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# Impact of packaging method on microbial flora and biogenic amines in chicken meat

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**Abstract**

Shelf life of chicken meat depends on the quality of chicken carcasses and method of packaging. Therefore, chicken fillet samples were obtained from a local poultry slaughterhouse in Benha and Damanhur province and packaged either under vacuum or non-vacuum packaging to determine the effects of packaging methods on pH values, microbial status and biogenic amines formation in packaged chicken fillet samples during storage at 4°C for 0, 3, 6, 9, 12 and 15 days. The obtained results revealed that pH value of chicken fillet samples increased steadily along different storage periods in both types of packaging. Regarding effect of packaging method on microbial status; total viable counts, Pseudomonads and Enterobacteriaceae counts in chicken fillet samples, the mean values were higher in non-vacuum packaged samples relative to the vacuum packaged samples, while lactic acid bacteria was higher, in vacuum packaged chicken samples during different storage periods at 4$^{o}$C, than non-vacuum packaged samples. Concerning, biogenic amine production during packaging, mean values of different biogenic amines (histamine, tyramine, cadaverine and putrescine) gradually increase in vacuum and non-vacuum packaged chicken samples throughout the entire storage period of chicken at 4$^{o}$C. While, spermine and spermidine decreased steadily in chicken fillet samples packaged under vacuum and non-vacuum packaging. Putrescine and cadaverine were the main biogenic amines produced during entire storage period. In conclusion, vacuum packaging methods had a significant effect on microbial flora and biogenic amines produced in chicken fillet samples and then increase the shelf life.

***Key words:*** *Packaging method, microbial flora, Biogenic amines, chicken meat, HPLC*

## Introduction

Chicken meat is one of the most desirable meats because of its low cost and good nutritional quality resulting from high-quality protein, low total fat and saturated fatty acids, and relatively high-unsaturated fatty acids contents (**Patsias *et al.*, 2006**).

Poultry meat is characterized by a higher content of unsaturated fatty acids (UFA) that are especially susceptible to oxidation processes, as well as by the presence of specific microorganisms which may freely proliferate under typical cold-storage conditions (4°C) (**Kozačinski *et al.*, 2012**). For this reason, a growing interest is observed among poultry meat producers in methods preserve freshness of products of animal origin **(Chiavaro *et al.*, 2008).**

The main commonly applied methods include the use of packages extending the shelf life of meat, like MAP (packaging in modified atmosphere) and VP (vacuum packaging), as well as preservation through freezing. Contemporary consumers seek food products with the minimum of processing, the most attractive however seems to be the modern methods of packaging, including MAP and VP **(Paramithiotis *et***

***al.,* 2009).** The main advantages of prolonging the freshness of meat products by these methods include; reduced proliferation of aerobes and increased oxidative stability of meat as a result of oxygen elimination (**Arvanitoyannis & Stratakos, 2012**).

Packaging of poultry meat and meat based products has always been challenging because of their perishable nature due to high sensitivity of spoilage and pathogenic organisms **(Fontes *et al.,* 2011).** In order to obtain products with high conservation durability and to increase the refrigeration effect, it is necessary to have as less initial microbial load as possible **(Tofan, 2005).**

Vacuum packaging is accomplished by evacuating all the air within a package and not replacing with another gas, then sealing that package **(Davies, 1995).** Vacuum packages for fresh meat increase the shelf life and thus improve the distribution efficiency and marketing of the product. Deterioration problems are minimized when the pH of the meat to be packaged is controlled and ideal storage temperatures are accurately maintained. Even at suitable refrigeration temperatures, however, meat may be subject to deterioration by microorganisms that are able to grow under these conditions in the absence of oxygen (**Maria *et al.,* 2010**).

The level of total bacterial and Enterobacteriaceae count in poultry meat can be routinely used as indicators of improper hygiene during processing and incorrect storage conditions, which can lead to proliferation of pathogens and toxin production **(Zweifel *et al.,* 2005).**

Although lactic acid bacteria (LAB) populations in the original product are usually below the detection limit (< 10 CFU/g), they increase during storage to $10^8$ CFU /g and cause spoilage (**Hamasaki *et al.,* 2003**). Lactic acid bacteria ferment glucose and other substrates that are present in meat. When these substrates are depleted, growth stops, typically when the population reaches 8 log/cm$^2$. The metabolic residues of most lactic acid bacteria are not eliminated, however, and can be identified as slightly acidic or milky tastes **(Holley and Gill, 2005**).

The formation of biogenic amines (BAs) is primarily a consequence of the decarboxylation of specific amino acids due to microbial enzyme activity (**Hernandez-Jover *et al.,* 1997).** The biogenic amines, histamine, putrescine, tyramine, tryptamine, β-phenylethylamine, and cadaverine, may be formed during storage or even during processing of meat products. The estimation of biogenic amines is important not only because of their toxicity but also because of their use as spoilage indicators **(Paleologos *et al.,* 2004).** The ingestion of high levels of tyramine and histamine may cause migraine headaches and food histamine poisoning, respectively (**Lehane and Olley, 2000**). Histamine poisoning is a chemical intoxication of short incubation period (30 minutes to 1hour). It is often manifested by a wide variety of symptoms as urticaria, edema, localized inflammation and rash (**Jean *et al.,* 2001**).

The concentration of some BAs (tyramine, putrescine and cadaverine) normally increase during the processing and storage of meat and meat products, whereas other (spermine and spermidine) decrease or remain constant **(Ruiz-Capillas, and Moral, 2001).**

The biogenic amines: putrescin, cadaverine, histamine, tyramine, tryptamine, β-phenylethylamine can be formed when storing the chicken meat due to microbial action. The biogenic amine determination is important not only because of their toxicity but also due to their potential use as freshness indicators **(Balamatsia *et al.,* 2006).**

Consequently, the determination of biogenic amines and free amino acid fractions can provide useful information for the industry regarding freshness or spoilage and sanitary quality of fresh muscle that could be consumed directly or used as raw material for meat products preparation. High concentrations of certain amines in food may be interpreted as a consequence of poor quality of the raw materials used, contamination, or inappropriate conditions during food processing and storage **(Triki *et al.,* 2018).**

Susceptibility of chicken meat to microbial

spoilage is an economic burden, which in some cases may also present a health hazard, since poultry meat may harbor pathogenic microorganisms. Consequently, developing methods to increase shelf life and overall safety/quality represents a major challenge for the poultry-processing industry. Therefore, the aim of this study was to evaluate the effect of either vacuum or non-vacuum packaging on pH values, microbial status and biogenic amines formation during storage at 4°C for different periods.

## Materials and Methods

### Samples collection:

The chicken fillet samples were obtained from a local poultry slaughterhouse in Benha and Damanhur province, wrapped in sterile polyethylene bags and transported to the laboratory under temperature-controlled conditions in isolated boxes with cooling packs. In the laboratory, the chicken fillet samples were divided into two groups using a sterile scalpel.

### Sample packaging

Non-vacuum-packaging: 30 chicken fillet samples were placed in Polyethylene (PE) bags. Their wrapping was careful, but purposely not airtight, simulating normal conditions in households, preventing samples mainly from desiccation.

Vacuum packaging: 30 chicken fillet samples were wrapped in Polyethylene (PE) foil (thickness 90 ml) and sealed under vacuum, level 8 (98%). This process was realized on a professional wrapping machine, Turbovac 700-ST-FLL (Leybold Vakuum GmbH, K€oln, Germany).

The samples were analyzed in the first day when received, then after storage for 3, 6, 9, 12 and 15 days at a temperature of 4°C.

### Measurement of pH according to ISO (1999):

The pH was measured by blending 10 g sample with 90 mL deionized water for 2 min. The pH of the obtained suspension was measured with a digital pH meter.

### Bacteriological Examination according to APHA (1992).

Chicken fillet samples were firstly cauterized by using hot spatula (surface sterilization) then the cauterized parts were removed by using sterilized scalpel and forceps, then under complete aseptic conditions 25 grams of each sample were weighted and transferred into a sterile homogenizer flask containing 225 ml of sterile peptone water 0.1%. and homogenized at 2000 r.p.m for 1-2 minutes then tenth fold serial dilutions were prepared. Total aerobic viable count (TVC), Pseudomonads, Enterobacteriaceae and Lactic acid bacteria were enumerated.

Total viable count was determined according to **AOAC (1990)** section 966.23(C). The plates were incubated at 35±1°C for 48h.

Pseudomonads were determined according to **Mead and Adams (1977)**, pseudomonas were enumerated on pseudomonas agar base supplemented with cetrimide, fucidin, and cephaloridine. Incubate spread plates, at 20°C for 48 hours..

Enterobacteriaceae were determined according to **ISO (2004)** by using Violet Red Bile Glucose Agar (VRBGA; Merck, Darmstadt), incubated at 37°C for 24h. The large colonies with purple halos were counted.

Lactic acid bacteria were determined by using Man Rogosa Sharpe Agar (MRS Agar (Merck, Darmstadt), incubated at 30°C for 3 days **(ISO, 1998).**

### Measurement of biogenic amines (BAs) content according to Moret and Conte (1996):

The estimation of biogenic amines as histamine, tyramine, cadaverine, putrescine, spermine and spermidine was recorded using HPLC.

**Statistical Analysis:**
Triplicate samples ($n$ = 3) were analyzed for each property. The results were expressed in terms of mean and stander deviation (SD) of mean. The means were compared by One Way ANOVA followed by Duncan's Multiple Range Test **(Duncan, 1955)** using SPSS software version 17.0. Differences between means were determined by the least significant difference test, and significance was defined at $P<0.05$.

## Results

**Table (1).** Mean values of pH for fresh chicken fillet during along storage periods at 4°C in case of non-vacuum and vacuum packaging.

| Sample packaging | Storage time (days) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 15 |
| Non-vacuum-packaging | 6.07 | 6.18 | 6.41 | 6.52 | 6.81 | 7.33 |
| Vacuum-packaging | 6.03 | 6.12 | 6.20 | 6.26 | 6.31 | 6.34 |

**Table (2).** Log means of microbial flora of fresh chicken fillet along storage periods at 4°C in case of non-vacuum packaging samples

| Microbial Flora Count (CFU/g) | Storage time (days) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 15 |
| Total viable counts | 3.2±0.2 | 4.1±0.5 | 4.6±0.3 | 5.4±0.2 | 6.5±0.3 | 7.6±0.5 |
| Pseudomonads | 2.6±0.3 | 3.3±0.3 | 3.9±0.5 | 4.4±0.5 | 5.7±0.1 | 6.3±0.2 |
| Enterobacteriaceae | 2.2±0.1 | 2.8±0.2 | 3.6±0.6 | 5.3±0.3 | 5.4±0.5 | 5.5±0.3 |
| Lactic acid bacteria | 1.2±0.3 | 1.5±0.0 | 1.4±0.3 | 1.7±0.5 | 2.0±0.7 | 2.4±0.5 |

**Table (3).** Log means of microbial flora of fresh chicken fillet along storage periods at 4°C in case of vacuum packaging samples

| Microbial Flora Count (CFU/g) | Storage time (days) | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 15 |
| Total viable counts | 2.7±0.2 | 3.5±0.4 | 3.8±0.5 | 4.6±0.5 | 4.8±0.4 | 5.1±0.5 |
| Pseudomonads | 2.2±0.3 | 2.5±0.2 | 2.8±0.3 | 3.4±0.4 | 3.7±0.5 | 4.2±0.7 |
| Enterobacteriaceae | 2.0±0.1 | 2.1±0.2 | 2.5±0.2 | 3.2±0.6 | 3.6±0.8 | 4.0±0.3 |
| Lactic acid bacteria | 1.6±0.3 | 2.0±0.6 | 2.7±0.3 | 4.1±0.7 | 4.3±0.3 | 4.6±0.2 |

**Table (4).** Mean values of different biogenic amines (mg/kg) levels of fresh chicken fillet along storage periods at 4°C in case of non-vacuum packaging

| BAs | Storage time (days) | | | | | |
|---|---|---|---|---|---|---|
| | **0** | **3** | **6** | **9** | **12** | **15** |
| **Histamine** | nd$^{c}$ | nd$^{c}$ | nd$^{c}$ | 6.8±2.38$^{b}$ | 8.3±1.14$^{b}$ | 9.4±2.63$^{b}$ |
| **Tyramine** | 1.2±2.21$^{c}$ | 4.6±1.72$^{b}$ | 5.4±1.61$^{b}$ | 5.8±0.49$^{b}$ | 12.7±0.9$^{a}$ | 18.9±0.7$^{a}$ |
| **Cadaverine** | 18.2±0.7$^{c}$ | 23.6±1.4$^{c}$ | 42.8±2.1$^{c}$ | 98.4±4.3$^{c}$ | 145.6±5.5$^{b}$ | 232.6±8.3$^{a}$ |
| **Putrescine** | 48.2±3.2$^{c}$ | 64.2±3.8$^{c}$ | 198.2±4.2$^{b}$ | 246±6.8$^{b}$ | 268±8.2$^{a}$ | 324±12.7$^{a}$ |
| **Spermine** | 56.6±2.8$^{a}$ | 44.4±1.9$^{b}$ | 38.5±1.6$^{c}$ | 37.7±1.4$^{c}$ | 37.2±2.6$^{c}$ | 36.6±1.3$^{c}$ |
| **Spermidine** | 7.9±0.40$^{a}$ | 6.8±0.90$^{b}$ | 6.68±2.38$^{b}$ | 6.4±0.31$^{ab}$ | 6..01±1.10$^{c}$ | 5.8±0.34$^{c}$ |

nd = Not detected.
Mean ± standard deviation within the same row with the same superscript were not significantly different; $p<0.05$).

**Table (5).** Mean values of different biogenic amines (mg/kg) levels of fresh chicken fillet along storage periods at 4°C in case of vacuum packaging

| BAs | Storage time (days) | | | | | |
|---|---|---|---|---|---|---|
| | **0** | **3** | **6** | **9** | **12** | **15** |
| **Histamine** | nd$^{c}$ | nd$^{c}$ | nd$^{c}$ | 4.8±0.64$^{b}$ | 5.6±0.74$^{b}$ | 8.2±1.2$^{a}$ |
| **Tyramine** | 0.4±0.01$^{c}$ | 0.5±0.02$^{c}$ | 2.3±0.14$^{b}$ | 2.5±0.14$^{b}$ | 2.9±0.16$^{b}$ | 4.8±0.30$^{a}$ |
| **Cadaverine** | 8.9±0.3$^{c}$ | 23.4±0.5$^{c}$ | 30.6±1.7$^{b}$ | 63.9±3.4$^{b}$ | 94.9±4.8$^{a}$ | 164.3±5.4$^{a}$ |
| **Putrescine** | 46.2±2.4 | 54.2±3.2 | 65.2±3.6 | 142.±6.8 | 169±8.4 | 198±9.7 |
| **Spermine** | 68.9±3.89$^{c}$ | 64.7±1.42$^{b}$ | 62.3±1.2$^{bc}$ | 55.4±4.0$^{c}$ | 44.93±3.74$^{c}$ | 39.8±4.2$^{d}$ |
| **Spermidine** | 7.8±0.2$^{a}$ | 7.5±0.3$^{a}$ | 6.8±0.6$^{a}$ | 5.2±0.5$^{b}$ | 5.0±0.3$^{b}$ | 4.2±0.4$^{c}$ |

nd = Not detected.
Mean ± standard deviation within the same row with the same superscript were not significantly different; $p<0.05$).

**Discussion**

The obtained results in **Table (1)** revealed that the pH value of chicken fillet increase steadily along storage periods in both types of packaging as follow; in case of non-vacuum package pH values increase from 6.07 at first day of storage till reach 7.33 at the 15$^{th}$ day of storage while in case of vacuum packaging pH values increase from 6.03 at first day of storage till reach 6.34 at the 15$^{th}$ day of storage. Increase in pH values of vacuum and non-vacuum package fresh chicken meat during refrigerated storage may be due to the microbial proliferation. In addition, **Hertanto *et al.,* (2017)** reported that chicken meat has pH value of 6.26 - 6.30 that meet the normal pH of chicken meat.

The data presented in **Tables (2 and 3)** show the changes in microbial flora (TVC, Pseudomonads, Enterobacteriaceae and Lactic acid bacteria) of fresh chicken fillet non-vacuum-packaging and vacuum packaging samples stored at 4°C. TVC which were in general higher *($p<0.05$)* for non-vacuum-packaging chicken fillet samples compared to vacuum packaging samples.

Initial (day 0) TVC of non-vacuum packaging and vacuum packaging stored chicken fillet samples were 3.2±0.2 and 2.7±0.2 $\log_{10}$CFU/g, respectively, suggesting overall good quality of chicken samples. Final TVC (day 15$^{th}$) were 7.6±0.5 and 5.1±0.5 $\log_{10}$CFU/g for non-vacuum -packaging and vacuum packaging stored chicken samples, respectively. **EOS (2005)** mentioned that when the aerobic plate count reaches $10^5$ CFU/g or mL in a chilled chicken, it is assumed to be at, or near spoilage, so the examined non-vacuum packaging chicken fillet samples were accepted till day 6 and the vacuum packaged samples accepted till day 12 of storage at 4ºC. Nearly similar results were obtained by **Mathew *et al.,* (2016)**, who reported that the vacuum packed chicken stored at 4˚C has shelf life of 15 days.

Pseudomonads counts at (day 0) of non-vacuum-packaging and vacuum packaging stored chicken fillet samples 2.6±0.3 and 2.2±0.3 $\log_{10}$CFU/g, respectively. Interestingly, final Pseudomonads counts (day 15$^{th}$) were 6.3±0.2 and 4.2±0.7 $\log_{10}$CFU/g for non-vacuum -packaging and vacuum packaging stored chicken samples, respectively. Those results agree with statements of **Petrová *et al.* (2013),** who reported that vacuum packaging, inhibited the growth of Pseudomonads, as compared to air packaging. It is believed that vacuum packaging extends the lag phase of aerobic microbial growth and decreases growth rate during the logarithmic phase **(Farber, 1991)**.

Enterobacteriaceae counts at (day 0) were low 2.2±0.1 and 2.0±0.1 $\log_{10}$ CFU/g in non-vacuum-packaging and vacuum packaging chicken fillet samples, respectively, thus suggesting good hygienic conditions applied during poultry processing. Nearly similar results were reported by **Cegielska-radziejewska, *et al.* (2008)** who found that the initial Enterobacteriaceae counts for examined chicken samples were 2.3 $\log_{10}$ CFU/g. On the other hand, higher counts were reported by **Ibrahim *et al.,* (2014)** who showed that the mean value of Enterobacteriaceae counts in examined samples of chicken fillet were 5.1 $\log_{10}$ CFU/g. Also, **Rindhe *et al.,* (2008)** found that the Enterobacteriaceae counts for examined chicken samples were 5.3 $\log_{10}$ CFU/g and these results were above the limit specified by the British Standard Institute **(BSI, 1993)**. The BSI specified that Enterobacteriaceae count greater than $10^4$ cfu/g is considered unsatisfactory.

Enterobacteriaceae counts were always higher in non-vacuum packaging stored chicken samples as compared to vacuum packaging samples during storage period. At the 6$^{th}$ day of storage; Enterobacteriaceae counts were 3.6±0.6 and 2.5±0.2 $\log_{10}$CFU/g for non-vacuum -packaging and vacuum packaging stored chicken samples, respectively. At the end of storage period (day 15$^{th}$), Enterobacteriaceae counts were 5.5±0.3 and 4.0±0.3 $\log_{10}$CFU/g for non-vacuum-packaging and vacuum packaging stored chicken fillet samples, respectively. According to British Standard Institute **(BSI, 1993),** the examined non-vacuum packaging chicken fillet samples were accepted till day 6 and the vacuum

packaged samples accepted till day 12 of storage at 4ºC. Evisceration is a step that, if carried out badly, can cause a significant increase in the microbial levels on carcasses **(Mead, 2004).**

Initially, lactic acid bacteria (LAB) were at low numbers in non-vacuum-packaging and vacuum packaging stored chicken samples (1.2±0.3 and 1.6±0.3 $\log_{10}$ CFU/g), respectively. Counts of LAB in vacuum packaging stored chicken samples were comparable to those stored in non-vacuum-packaging throughout the storage period and reached to 2.4±0.5 and 4.60.2 $\log_{10}$ CFU/g on day 15 of storage in non-vacuum-packaging and vacuum packaging stored chicken samples, respectively. In this respect **Davies (1995)**, reported that in the case of chicken meat stored in air at refrigeration temperatures, Pseudomonads and Enterobacteriaceae become the dominant spoilage bacteria while under vacuum LAB contribute significantly to the meat microflora.

In general, the biogenic amines content increased earlier and more rapidly in chicken meat due to the presence of shorter muscular fibers in chicken, consequently, the presence of proteins with shorter chains, facilitating attack by proteolytic enzymes and increasing quantities of amino acid precursors for the biosynthesis of biogenic amines **(Vinci and Antonelli, 2002).**

Illustrated data in **Table (4 and 5)** showed that mean values of different biogenic amines (histamine, tyramine, cadaverine and putrescine) in case of vacuum and non-vacuum packaging gradually increase along different storage periods at 4ºC till reach the highest level at 15th day of storage. While, (spermine and spermidine) biogenic amines gradually decrease alone different storage periods at 4ºC until reach the lowest level at the 15th day of storage. The biogenic amines are formed during storage of chicken meat due to microorganism activity. The decrease in time of spermidine and spermine is due to their use as nitrogen sources by microorganisms **(Balamatsia *et al.*, 2006)**.

Histamine cannot be detected in day 0, 3 and 6 of storage period and begin to be detected in 9th day of storage at a value of 6.8±2.38 and 4.8±0.64 mg/kg and increase gradually till reach 9.4±2.63 and 8.2±1.2 mg/kg at the 15th day of storage in case of non-vacuum and vacuum packaging chicken fillet samples, respectively. The present results were agree with the results obtained by **Baston and Barna (2010),** who reported that histamine had a small initial content, in the seventh day being at a value of 4 mg/kg, also due to microbial activity. **Silva and Glória (2002)** also reported that histamine cannot detected in day 0, 4 and 10 of storage of chicken breast at 4ºC and being detected in day 15 of storage at value of 10.3±4.5 mg/kg.

They also added that level of tyramine increase gradually from 1.2±2.21 and 0.4±0.01 mg/kg at the day 0 until reach to 18.9±0.7 and 4.8±0.30 mg/kg at day 15th of storage in case of non-vacuum and vacuum packaging of chicken breast, respectively **(Table 4&5)**. This increase might be due to decarboxylation action of microbial enzymes. Our tyramine values are in the same range as those (<33 mg/kg) reported for chicken-based meat products and for fresh chicken (18 mg/kg) for non vacuum packaging after 15 days of refrigerated storage **Vinci and Antonelli (2002).** Level of tyramine was higher in case of non-vacuum packaging than level of vacuum packaging chicken fillet. There is a significant difference between tyramine level at day 0 and day 15 of storage in case of both type of packaging.

The aforementioned results are nearly agree with results obtained by **Apostolos *et al.* (2006),** who reported that tyramine was formed in both chicken samples stored either aerobically and under modified atmosphere packaging and levels progressively increased from initial (day 0) concentrations of 0.3±0.01 and 0.1±0.01 mg/kg, reaching final values of 18.8±0.7 and 8.8±2.1 mg/kg, respectively (day 23 of storage).

Tyramine and histamine are normally present in human food, particularly in fermented products (**Holzapfel and Bover-Cid, 2005).** These amines (being vasoactive) are known to induce various adverse effects to individuals, and react with diamine oxidase (DAO) and monoamine oxidase inhibitor (MAOi) drugs resulting in

hypertension and hypotension crisis **(Halász and Barath, 2002).**

Several studies have shown that Pseudomonads are responsible for the decarboxylation of the amino acids lysine and ornithine leading to formation of putrescine and cadaverine, respectively **(Okuzumi *et al.* 1990).**

Cadaverine progressively increase from 18.2±0.7 and 8.9±0.3 mg/kg at the day 0 until reach to 232.6±8.3 and 164.3±5.4 mg/kg at day 15$^{th}$ of storage in case of non-vacuum and vacuum packaging of chicken fillet, respectively **(Table 4 & 5)**. The increase of cadaverine content in chicken fillet was due to microbial activity. This result agrees with that obtained by **Vinci and Antonelli (2002)** who mentioned that level of cadaverine was higher, in case of non-vacuum package, than level of vacuum packaging of chicken fillet. There is a significant difference between cadaverine level at day 0 and day 15 of storage in case of both type of packaging.

Many strains of Enterobacteriaceae produce appreciable amounts of cadaverine, while pseudomonas produce mainly putrescine. Based on this information and on the bacterial strains associated with poultry. putrescine, cadaverine, tyramine and histamine could be found in chicken meat (**Georgnaras *et al.*, 1995)**. It has been reported that the types and levels of biogenic amines formed will depend on the microflora count **(Halász *et al.* 1994; Veciana-Noguès *et al.* 1997)**.

Putrescine was the main biogenic amines formed during storage and had the highest content from all six biogenic amines in non-vacuum and vacuum packaging chicken samples. The initial (day 0) values were 48.2±3.2 and 46.2±2.4 mg/kg and attaining final values (day 15) of 324.6±12.7 and 198.0±9.7 mg/kg in non-vacuum and vacuum packaging chicken fillet samples, respectively. Level of putrescine was higher, in case of non-vacuum package, than level in case of vacuum packaging of chicken fillet. There is a significant difference between putrescine level at day 0 and day 15 of storage in case of both type of packaging. **Balamatsia *et al.*, (2006)** reported that the higher concentrations of putrescine and cadaverine in aerobically stored chicken meat may be attributed to higher numbers of Pseudomonas species.

The present results seem in the same direction with **Silva and Glória (2002)** who reported that putrescine was the main BA formed for fresh chicken breast and chicken-based meat products. In addition, **Vinci and Antonelli (2002)** reported the same finding for chicken meat stored at 4 ◦C.

It is clear that in the present study, the vacuum packaging conditions had a significant effect on putrescine and cadaverine production in chicken samples throughout the entire storage period. Cadaverine and putrescine could be indicators for onset of spoilage of poultry, especially since they were detected in the pre-spoilage stages from colony count $10^5$ cfu/cm$^2$ (**Schmitt and Schmidtlorenz, 1992).**

It is interesting to note that both spermine and spermidine production gradually decrease in both packaging condition (non-vacuum and vacuum packaging) until reach the lowest level at the day 15 of storage and there is a significant difference between concentration of both spermine and spermidine at day 0 and day 15 in both types of packaging. The decrease in spermine content may be attributed to the fact that this polyamine is taken as a source of nitrogen by microorganisms (**Baston and Barna, 2010)**.

Spermine and spermidine gradually decrease from (56.6±2.8 & 68.9±3.89) (7.9±0.40 &7.8±0.2) mg/kg at day 0 until reach (36.6±1.3 & 39.8±4.2) (5.8±0.34 & 4.2±0.4) mg/kg in the day 15 of storage in case of non-vacuum and vacuum packaging of chicken breast, respectively **(Table 4 & 5)**. It is clear that in the present study, spermine and spermidine decreased steadily throughout the entire storage period of chicken meat in case of non-vacuum and vacuum packaging, so these two amines cannot be used as indicators of fresh chicken meat quality. According to **Veciana-Nogues *et al.* (1997) and Bover-Cid *et al.* (1999)** it is expected to find spermine and spermidine in meat under physiological conditions as these amines play an important role in microbial growth

(**Bardocz, 1995**).

The present results agree with result obtained by **Balamatsia *et al.*, (2006)** who reported that spermine and spermidine gradually decrease from (53.3±2.4 & 7.9±0.4) at day 0 until reach (36.6±1.9 &4.8±0.2) mg/kg at day 17 in case of fresh chicken breast stored in air at 4°C while, in case of packaging under MAP; spermine and spermidine decrease from (56.6±2.6 & 13.2±0.6) at day 0 until reach (31.5±1.6 & 7.8±0.4) mg/kg at day 17, respectively. On the contrary, **Min *et al.*, (2007)** reported that spermine concentration increased from (38.8±4.01) at day 1 until reach (77.4±0.48) µg/g at day 9 during storage of chicken breast during storage at 4±2°C.

## Conclusion and Recommendation

It was concluded that vacuum packaging is used as preservation method to retards the microbial growth and preserve the quality of chicken meat. A high microbial total count is only one of the factors influencing the shelf life of vacuum packaged meat. Our determinations showed a difference of biogenic amines content between non-vacuum and vacuum packaged chicken samples; all detected biogenic amines (histamine, tyramine, cadaverine and putrescine) gradually increase in case of non-vacuum and vacuum package but level of cadaverine increase higher in case non-vacuum package. While, spermine and spermidine are natural amines in chicken fillet and both gradually decreases during storage of chicken meat at 4°C, so cannot be used as indicators of fresh chicken meat quality. Therefore, we recommended that application of hygienic handling of chicken meat from the moment of slaughter to the point of consumption to reduce the formation of biogenic amines as their formation was clearly correlated to its bacterial counts.

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