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Microbial and Chemical Evaluation of broiler's skin as co-product incorporated in meat industry

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Thirty samples of freshly slaughtered broiler frame with skin were obtained from small scale poultry processing plant in Cairo and Giza markets. Samples of neck and breast skin were examined for Total colony count, Psychrotrophic count, *Staphylococcus aureus* count, Coliform Count, presumptive *E. coli* count and total yeast and mould count. In addition isolation of Salmonella spp. and thermotolerant Campylobater were performed. Lower bacterial counts were recorded in cooked samples, with mean value of 7.6 ± 0.18, 5.68 ± 0.16, 5.12 ± 0.14, 3.6 ± 0.3, 2.3 ± 0.39 and 6.85 ± 0.37 log10 cfu /g in raw samples and 0.91 ± 0.27, 0.74 ± 0.21, 0.56 ± 0.19, 1.1 ± 0.13, < 3 and 2.44 ± 0.12 log10 cfu/g in cooked samples respectively. The incidence of *S. aureus*, Salmonella and *Campylobater jejuni* in raw skin samples were 66.7%, 20%, and 56.6%, respectively. While *S. aureus* was unexpectedly isolated from cooked samples. Fat content was estimated by using Sohexelt method and fatty acids content of methylester were determined.

Keywords: broiler's skin, Campylobacter, fatty acid profile, microbial evaluation Salmonella, *S. aureus*

Poultry has become an important food supply allover the world and growing consumption of chicken increasingly has been varied. Nowadays, consumer habits have changed; most poultry is sold as portioned or further processed, rather than as whole birds. This change in consumer preference has resulted in the poultry processing industry generating ever increasing amount of under utilized co-products. Chicken skin in particular, accumulates in huge quantities. Most of excess skin was generally combined with other waste to produce poultry by-products meal of various qualities, meanwhile a small proportion is used in meat emulsion or used as source of fat (Cliche *et al.,* 2003). Poultry skin contains the most calories as the chicken meat is low in calories so health conscious consumers should avoid skin as all most recent medical advice has reinforced the importance of reducing fat, eating a balanced diet in order to bring down the instances of heart diseases and obesity (British poultry council, 2001).

The bacterial load of chicken skin is investigated by Emara and Nouman (2002), Buhr *et al.* (2003) and Abd-El Wahab (2005) they found that total colony count, Coliform count, *S. aureus* count *and E. coli* count were 10^4-10^9, $3x10^3$ - $6x10^3$, 10^3, $7x10$-$7x10^2$ cfu /g respectively. Bacterial contamination of external surfaces of processed poultry carcasses can originate from contact with ingesta or feces excreted from alimentary tract during growing out, transportation, or processing (Byrd *et al.,*1998 and Berrang *et al.,* 2002). Moreover, empty feather follicles harbor bacteria making complete removal of bacteria difficult if not impossible (Nacomcf, 1997).

The presence of Campylobacter in commercial broiler flocks and processed poultry has been widely demonstrated (Jacobs-Rietsma, 2000) as Campylobacter cells adhering to the skin were located primarily on rough areas of chicken skin, in crevices or entrapped inside deep channels and feather follicles with water provide a micro environment suitable for their survival (Lee *et al.,*1998 and Chantarapanont *et al.,* 2003). Meanwhile, Waldroup (1996) and Jeffry *et al.* (2001) reported that Campylobacter incidence in poultry carcasses vary considerably ranged from 30-100%, while that of Salmonellae is ranged

from 30-50%. The incidence of Salmonellae and Campylobacter in raw poultry carcasses are greatly affected by the operation condition of scalding process. High scalding temperature greatly reduced bacterial survival in the scalders, while cause the broiler skin to lose more of the stratum cornium layer and making the skin easier for bacteria to adhere during defeathering and evisceration (Oosterom *et al.,* 1983, Yang *et al.,* 2001 and Alter *et al.,* 2005). It is noteworthy mention that the numbers of reported cases of Campylobacteriosis increased rapidly in most countries. It is now recognized as a more common enteric pathogen than Salmonellae in several countries, developed as well as developing Berndtson (1996). In adequately cooked poultry and poultry products are the most common source for epidemic and sporadic food borne cases.

Recently, poultry skin is incorporated in the formulation of most meat and poultry products which constitutes a major concern facing meat industry. Therefore, the current study was under taken with the objective of evaluating microbiological condition of marketed broiler's skin, determined of their fat and fatty acid content as well as studying the effect of heat treatment on skin quality.

Material and Methods

Samples. Thirty samples of freshly slaughtered broiler's frame with skin were purchased from small scale poultry processing plants in Cairo and Giza markets, and transported to the laboratory in an ice-box. Skin samples from neck and breast were used for microbiological investigation According to (Kotula and Davis, 1999), while whole skin was used for chemical analysis. Each sample was divided into two portions; the first was used as raw samples while the other part was cooked in boiling water bath for 30 min. as cooked sample, according to (Emara and Nouman, 2002).

Microbiological examination. Ten grams from each sample were homogenized with 90 ml Ringer's solution for one minute to provide a dilution of 10^{-1}. Ten fold decimal dilutions up to 10^{-8} were performed from the original dilution. Decimal dilutions of raw and cooked samples were examined for Total colony count (ISO 1991), Psychrotrophic count (APHA 1992), *Staphylo-coccus aureus* count (ISO 1995), Coli-form counts (MPN*)* (ISO 1994 and De Man 1983), presumptive *E. coli* count (MPN) (ISO 1994 and De Man 1983) and total yeast and mould count (APHA, 1992). As well as isolation and identification of Salmonella (ISO, 1993 and Kauff-mann, 1974) and thermotolerant Campylo-bacter (ISO 1994).

Chemical analysis.

Fat content. It was determined according to (AOAC, 1990) by using Soxhlet method. While the fatty acids profile was performed by fat extracted according to (Folch *et al.,* 1957) and the methylester of fatty acids was prepared according to the method recommended by (Vogel, 1975). Analysis was performed in triplicate and reported on dry weight basis.

Table (1): Microbial load $\log_{10}$ cfu/g of raw and cooked broiler's skin samples.

Bacterial Groups	Raw				Cooked			
	Max.	Min.	Mean	±SE	Max.	Min.	Mean	±SE
TCC	9.47	6.0	7.6	0.18	3.3	$<10^2$	0.91	0.27
Psych C*	7.0	4.32	5.68	0.16	2.89	$<10^2$	0.74	0.21
***S. aureus* C**	6.32	3.43	5.12	0.14	2.68	$<10^2$	0.56	0.19
Coliform C	4.2	1.9	3.6	0.30	1.4	<3	1.1	0.13
Presumptive *E. coli* C	2.7	<3	2.3	0.39	<3	<3	<3	----
Total Yeast and Mould C	10.56	3.95	6.85	0.37	3.36	1.48	2.44	0.12

*C = count.

Table (2): Potential food poisoning bacteria in raw and cooked broiler's skin samples.

Isolated microorganism	Raw		Cooked	
	No. of positive	%	No. of positive	%
***S. aureus* (Coagulase +ve)**	20	66.7	7	23.3
Presumptive *E. coli*	16	53.3	-	-
Campylobacter (*C. jejuni*)	17	56.6	-	-
Salmonella spp	6	20	-	-

N= 30

Table (3): Serotypes of isolated salmonella strain.

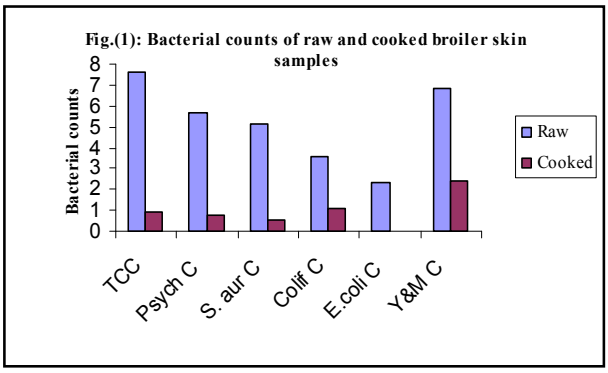
Serotype	No.	%
S. enteritidis O:1	2	6.66
S. london O: 3	2	6.66
S. typhimurium O: 4	1	3.33
S .kentucky O: 8	1	3.33

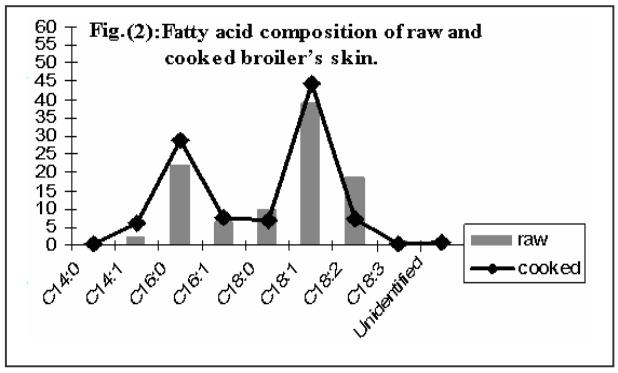
N= 30

Table (4): Fatty acid Profile and fat content of raw and cooked broiler's skin.

Fatty acid	Fatty acid % of total Fatty Acids	
	Raw	Cooked
Capric acid C10:0	0.036	0.15
Lauric acid C 12:0	0.047	0.28
Myristic acid C 14:0	0.54	0.53
Myristoleic acid C 14:1	2.46	5.9
Palmitic acid C 16:0	22.09	28.84
Palmitoleic acid C 16:1	6.61	7.59
Stearic acid C 18:0	9.722	6.84
Oleic acid C 18:1	39.30	44.59
Linoleic acid C 18:2	18.75	7.25
Linolenic acid C 18:3	1.02	0.27
Unidentified	0.37	0.79
***SUM SAT**	33.087	37.61
SUM MONO	48.37	58.08
SUM PUFA	19.77	7.52
Ratio UNSAT/SAT	2.05	1.74
FSat content	36.6/100g	19.3/100g

*SUM= summation





Results and Discussion

The different bacterial counts data were converted to $\log_{10}$ cfu/g of skin before estimation of maximum, minimum, mean and standard error. The data present in Table (1) and Fig. (1) showed that mean count of Total colony count (TCC), Psychrotrophic bacteria (Psych.), *Staphylococcus aureus* (*S. aureus*), Coliform (MPN), presumptive *E. coli* (MPN) and Total yeast and mould were 7.6 ± 0.18, 5.68 ± 0.16, 5.12 ± 0.14, 3.6 ± 0.3, 2.3 ± 0.39 and 6.85 ± 0.37 log10 cfu/g for raw samples respectively. Generally, yeast and mould contents are neglected in quality investigation of poultry and poultry products, although their count of examined skin samples were high and couldn't be eliminated by heat treatment, which may constitute an unavoidable source of contamination to meat and poultry products. Bryan (1990) stated that yeast and mould have been isolated from air, soil of poultry brooding houses, wet feed and bird droppings, in addition yeasts and moulds have been isolated from feathers, feed and bodies of the birds during the time of slaughter.

The given results proved that chicken skin is a major source of carcass contamination. Similar results were recorded by (Berrang *et al.,* 2001; Chantarapanont *et al.,* 2003); Goksoy *et al.,* 2004 and Ali and Ouf, 2005). While lower results were recorded by (Buhr *et al.,* 2000). It could be referred to the bad sanitary condition and unhygienic practices in the small poultry processing plants from which examined samples were purchased. Moreover, differences in samples collection, size, technique used and culture methods may account for the variability of results between studies.

The present situation may reflect an important problem where these plants are the main supply of poultry and poultry skin to meat products processing factories and fast food establishments which may constitute a public health hazard.

Cooking of the skin samples in boiling water bath for thirty minutes reduced the bacterial recovery of TCC, Psych C, *S. aureus* C, Coliform C, presumptive *E. coli* C and total yeast and mould C by 6.69, 4.94, 4.56, 2.5, 2.3 and 2.44 log10 cfu/g respectively. Nearly similar results were recorded by Emara and Nouman (2002). The same authors found that an increase in TCC by 2-4 log10 cfu/g and higher incidence of Salmonella when raw avian skin is added to luncheon and beef burger formulation. Also addition of cooked skin lead to an increase in TCC, but Salmonella could not be detected.

The prevalence of Coliform, faecal Coliform and presumptive *E. coli* was 100, 100 and 53.3% from examined samples respectively. These results in harmony with that obtained by Buhr *et al.* (2003). In this respect Dickens and Whitetemore (1997) found that artificial contamination of picken fingers with *E. coli* on one chicken lead to contamination of the following 50th poultry during picking. Meanwhile Kotulu and Pandya (1995) and Buhr *et al.* (2000) reported that broiler carcasses with feaces soiled feather and skin had high levels of Coliform, and *E. coli* than carcasses wit clear feather prior to scalding and picking.

Salmonella was isolated from raw samples at rate of 20% of examined samples was positive as shown in (Table 2). The biochemical and serological identification of isolated strain (table 3) revealed that 6.66% was *Salmonella enteritidis* O: 1, 6.66% was *Salmonella london* O: 3, 3.33% *Salmonella typhimurium* O: 4, and 3.33% was *Salmonella kentucky* O: 8. Similar result obtained by (Waldroup, 1996; Jeffrey *et al.,* 2001 and

Jorgensen *et al.,* 2002). Higher results were recorded by Yang *et al.* (2001).

The incidence of thermotolerant Campylobacter and *C. jejuni* in examined broiler skin was 73.3% and 56.6% respectively. The high prevalence of Campylobacter species in broiler skin samples found in this study agreed with data reported by (Kotula and Pandya 1995; Brendtson *et al.,* 1996; Waldroup, 1996; Achen *et al.*, 1998; Kramer *et al.,* 2000; Harrison *et al.*, 2001; Jeffrey *et al.*, 2001 and Abd-El Wahab, 2005). In this regard Stern and Robach (2003) suggested that Campylobacter levels found on the broiler carcasses might represent an important source of consumer exposure and potential risk for infection.

High level of enteric bacteria detected in broiler skin may be derived from the cloaca during picking or due to rupture of the intestinal tract during evisceration and contaminates the carcass (Berrang and Dickens 2000). On the other hand Murphy *et al.* (2001) proved that Salmonella survive longer in the chicken patties cooked under low humidity condition than high humidity, moreover, prolonged storage time and temperature increased incidence of Salmonella in cooked chicken patties.

Unexpectedly, *S. aureus* was isolated from steamed skin samples with incidence of 23.3%. Whereas, no *E. coli,* Campylobacter and Salmonellae could be detected in cooked skin samples, as recorded by Emara and Nouman (2002).

The results obtained in (Table 4) showed high fat content 36.6 and 19.3% in raw and cooked broiler skin samples respectively. Similar results were recorded by Paul and Southgate (1978), Bonifer and Froning (1996), British poultry council (2001) and Cliché *et al*. (2003). It is noteworthy mentioned that heat treatment of skin samples reduced their fat content by about 50%. Fatty acids (FA) composition of examined raw and cooked broiler skin samples are illustrated in (Table 4) and Fig (2). The present data revealed that total monounsaturated fatty acids (MUFA) constituted the highest percentage (48.37 & 58.08%) of total FA, followed by total saturated fatty acids (SFA) 33.087 and 37.61% for raw and cooked samples respectively. Polyunsaturated fatty acids (PUFA) showed the lowest percentage (19.77 & 7.52%) of total FA, these decreases in PUFA content in cooked samples appeared to be mainly due to change in linoleic acid. Major FA in broiler skin are Oleic acid C 18:1, Palmitic acid C 16:0, Linoleic acid C 18:2, Stearic acid C 18:0, Palmitoleic acid C 16:1. While Palmitic acid, Oleic acid and Linoleic acid were the dominating FA in the examined samples. The obtained results are in harmony with that recorded by Myers and Harris (1975) and Souza *et al.* (1999).

Conclusion and recommendations

It could be concluded that fat content of broiler skin is reduces to about 50% after cooking and is less saturated than that found in red meat. It supplies better proportion of monosaturated fatty acids and poylsaturated fatty acids which helps to reduce blood cholesterol level and also help the maintenance of healthy heart. Poultry skin contains most fatty tissues on poultry carcass. However, broiler's skin is considered as a major source of contamination with pathogenic as well as nonpathogenic bacteria. Cooking by ordinary methods could reduce but not eliminate all bacterial contamination. Hormonal and other residues may also be present. So use of skin as fat source in meat products may consider as bacterial and chemical risk factors especially in meat products don't processed at high temperature and during bad storage conditions. Recently poultry skin produced in recent days may be used in other industries, such as fat extraction and collagen extraction with advantages of low antigenicity to avian collagen.

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