Discussion

Sensory evaluation:

The sensory scores of different raw marinated chicken shish when examined before cooking are presented in Table 1. The color scores of HCFCS were significantly ($P < 0.05$) lower than those of RCCS and RFCS, where, darker color in HCFCS samples was observed by the panelists. The darker color of HCFCS may be attributed to the cooking process as myoglobin undergo denaturation after cooking ***(Lawire, 1994)***. Globin hemochrome, in which the iron is in the fe^{2+} state, has typically dull red color, while, globin hemichrome with iron In the fe^{3+} state, is largely responsible for the brown-grey hue ***(Young et al 2001)***.The balance between hemochromes and hemichromes is affected by the state of meat before cooking and other factors including species, animal maturity and muscle type ***(Latif, 2013)***. The odor scores of HCFCS were significantly higher ($P<0.05$) than those of RCCS and RFCS, such acceptable odor can be attributed to flavor producing reaction that occurs during cooking ***(Pawer et al 2007)***. The odor scores of RCCS and RFCS were lower than the acceptable scores (3.5) and off-odor was detected by the panelists. The off-odors observed in RCCS and RCCS samples may be attributed to improper processing, handling and storage, as off odors usually is a product of the microbial spoilage and oxidation. Slimness scores of RCCS significantly lower than that of RFCS or HCFCS ($P<0.05$) which usually reflect the increased microbial growth. Concerning texture, no significance difference on its score could be noticed among different marinated chicken shish samples.

The sensory attributes scores of cooked marinated chicken shish samples are presented in Table 2. Cooked RFCS color scores were significantly higher ($P<0.05$) than those of RFCS and HCFCS. The higher scores for appearance in HCFCS samples may be explained by the good storage condition at freezing temperature which, prevent loss of meat myoglobin or oxidative changes that affects the color of cooked products. However, cooked RCCS samples may be affected by either loss of myoglobin or oxidation during storage. The flavor scores of all cooked chicken shish samples were lower than the acceptable scores (3.5) and this may be attributed to the bad quality of raw meat materials used in addition to bad hygienic and storage condition of examined samples. Juiciness scores of RFCS were significantly higher ($P<0.05$) than other samples such difference may be due to freezing storage as high water holding capacity (WHC) and slightly low pH. Cooked RFCS have the highest tenderness scores among the different shish types, as a function of marinade ingredients absorbed by the meat muscle and retained for a period of storage. Moreover, the entire results of sensory cooked marinated chicken shish indicated bad overall acceptability scores that may be related to off-odors of raw samples, off-flavors of cooked samples and use of insufficient antimicrobial spices and marinating time.

Table (1): Mean value of Sensory attributes scores of raw marinated chicken Shish.

	RCCS	RFCS	HCFCS
Color	4.6±0.08^{a}	4.81±0.23^{a}	4.35±0.17^{b}
Odor	3.1±0.16^{a}	3.3±0.08^{a}	4.1±0.41^{b}
Slimness	4.1±0.54^{a}	5.47±0.26^{b}	5.15±0.36^{b}
Texture	5.4±0.38^{a}	5.57±0.19^{a}	5.36±0.47^{a}

RCCS: Raw chilled marinated chicken shish.
RFCS: Raw frozen marinated chicken shish.
HCFCS: Half cooked frozen marinated chicken shish
$^{a-c}$Values with different superscripts within the same raw are significantly different ($P < 0.05$)

Table (2): Mean value of sensory attributes scores of cooked marinated chicken Shish.

	RCCS	RFCS	HCFCS
Color	4.52±0.34^{a}	5.17±0.25^{b}	4.85±0.11^{a}
Flavor	3.2±0.17^{a}	3.3±0.18^{a}	3.4±0.27^{a}
Juiciness	4.55±0.22^{a}	5.47±0.21^{b}	5.14±0.19^{a}
Tenderness	5.06±0.42^{a}	5.9±0.32^{b}	5.41±0.42^{a}
Overall acceptability	3.1±0.37^{a}	3.4±0.09^{a}	3.4±0.31^{a}

RCCS: Raw chilled marinated chicken shish.
RFCS: Raw frozen marinated chicken shish.
HCFCS: Half cooked frozen marinated chicken shish.

[a-c]Values with different superscripts within the same raw are significantly different (P < 0.05)

Table (3): Mean Values of deterioration criteria of marinated chicken Shish.

Deterioration criteria	RCCS	RFCS	HCFCS
pH	6.3±0.39[a]	6.1±0.29[a]	6.04±0.27[a]
TBA(mg malonaldehyde/kg)	1.3±0.09[a]	1.18±0.08[ab]	1.025±0.08[b]
TVBN(mg/100gm)	20.19±1.7[a]	19.55±1.6[b]	20.07±2.1[ab]

RCCS: raw chilled marinated chicken shish.
RFCS: raw frozen marinated chicken shish.
HCFCS: half cooked frozen marinated chicken shish.
[a-c]Values with different superscripts within the same raw are significantly different (P < 0.05)

Deterioration criteria:

Data of deterioration criteria for RC/CS showed that the mean pH value, TBA (mg malonaldehyde/kg) and TVBN (mg/100gm) were 6.30, 1.3 and 20.19. While, the mean values for RFCS were 6.1, 1.18 and 19.55 respectively and the mean values for HFCS were 6.04, 1.025 and 20.07 (Table 3). The pH value of RCCS (6.3) indicated that these marinated products are in borderline state and should be used for rapid consumption. It is clearly that pH values of RCCS samples were higher than those of RFCS and HCFCS, however, this increase was not statistically (P>0.05) significant. The high pH values and the low sensorial attributes in all marinated chicken shish substantiated the findings of ***Alvarado and Sam (2003)*** who concluded that the increase in pH has an adverse effect on quality of marinate chicken samples quality during storage; especially odor, color and flavor. This high PH values could be attributed to addition of alkaline phosphates in the marinade during production. Moreover, ***Yong et al. (2005)*** reported a higher PH value in marinated fillets with sodium triphosphate and NaCl solution than the control samples without sodium triphosphate in fillets deboned immediately after chilling. All examined samples showed higher TBA values were higher than the acceptable value (0.9 mg/kg) established by ***EOSQC (2005)***. The high TBA values may indicate the occurrence of oxidative or lipolytic rancidity or both during storage as a function of bad production and or storage condition. Total volatile basic nitrogen can be used as quality indicator for poultry products and it is associated with the amino acid decarboxylase activity of micro-organisms during storage ***Smaoui et al. (2011)***. The higher TVBN in all samples may be attributed to breakdown of proteins as a result of activity of microbial and proteolysis enzymes (***Yassin and Nessrien 2003).*** Overall we must spotlight that all marinated chicken shish have higher pH, TBA and TVBN in spite of the difference in their processing and storage condition which may claims the input raw material, mainly chicken meat and spices.

Table (4): Mean value of bacterial counts (log_{10}CFU/g) of marinated chicken Shish

Bacterial count	RCCS	RFCS	HCFCS
APC	5.8±0.27[a]	4.9±0.47[b]	4.5±0.36[b]
PSC	5.2±0.54[a]	4.8±0.31[ab]	4.3±0.35[b]
Enterobcteriacae count	4.1±0.26[a]	4.00±0.21[a]	1.7±0.31[b]
Total staphylococcal count	4.6±0.36[a]	3.19±0.35[b]	1.7±0.18[c]
Coliforms	3.4±0.12[a]	2.18±0.37[b]	2.5±0.19[b]

RCCS: Raw chilled marinated chicken shish.
RFCS; Raw frozen marinated chicken shish. HCFCS: Half cooked frozen marinated chicken shish
APC: Aerobic plate count.
PSC: Psychrophilic plate count
[a-c]Values with different superscripts within the same raw are significantly different (P < 0.05)

Bacteriological examination:

Results obtained for bacterial counts (Table 4) declared that RCCS were the highest among different chicken shish samples. The mean number of aerobic plate count in the current study was 5.8 (Log_{10} CFU/g). This result similar to those obtained by ***Cohen et al (2007)***, ***Andritsos et al (2012)*** and ***Szosland-Faltyn (2013)***, who found the mean value of aerobic plate count 5.9 (Log_{10}CFU/g), 5.9 (Log_{10}CFU/g) and 5.87 (Log_{10}CFU/g)

respectively. This higher total bacterial count may be attributed to the added spices which could be a cause of increased microbial contamination. ***Steinhauserova et al (2012)*** reported that the quality and age of the raw meat play an important role in the bacterial load of the final product processed from it.

Enterobacteriacae family is a group of bacteria that can be used to assess the general hygiene status of marinated chicken. Moreover, it constitutes a part of the microbial association implicated in the spoilage of a food product during refrigerated storage. The maximal recommended limit is 3.7 (log_{10} CFU/g), ***(Smaoui et al 2011)***. As the enterobacteriacae counts in RCCS and RFCS are significantly higher ($P<0.05$) than maximal recommended limits independent marinades and spices used, is an indication of fecal contamination and poor hygiene during processing ***(Szosland-Faltyn 2013)***.The effect of freezing in RFCS was significant in decreasing the bacterial counts ($P<0.05$) than RCCS as freezing and low-temperature storage equipment is designed to maintain perishable foods and prevent pathogen growth. In addition to inhibiting microbial growth, refrigeration temperatures also slow enzymatic actions and other biological and chemical actions that may enhance rancidity, and quality deterioration of foods. The HFCS received the lowest bacterial count and these low counts in comparison to RCCS and RFCS ($P<0.05$) could be attributed to the effect of heating as from the safety standard point the most important purpose of heating is to kill or inactivate spoilage and pathogenic organisms, cooking or heating easily destroys the vegetative cells of psychrophiles and mesophiles.

Conclusion: Some marinated chicken shish marketed in Cairo markets have high TBA, PH and TVBN in addition to low sensorial attributes and high aerobic, psychrotrophic, enterobacteriacae count. These finding could be attributed to use raw material and spices of low quality which not sufficient as antioxidant or antibacterial. Experimental improvement must applied by using strong antioxidant and raw material of high quality. Also strict hygienic condition should be applied in processing plant.

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الملخص العربي

تعتبر لحوم الدجاج من أكثر اللحوم الأساسية في غذاء المستهلك في جميع أنحاء العالم نظرا لقيمتها الغذائية العالية و انخفاض سعرها مقارنة بأنواع اللحوم الاخري لذلك فقد اقبل المصنعين علي ادخال نوع جديد اضافة الي الانواع الأخري من مصنعات الدجاج و هو الدجاج المتبل و لقد أقبل المستهلك علي هذه المنتجات أقبالا كبيرا و ذلك لما تضيفه التوابل المضافة للدجاج من تحسن في مظهر و طعم المنتج بهذه التقنية, و كذلك التحسن الكبير في المذاق النهائي للمنتج, كما أن المواد المستخدمة في تصنيع التتبيلة تضيف قيمة غذائية, بالأضافة الي الأحساس بمتعة التذوق حال تناولها و من هذه المواد المستخدمة ما يحسن من طراوة المنتج و يقلل الفقد أثناء الطهي.

من المعروف أن الدجاج منتج سريع الفساد لذلك يتم أضافة بعض التتبيلات و كذلك الملح لأطالة فترة صلاحية الدجاج. و تواجه صناعة منتجات الدجاج المتبل العديد من المشكلات من أهمها أستخدام أنواع رديئة من التوابل, أستخدام لحوم دجاج قليلة الجودة أو الأفراط في أستخدام بعض التوابل مما يسبب مشكلة في لون المنتج الذي يحد بصورة كبيرة من قابلية المستهلك علي شراء المنتج و كذلك تعرض المنتج لمشاكل أثناء التجهيز, التعبئة, التداول و الحفظ.

جودة المنتجات المعروضة بالأسواق:

أجريت هذه الدراسة بغرض دراسة جودة منتجات الدجاج المتبل المعروضة بالاسواق المصرية و لذلك تم جلب عدد ثلاثة وثلاثون عينة, خمسة عشر عينة من شيش الدجاج المتبل النئ المبرد, عشرعينات من شيش الدجاج المتبل النئ المجمد و ثماني عينات من شيش الدجاج المتبل النصف مطهي المجمد و فحصها حسيا و كيميائيا و بكتريولوجيا. وقد أظهر الفحص الحسي لهذه المنتجات أنتشار عيوب الطعم واللون والرائحة مما أثر سلبا علي الشكل النهائي للمنتج وأظهر الفحص الحسي أيضا أنخفاض النكهة مما قد يكون بسبب أنخفاض جودة لحوم الدجاج المستخدمة في التصنيع و كذلك أستخدام أنواع رديئة من التوابل في التتبيل. وكذلك أظهر التحليل الكيميائي لمنتجات الدجاج المتبل أرتفاع الأس الهيدروجيني و يعتبر ذلك من دلالات الفساد و كذلك أرتفاع المركبات النيتروجينية الطيارة و حمض الثيوبابتيورك عن الحدود المقبولة صحيا. و قد أظهر الفحص البكتريولوجي للمنتجات أرتفاع عدد بعض انواع البكتيريا خاصة في شيش الدجاج المتبل النئ المبرد عن الحدود المسموح بها و لم يتم العثور علي السالمونيلا أو الأيكولاي في أي من العينات.