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Chemical studies on shelf life time of chilled chicken meat

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ABSTRACT

Different trails were applied to chicken meat to prolong their shelf life by adding spices such as clove, ginger, soy sauce and mixture of them and keep the sample at 4 degree C at the refrigerator and the samples were examined 2 days interval till it's decomposition. A total of 180 chicken samples divided into control samples and samples treated with spices were analyzed for determination of keeping quality tests as: pH, Thiobarbituric acid (TBA), total volatile base nitrogen (TVBN), and sensory evaluation (color, odor and taste) by score number provided by panelists. The results showed that the mean value of pH, TBA, TVBN in all the treated samples through all the storage period (1st, 3rd, 5th, 7th, 9th and 11th) were significantly ($P < 0.05$) lower than the control samples with best results in the mixture spiced samples in the keeping quality indices, and higher color, odor and taste scores in the treated samples than the control, which resulted in extension of the shelf life till 11 days in the treated samples, while in the mixture samples exceeds 11 days, however the control sample reaches 7 days only. These results concluded that spices are very important as a natural antioxidant against lipid oxidation in chicken samples. So, it needs more attention in the processing of chicken and meat products.

1. INTRODUCTION

Chicken meat is a good and popular food in the whole world and the consumption of it very increased over these past 30 to 40 years. As Chicken is a good source of animal protein of high biological value required for nutrition of all the ages: infants, young children, adults and convalescent (Cahe et al., 2002). The increase in pH value, moisture, and protein content, caused the chicken meat to be highly perishable and a good media for the growth of spoilage and pathogenic microorganisms (Kerry, et al. 2006).

The food quality deterioration and product rejection can be caused by the oxidative rancidity as it leads to the formation of bad flavor as well as some harmful compounds (Decker, et al., 2010). The development of rancid flavor leads directly to product quality losses, changes in color and texture and consequently leads to decrease the consumer approval of the product; besides the losses in the nutritive quality caused by the degradation of vitamins and essential fatty acids. Eventually, the health risks comes from lipid oxidation may be caused by the formation of some toxic compounds when oxidative degradation happens to fats and oil. These toxic compounds can lead to mutagenesis, carcinogenesis and damage in the living organisms some of these oxidation products are: malondialdehyde (MDA) and lipid peroxide.

Spices have been used in traditional medicine and to flare up the sensory values such as: flavor, color and aroma of food for thousands of years, therefore they considered as an important part of the human diet. Spices also have antioxidative (Shobana and Naidu, 2000), preservative (Neilsen and Rios, 2000), and antimicrobial roles.

Several studies discussed that the spices were famous for the antioxidative activity and the presence of the phenolic constituents (Konczak et al., 2010). The clove, ginger and soy sauce can be considered the most valuable spices which have strong antioxidative activity.

Spices have been used to preserve food by inhibiting microbial growth and lipid oxidation in raw chicken meat. Several studies discussed the spices role in inhibiting the lipid oxidation and the development of oxidative rancidity in food, as well as their important role in reducing the formation of toxic substances such as heterocyclic amines (HCAs) (Gibis, 2007; Smith, et al., 2008; Rounds, et al., 2012; Viegas, et al., 2012; Zeng et al., 2014).

The chemical, physical and microbiological examination always needed to study the deterioration occurring in food items during the storage time as they lose their quality by the extension of the storage period.

Several studies always discussed the microbial spoilage of chicken meat and its products; therefore, there is more interest to investigate the chemical changes and sensory attributes occurring in these food items during refrigeration. Consequently, chicken meat, as an important item in the diet, needed much more attention than it has received.

Nowadays, the problem we face due to the short shelf life of the chicken meat (about 4-5 days) has brought us to extend the shelf life of raw chicken meat by using good preservatives (Latou et al., 2014).

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The consumers always search for the food appearance by observing the changes happens in the food color, flavor, texture, taste and over all acceptability; which gives the product appeal and consequently determine the product sales.

So, the present study was planned out to study the chemical changes during chilling of chicken meat and how to prolong shelf life by adding spices; Furthermore, the effect of clove, ginger and soya sauce, alone or mixed, on raw chicken meat have not been studied yet. So, the present work objective was to determine the effect of clove, ginger and soy sauce, during refrigerator storage at 4°C of chicken meat on keeping quality parameters and sensory evaluation through estimating the following tests: Determining the pH values, Thiobarbituric acid (TBA) number, determining the total volatile basic nitrogen (TVBN) values and Sensory evaluation as Color, Odor, and Taste.

2. MATERIAL AND METHODS

2.1. Collection of the samples:

A total of 180 random chicken samples were collected from different supermarkets at Qalyubia governorate to evaluate their chemical profiles. Each carcass weighed about 2 Kg and transferred in an insulated ice box to the laboratory without delay.

2.2. Sample treatment with spices:

Samples were classified into five groups (control, clove, ginger, soy sauce and the mixture) each group other than control consists of 45 chickens, each chicken sample treated with one kind of spices which are clove, ginger, soy sauce and mixture of them. Then all chicken samples were cut to 4 quarters one quarter as a control sample and the other 3 quarters in the chicken treated by one kind of the studied spices (clove, ginger, soya sauce, and the mixture) one for each chicken then the samples subjected to chemical examination

2.3. Chemical analysis of spiced samples:

The treated samples with various spices were analyzed for keeping quality indices through determination of pH (Pearson, 1984), determination of total volatile nitrogen; TVBN (EOS, 2006) and determination of Thiobarbituric acid; TBA (EOS, 2006).

2.4. Sensory evaluation of spiced samples:

It was performed according to Szczesniak (1987). Briefly, Chicken meat samples (approximately 50 g) were examined by a panel of five judges experienced in chicken meat evaluation (laboratory-trained) to perform sensory analysis after cooking the samples in a microwave oven for 4 min at high power (700 W). Panelists evaluated the color, odor and taste of the cooked samples. The acceptability level was recorded using a five-point scale as follows: (5) very good; (4) good; (3) common; (2) poor and (1) very poor.

2.5. Statistical analysis

Data were analyzed using the descriptive statistic SPSS (Version 20). Differences in mean of analyzed data were considered significant at $P \leq 0.05$.

3. RESULTS

The results recorded in tables 1, 2, and 3 for the initial pH, TBA, and TVBN in the 1st day storage was 5.95, 5.87, 5.9, 5.79, and 5.82, for pH, 0.38, 0.34, 0.35, 0.36, and 0.3 for TBA, 11.88, 11.4, 11.5, 11.6, and 11.27 for TVBN in the tested groups (control, clove, ginger, soy sauce, and the mixture of the spices). The pH, TBA, and TVBN values increased through the days of storage to reach 6.54, 0.95, and 20.56 in the 7th day for the control sample and the spiced samples reaches 11th day of storage with best results in the mixture group with mean value of 6.32, 0.81, and 18.58.

Furthermore, tables 4, 5, and 6 the sensory evaluation: color, odor and taste mean values were obtained through the 1st, 3rd, 5th, 7th, 9th, and 11th day of chilled storage of chicken meat with/without spices, the score in all the groups were between very good (5) and good (4) in the spice treated samples till 7 day of the storage and continued to be nearly good (4) and common (3) in the 11 day of storage, while the control sample were good (4) and decreased to be poor (2) in the 7the day of storage.

Table 1 Chicken pH mean values through the 11th days of shelf life

Groups	The mean values of pH/days					
	1st	3rd	5th	7th	9th	11th
Control	5.95^{a}	6.13^{a}	6.31^{a}	6.54^{a}	6.54^{a}	6.54^{a}
Clove	5.87^{a}	5.98^{c}	6.11^{d}	6.16^{c}	6.24^{d}	6.48^{c}
Ginger	5.90^{a}	6.02^{bc}	6.15^{c}	6.18^{bc}	6.28^{c}	6.52^{b}
Soy Sauce	5.79^{a}	6.05^{b}	6.19^{b}	6.21^{b}	6.31^{b}	6.54^{a}
Mixture	5.82^{a}	5.91^{d}	6.01^{e}	6.08^{d}	6.18^{e}	6.32^{d}

All a, b, c, d refers to the significance difference between the groups.

Table 2 Chicken TBA mean values through the 11th days of shelf life

Groups	TBA mean values/days					
	1st	3rd	5th	7th	9th	11th
Control	0.38^{a}	0.53^{a}	0.72^{a}	0.95^{a}	0.95^{a}	0.95^{a}
Clove	0.34^{ab}	0.45^{b}	0.59^{c}	0.72^{d}	0.78^{d}	0.92^{c}
Ginger	0.35^{ab}	0.47^{b}	0.62^{b}	0.75^{c}	0.81^{c}	0.94^{b}
Soy Sauce	0.36^{a}	0.49^{ab}	0.65^{b}	0.78^{b}	0.83^{b}	0.96^{a}
Mixture	0.30^{b}	0.37^{c}	0.49^{d}	0.62^{e}	0.71^{e}	0.81^{d}

Table 3 Chicken TVBN mean values through the 11th days of shelf life

Groups	TVBN mean values/days					
	1st	3rd	5th	7th	9th	11th
Control	11.88^{a}	14.28^{a}	17.18^{a}	20.56^{a}	20.74^{a}	20.74^{a}
Clove	11.40^{ab}	12.87^{c}	14.31^{d}	16.85^{c}	18.24^{d}	20.27^{c}
Ginger	11.50^{ab}	13.17^{b}	14.64^{c}	17.09^{b}	18.67^{c}	20.59^{b}
Soy Sauce	11.60^{ab}	13.40^{b}	14.91^{b}	17.26^{b}	18.95^{b}	20.82^{a}
Mixture	11.27^{b}	12.24^{d}	13.80^{e}	16.04^{d}	17.62^{e}	18.58^{d}

Table 4 Chicken color mean values through the 11th days of shelf life

Groups	Color mean values/days					
	1st	3rd	5th	7th	9th	11th
Control	3.89^{a}	3.40^{a}	3.02^{a}	2.11^{a}	1.84^{a}	1.36^{a}
Clove	4.67^{c}	4.51^{c}	4.31^{c}	4.00^{c}	3.84^{c}	3.47^{b}
Ginger	4.11^{b}	4.20^{b}	4.11^{b}	3.84^{b}	3.64^{b}	3.51^{b}
Soy Sauce	4.13^{b}	4.04^{b}	4.02^{b}	3.73^{b}	3.80^{c}	3.53^{b}
Mixture	4.82^{c}	4.56^{c}	4.52^{d}	4.18^{d}	4.00^{d}	3.80^{c}

1.very poor; 2.poor; 3.common; 4.good and 5.very good

Table 5 Chicken odor mean values through the 11th days of shelf life

Groups	Odor mean values/days					
	1st	3rd	5th	7th	9th	11th
Control	4.24^{a}	3.84^{a}	3.16^{a}	2.11^{a}	1.87^{a}	1.33^{a}
Clove	4.87^{b}	4.53^{c}	4.20^{b}	4.00^{c}	3.82^{c}	3.29^{c}
Ginger	4.31^{a}	4.16^{b}	4.04^{b}	3.82^{b}	3.49^{b}	2.93^{b}
Soy Sauce	4.42^{a}	4.09^{b}	4.04^{b}	3.78^{b}	3.53^{b}	3.04^{bc}
Mixture	4.84^{b}	4.67^{c}	4.49^{c}	4.11^{c}	4.00^{d}	3.64^{d}

1.very poor; 2.poor; 3.common; 4.good and 5.very good

Table 6 Chicken taste mean values through the 11th days of shelf life

Groups	Taste mean values/days					
	1st	3rd	5th	7th	9th	11th
Control	4.07[a]	3.42[a]	2.93[a]	2.13[a]	1.82[a]	1.31[a]
Clove	4.82[e]	4.49[e]	4.27[c]	3.98[cd]	3.80[c]	3.27[cd]
Ginger	4.36[b]	4.16[b]	4.11[bc]	3.84[bc]	3.49[b]	3.07[bc]
Soy Sauce	4.38[b]	4.11[b]	4.07[b]	3.73[b]	3.36[b]	2.87[b]
Mixture	4.87[e]	4.62[e]	4.51[d]	4.11[d]	3.28[c]	3.44[d]

1.very poor; 2.poor; 3.common; 4.good and 5.very good

4. DISCUSSION

As illustrated in table (1) the initial mean pH value of control sample was found to be 5.95 which rises to 6.54 in the 7th day of storage and the all groups of spices reaches the 11th day of storage period.

The control samples results indicate the increase in pH values could be caused by the bacterial utilization of amino acids, which produced due to the protein break down after the depletion of the stored glucose and the accumulation of amino acid product degradation and ammonia (Gill, 1983).

The pH values estimated through 1st, 3rd, 5th, 7th, 9th, and 11th days of chilled storage ware found to be non-significant in the 1st day of storage to all groups but became more significant through the 11 days of storage by being lower in the spice treated samples than the control samples till the end of the storage. Treatment with the mixture of clove, ginger and soy sauce gives the best results, as the pH mean value was only 6.32 in the 11th day of storage compared to the control samples which gives 6.54 in the 7th day of storage. From table 1 the significant difference ($P < 0.05$) appeared in the clove, ginger and soy sauce group samples through the 11th day of storage as the pH mean values were 6.48, 6.52 and 6.54, respectively in the 11th day of storage. The natural spices: clove, ginger and soy sauce results in lowering pH results for chicken meat samples treated with it caused by the inhibitory effect of antimicrobial ingredients in these spices on the growth and proliferation of the spoilage microorganisms that metabolize basic nitrogen compounds. The pH mean values were nearly similar to El-Shehry-Eman (2012) and lower compared to Schmitt and Schmidt-Lorenz (1992) and higher when compared to the results of Zhang et al. (2016), as it reaches 15 day of storage without decomposition, and higher also when compared to Hala et al. (2011).

As illustrated in table (2) the effect of spices on TBA mean values of raw chicken meat samples at 4 degree of storage. In the 1st day of storage, the TBA mean value of the control sample was 0.38, and 0.34, 0.35, 0.36, in the spice treated samples (clove, ginger, and soy sauce), respectively, with the best result in the mixture samples 0.3. These results through all days of storage indicate that when compared to control samples the spices in study (clove, ginger, and soy sauce) results in lowering the TBA values. The control chicken samples increase in TBA mean values was fast and high when compared to all the spice treated samples through all the 11th days of storage period which remained slow and low. Therefore, the lipid oxidation in chicken samples always related to the storage time, which leads to increase in TBA mean values during their storage. The control TBA mean values were significantly higher than TBA mean values of all the spice treated samples on all days of storage. The significance difference ($P < 0.05$) between all the groups with best results in the mixture spices caused by the lipid oxidation suppression was more than those of the spice treated samples alone. The effect of spices may be related to its phenolic compounds. The phenolic constituents of the spices were of great protective effect against lipid oxidation in raw chicken meat due to their pharmacological and biochemical effects including antioxidant and anticarcinogenic effects (Doshi et al. 2006).

The TBA mean values of the control samples were higher when compared with Conchillo et al. (2003) and El-Shehry-Eman (2012), and lower when compared with the results of Krishnan et al. (2013).

Results in table 3 could be noticed that, at 1st day of storage the mixture samples had the lowest total volatile basic nitrogen (11.27) and control samples had the highest level (11.88), this also happened in 3rd, 5th, 7th days of storage till the control samples reach the rejection level of (20mg/100g) as reported by Egyptian standard (2005). The control chicken samples increased significantly in TVBN mean values when compared to all the spice treated samples through all the 11th days of storage period which remained slow and low as they all reached the 11th day of storage, but the mixture sample was the best result of them all (18.58) as it did not reach the rejection level even in the 11th day of storage. This could be attributed to the low and high pH values of these treatments, respectively. It is known that TVBN value is a result of protein break down, which produces basic nitrogenous compound. Since the pH values through the days of the storage were close to neutrality, high pH leads large amount of protein break down, and finally to the highest TVBN values for the samples.

The TVBN mean values were lower when compared with Afifi-Jehan (2000) and Hassanin et al. (2017), and were nearly similar when compared with Hala et al. (2011).

Table 4 expressed the color values in all the groups of raw chicken meat samples spiced and control. The spices in study (clove, ginger, soy sauce, and the mixture) affected slightly the chicken meat samples. The significance difference between all the groups was ($P < 0.05$) through all the storage period. The color values remained normal through all the 11th days of storage in the spice treated samples and the best results were in the mixture sampled spices. The control samples' color values decreased through all the storage period to be poor (2) in the 7th day of storage. The color values of the spice treated samples were significantly stabilized nearly (5) very good and (4) good in the 1st, 3rd, 5th, 7th, days of storage then slightly decreased to be (3) common till the 11th day of storage period with best results of the mixture group. The spices contain slight color compounds which results in the color changes or due to lipid or protein oxidation (Lynch and Faustman 2000).

The results presented in tables 5 and 6 shows the score changes for the odor and taste of the chicken samples with/without spices. All the chicken samples results were nearly (4) good in odor and taste in the 1st day of storage. The results showed that the samples decreased significantly between the groups through all the storage period and stayed nearly (4) good in odor and taste till the 7th day of storage except the control samples score which reached (2) poor for odor and taste mean values: 2.11 and 2.13 respectively, while all the spices treated samples remained higher nearly good (4) and common (3) till the 11th day of storage with best sensory score in the mixture samples. The sensory analysis results were similar to Krishnan et al. (2013) and Zhang et al. (2016).

The odor and taste were equally important in the chicken meat analysis. The lipid oxidation and ammonia production caused by protein break down may be the main reasons for the production of off-odor and poor sensory scores in the control samples.

5. CONCULOSIONS

The addition of spices results in extending the shelf-life of raw chicken meat during refrigerated storage, reduction of lipid oxidation, and maintaining or improving the sensory attributes. The results of our study showed that clove was significantly different from the other spices with nearly best results close to the mixture group and was significantly different from ginger and soy sauce as it had very good antioxidant activity. Further, the spices addition gives significantly increased values ($P< 0.05$) than the control samples, besides the improving in the sensory analysis: color, odor, and taste, along with the chemical parameters which decreased significantly ($P< 0.05$) due to the synergism comes from the combination of the spices. The best results in all the tests were in the spice extracts mixture (clove, ginger and soy sauce), which prolong the shelf-life to 11 days when compared with the control samples shelf-life which reaches only 7 days, due to mixing the three gives the additive effect of the spices. These spices proved to be highly effective; therefore, they should have more attention and be of highly valuable and desirable application in the development of functional healthy chicken products.

CONFLICT OF INTEREST

There is no conflict of interest.

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