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Water activity stability of Cold Storage Broiler Chicken Breast Muscles Fed on Diets Containing Medicinal Plants

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Abstract

Broiler chicken, a total of 30 birds were fed on diets containing garlic (*Allium sativum*), ginger (*Zingiber officinale*) and nigella (*Nigella sativa*) in concentrations of 0 (control), 1%, 2% and 3% for 45 days. The birds were then slaughtered, defeathered, eviscerated and breast muscles were obtained, packed aerobically in polyethylene vinyl acetate (PVA) plastic bags and stored at 4^{o}C for one week. The muscles were evaluated for the effect of the diets on water activity stability on first day (day 0) and after one week of storage. The results showed that the chicken muscle fed on diet containing 3% of nigella followed by 3% of garlic had the best the lowest a_w value on first day of the experiment. At the end of the storage time, samples fed on diets containing 3% garlic and 3% of nigella had the best a_w stability. Therefore, these concentrations are recommended for further related researches in this regard.

Keywords: Broiler chicken, Diets, Water activity, Breast muscles, Medicinal Plants

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1- Introduction

Chicken meat has desirable nutritional qualities and considered as low fat content meat with relatively high concentration of polyunsaturated fatty acids which make it favored by consumers around the world [1].

Nigella (*Nigella sativa*), ginger (*Zingiber officinale*) and garlic (*Allium sativum*) are medicinal plant sources and commercially available in Saudi Arabia and considered as important aromatic materials beside their health benefits. They are generally used as condiments to enhance the sensory quality of foods in Saudi Arabia. Many studies were dedicated and investigated water activity values of chicken meat as affected by diets supplementations using various functional food materials [3 -10].

Water activity is a measurement of the availability of water for biological reactions. It determines the ability of micro-organisms to grow. If water activity decreases, micro-organisms with the ability to grow will also decrease. Manitoba [2] reported that water activity (a_w) is expressed as the ratio of the vapor pressure in a food (P) to the vapour pressure of pure water (P_0). It predicts whether water is likely to move from the food product into the cells of micro-organisms that may be present.

$a_w = P/P_0$

Most food has a water activity greater than 0.95 which supports the growth of bacteria, yeast and mould. Knowing the water activity of a food is important when preparing a Hazard Analysis Critical Control (HACCP) plan. The water activity of a product or ingredient is necessary when conducting a hazard analysis. The effect of dietary treatments on water activity changes during cold storage of chicken meat is not much investigated. Therefore, this study aims at evaluating the effect of adding various medicinal

plants including nigella (*Nigella sativa*), ginger (*Zingiber officinale*) and garlic (*Allium sativum*) with different concentrations to the standard diet on water activity stability of broiler chicken breast meat.

2. Material and Methods

2.1. Birds and sampling

Four groups of Broiler chickens, each group consisted of 10 chickens were fed a single diet throughout the experiment for 45 days. Standard diet mixture which based on crushed soybeans and corn was purchased from General Organization for Grains, Saudi Arabia. Take 1 shows the contents and concentration of the standard diet. Group I - control (fed with standard mixture only); Group II- (fed with standard mixture supplemented with crushed ginger in concentration of 1%, 2% and 3%; Group III- (fed with standard mixture supplemented with crushed garlic in concentration of 1%, 2% and 3% and Group IV (fed with standard mixture supplemented with crushed nigella in concentration of 1%, 2% and 3%. After 45 days, the birds were slaughtered, defeathered, eviscerated and breast muscles were obtained, packed aerobically in polyethylene vinyl acetate (PVA) plastic bags and stored at 4^{o}C for one week..

2.2. Water activity (a_w) measurement

a_w of the samples were determined in the control and diets supplemented samples using Aqua Lab model 3TE, USA according to the method described by Abd Elgadir *et al*. [11]. Water activity measurement was conducted on first day (day 0) and after one week of cold storage condition. The samples were prepared by chopping each sample individually into fine pieces. The copped pieces were homogenized using glass rod and then Aqua Lab instrument was switched first to warm for 30 min and the prepared samples were put individually and carefully into the cup of the instrument. Carefully the drawer of the

instrument was closed and the water activity value of each individual sample was digitally read out from the instrument directly in about 40s at temperature of 25°C. Triplicate measurements of each sample were conducted.

Table 1: Contents and percent of standard mixture used for control diet

S. No.	Name of the item	Concentration
1	protein	20.5%
2	fat	6.0%
3	crude fibre	3.3%
4	ash	5.5%
5	calcium	0.9%
6	salt	0.35%
7	phosphorus	0.65%
8	vitamin A	10 mg/ g
9	vitamin D	3 mg/g
10	vitamin K	25 mg/g

2.3. Statistical analysis

The data obtained were subjected to analysis of variance (ANOV) using two-way analysis of variance (ANOVA) to evaluate diets treatments and storage condition on a_w stability. Differences between samples were considered significant when $P < 0.05$. Minitab Statistical Software (Minitab Inc., PA, USA) package 17 was used for data analysis. The results are expressed as mean ± S.D.

3. Results and discussion

Control sample had a_w value of 0.96 and increased to 0.99 at the end of the storage period with an increase of 0.03 of a_w. This value was also increased in diet supplemented sample to arrange between 0.0 – 0.01 after one

week of the storage which approved that supplementation treatments had better effects on a_w values of the fresh chicken meat. On first day, the lowest value of a_w (0.93±0.1) was recorded in the muscle sample fed on diet containing garlic with concentration of 3% as well as that containing garlic with concentration of 3%. However, a_w of the control sample significant ($p<0.01$) increased from 0.96±0.01 to 0.99±0.01 comparing to the treated samples. Milicevic *et al*. [12] conducted a_w measurement on chicken meat in order to investigate some physical properties of chicken breast meat and found that the value of a_w was 0.96±0.01 which agreed with the finding in this study as well as the literature review [2]. María *et al*. [13] investigated freeze-dried chicken meat fillets stored at 21 ± 1°C for 8 months and reported that water activity might be considered as the most important factor predicting the survival of microorganisms in meat due to their direct influence on product quality and stability. They found that the initial a_w of fresh chicken meat was about 0.984 ± 0.002 and a significant decrease ($P < 0.05$) of about 0.131 ± 0.002 was observed after treatment which might inhibit microorganisms' growth in fresh meat. It was reported that different chicken meat treatment as well as storage condition could highly affected values of a_w [15]. They evaluated five (M1-M5) different treatments of chicken breast for a_w level. Their treatments included M1 (under refrigeration in a domestic refrigerator at around 7°C for 22 hours); M2 (in a microwave oven for 6 minutes); M3 (in an electric oven with air circulation at approximately 40 °C for 2 hours and 15 minutes); M4 (packed in low-density polyethylene bags and placed in cold water of around 10 °C for 2 hours and 15 minutes); and M5 (at room temperature of approximately 17 °C for 2 hours and 20 minutes). Then the samples were submitted to fast freezing (-36 °C for 2 hours) and kept under freezing temperatures (-18 °C) until analysis. The sample were subjected to thawing method before evaluation. Thawing method was terminated when deep muscle temperature reached 10 °C in all methods. The result reviled that 0.991± 0.001, 0.993 ± 0.002, 0.993 ± 0.002, 0.993 ± 0.001 and 0.992 ± 0.002 for M1,

M2, M3, M4 and M5, respectively. According to ICMSF [15] most spoilage and pathogenic microorganisms need a_w value between 0.95 – 0.99 to growth in fresh meat.

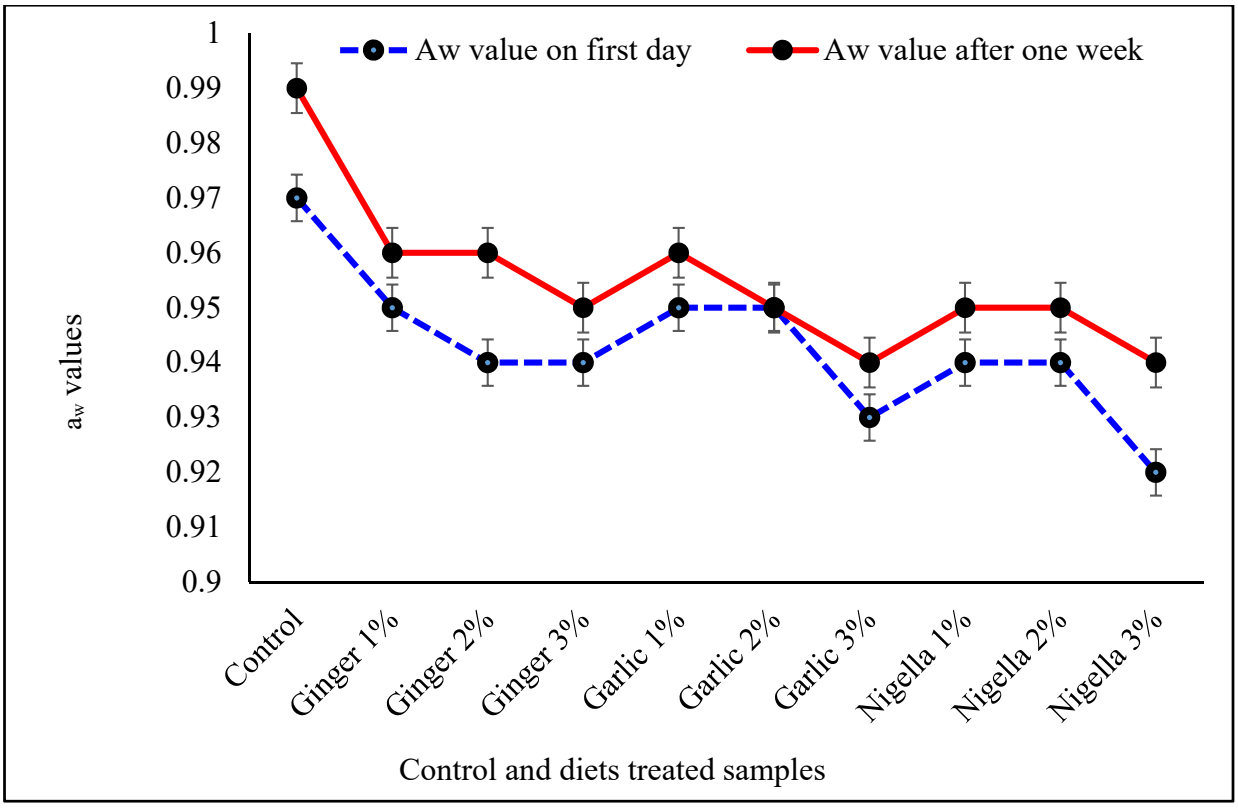

Fig. 1: a_w values of different diets treated chicken breast stored at 4°C on first day

4. Conclusion

In conclusion, the water activity (a_w) values of broiler chickens meat fed on diets supplemented with ginger (*Zingiber officinale*), nigella (*Nigella sativa*) and garlic (*Allium sativum*) in concentrations of 0.0%, 1.0%, 2.0% and 3.0% were highly affected during cold storage at 4°C for one week. There is an increase in a_w values in all treatments during cold storage. The best treatment that showed lowest a_w value at first day was the sample supplemented with the diet containing 3% of nigella followed by 3%

of garlic. At the end of the storage period, samples fed on diets supplemented with 3% of garlic and 3% of nigella had the best a_w stability. Therefore, these concentrations are highly recommended in this regard. More research could be needed to investigate the effects of these diets supplementations as well as their combinations on fresh chicken meat histology structure and microbial quality.

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