# International Journal of Meat Science

ISSN 2071-7113

science alert

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International Journal of Meat Science 1 (2): 108-116, 2011
ISSN 2071-7113 / DOI: 10.3923/ijmeat.2011.108.116


# A Comparative Study on the Antioxidant and Antimicrobial Properties of Garlic and Coriander on Chicken Sausage

A. Bali, Sudip Kumar Das, Anupam Khan, Dipanwita Patra, S. Biswas and D. Bhattacharyya
Department of Livestock Products Technology, West Bengal University of Animal and Fishery Sciences, 37, K. B. Sarani, Kolkata-700037, India

*Corresponding Author: S. Biswas, Department of Livestock Products Technology, West Bengal University of Animal and Fishery Sciences, 37, K. B. Sarani, Kolkata-700037, India*

## ABSTRACT

Aim of this study was to find out antioxidant and antimicrobial effect of garlic and coriander on chicken sausage. Chicken sausages were prepared to evaluate the antioxidant and antimicrobial effects of garlic (3% w/w) and coriander (3% w/w) during refrigeration storage (4±1°C) on 0th, 3rd, 7th, 14th and 21st day. The level of incorporation was established from the results of preliminary trials conducted using 2, 3 and 5% level. Coriander and garlic both was taken for further study @ 3% (w/w) which revealed best from sensory attributes. pH, emulsion stability, cooking loss, ThioBarbituric Acid (TBA) value, Total Plate Count (TPC), yeast and mould count, coliform count and sensory properties of control and treated samples were evaluated at each day of refrigeration storage (4±1°C) separately. A significant ($p<0.01$) increasing trend in pH, TBA value and TPC value with the advancement of storage period was observed. Coriander treated samples showed better antioxidant property whereas garlic treated samples showed better antimicrobial property. This study revealed that chicken sausage treated with garlic or coriander can be stored at 4±1°C for 14 days with good quality and overall acceptability.

**Key words:** Chicken sausage, garlic, coriander, refrigeration, antioxidant, antimicrobial property

## INTRODUCTION

Chicken meat and its products have become increasingly consumed worldwide, with chicken sausage being one of the most popular with consumers. However, the quality of chicken sausage can deteriorate during storage due to microbial growth and lipid oxidation, reducing nutritional quality and affecting flavor. Food conservation has been characterized for nutritious and microbiologically stable foods and it has been achieved by controlling the growth of spoiling and pathogenic food-related microorganisms. Microbial control in foods could be assured by suppressing one or more essential factors for microbial survival (Horace, 1982). Considering the possibility of undesirable influences of oxidized lipids on the human health, it seems to be of essential importance to minimize the content of products of lipid oxidation in food. In industrial processing, mainly synthetic antioxidants are used, in order to prolong the storage stability of food. However, toxicologists and nutritionists have for long noted the noxiousness of some synthetic antioxidants, such as Butylated hydroxytoluene (BHT) and Butylated hydroxyanisole (BHA), which are used in food processing. They may show carcinogenic effects in living organisms. Consumers are also becoming increasingly concerned about the safety of synthetic food additives. There has been a

constant search for alternative and efficient compounds for food conservation, aiming a partial or total replacement of antimicrobial chemical additives. Here lies the scope of natural antioxidants and antimicrobial agents.

Spices and herbs have been used for thousands of centuries by many cultures to enhance the flavor and aroma of foods. Scientific experiments since the late 19th century have documented the antimicrobial properties of some spices, herbs, and their components. Inhibitory activity of spices and derivatives on the growth of bacteria, yeasts, fungi and microbial toxins synthesis has been well reported, so they could be used in food conservation as main or as adjuvant antimicrobial compounds in order to assure the production of microbiologically stable foods.

Garlic (*Allium sativum)* have been used since antiquity for both medicinal as well as culinary purpose, it is a broad spectrum antibiotic killing a very wide variety of microorganism so called as dietary antibiotic. Besides having potent antioxidant and antimicrobial action, garlic is one of the most commonly used ingredients as a flavor enhancer in meat products. In addition to its flavoring properties, garlic also possesses a wide range of medicinal attributes. These include antibacterial, antiviral, antifungal and antiprotozoal activities (Ankri and Mirelman, 1999) and beneficial effects on the cardiovascular and immune systems. There are a lot of reports concerning the antibacterial and antioxidant effects of garlic on meat products (Kourounakis and Rekka, 1991; Lin *et al*., 1991; El-Khateib and El-Rahman, 1987; Ismaiel and Pierson, 1990). Pretreatment with garlic extract and ascorbic acid significantly decreased lipid peroxidation in both liver and kidney of rats exposed to cadmium-induced oxidative stress (Ogungbe and Lawal, 2008).

Coriander (*Coriandrum sativum)* also has shown promising activity in this field. Cuvelier *et al.* (1994) noted considerable antioxidant activity in the aqueous coriander extract. Grohs and Kunz (2000) observed that spice mixture containing coriander were able to inhibit the growth of various meat-spoiling microorganisms *(Bacillus subtillis, Enterococcus* spp., *Staphylococcus* spp., *E. coli* K12 and *Pseudomonas fluorescens*) providing stabilizing effect on color and smell of fresh portioned pork meat. Ali (2009) also demonstrated that Freeze-Dried Hydro-distilled extract of coriander is having anti-oxidant activity on butter-oil greater than caraway (*Carum carvil* L.) and control in terms of acid value, peroxide value and thio-barbituric acid value.

In this context the antioxidant and antimicrobial effect of garlic and coriander on chicken sausage was studied.

## MATERIALS AND METHODS

The study was conducted in the Department of Livestock Products Technology, West Bengal University of Animal and Fishery Sciences, Kolkata, India, in 2009 to determine the antioxidant and antimicrobial effects of garlic and coriander on chicken sausage.

For each trial, birds weighing approximately 1.5-2 kg were collected from local market. After slaughter and dressing following standard humane procedure, the carcasses were hand deboned. Meats along with subcutaneous fat were weighed, cut into small chunks and placed in the meat mincer (Sirman®, Italy, Model Buffalo TC 32) fitted with 6 mm plate). The minced meat was placed on a stainless steel bowl chopper (Mado® Model Garant, Germany) and the sausage emulsion was developed as per the recipe given in Table 1 where percentages of garlic and coriander pastes were at 2, 3 and 5% level. Based on Mean scores of sensory evaluation viz., appearance, colour, flavour, texture, juiciness and overall acceptability, 3 garlic and 3% coriander treatment was selected the best concentration for further study. The selected products were packed in low density polyethylene

Table 1: Preparation of sausage emulsion

| | | Garlic treatment (%) | | | Coriander treatment (%) | | |
|---|---|---|---|---|---|---|---|
| Ingredients | Control (%) | G-I | G-II | G-III | C-I | C-II | C-III |
| Chicken meat | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Visceral fat and skin | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Ice flakes | 14 | 12 | 11 | 9 | 12 | 11 | 9 |
| Salt | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Sugar | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Refined wheat flour | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Spice mix | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| Condiment mix | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Monosodium glutamate | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Sodium nitrate | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sodium nitrite | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Garlic | - | 2 | 3 | 5 | - | - | - |
| Coriander | - | - | - | - | 2 | 3 | 5 |

bags and stored at refrigeration temperature (4±1°C). Antioxidant and antimicrobial quality of chicken sausages were studied on 0th, 3rd, 7th, 14th and 21st days of storage.

**Physico-chemical parameters:** The pH of the finely minced sausage sample was determined by the method of Troutt *et al.* (1992). The emulsion stability of the sausage emulsion was determined by the method of Baliga and Madaiah (1970) with minor modifications. Cooking loss (percent) was estimated based on the method of Huang *et al.* (2001) with slight modifications.

**Evaluation of antioxidant activity:** Thiobarbituric acid numbers of sausage samples were determined as per the procedure of Strange *et al.* (1977).

**Microbial analysis:** Total Plate Count (TPC) was determined by the method described by APHA (1984). Readymade media (Himedia) were used for the analysis. Yeast and Molds count and Coliforms were detected by the Flexi Plate used as culture Plate (spread plate Technique) as described by Himedia Laboratories (FL006, Nov-2008).

**Sensory evaluation:** The sensory quality of samples was evaluated using 8 point hedonic scale where 8 denoted extremely desirable and 1 denoted extremely poor.

**Statistical analysis:** The results were expressed in terms of mean and Standard Error (SE) of mean. The means were compared by One Way ANOVA followed by Duncan's Multiple Range Test at 5% level of significance (Duncan, 1955). A probability value of $p<0.05$ was described as significant and $p<0.01$ was noted as highly significant.

## RESULTS AND DISCUSSION

**Physico-chemical properties:** A significant ($p<0.01$) increasing trend in pH with the advancement of storage period was observed during the first 7 days of storage and thereafter the pH decreased gradually (Table 2). Initially at 0th day, pH of garlic treated sample was highest (5.946±0.008) than coriander treated sample (5.746±0.014) and control (5.860±0.015). At 7th day,

Table 2: Effect of different treatments on the pH, TBA, total plate count (log cfu $g^{-1}$) yeast and mold count (log cfu $g^{-1}$) of chicken sausages (Mean±SE)

| | Storage periods (day) | | | | | |
|---|---|---|---|---|---|---|
| Treatment groups | 0 | 3 | 7 | 14 | 21 | p-value |
| **pH** | | | | | | |
| Garlic | 5.946±0.008$^{cx}$ | 6.096±0.012$^{bx}$ | 6.166±0.012$^{ax}$ | 5.926±0.014$^{cy}$ | 5.743±0.018$^{dy}$ | p<0.01 |
| Coriander | 5.746±0.014$^{dz}$ | 5.946±0.013$^{bz}$ | 6.093±0.007$^{ay}$ | 5.976±0.016$^{bx}$ | 5.84±0.014$^{cx}$ | p<0.01 |
| Control | 5.860±0.015$^{dy}$ | 6.000±0.014$^{by}$ | 6.076±0.008$^{ay}$ | 5.923±0.009$^{cy}$ | 5.813±0.006$^{ex}$ | p<0.01 |
| p value | p<0.01 | p<0.01 | p<0.01 | p<0.05 | p<0.05 | N = 6 |
| **TBA** | | | | | | |
| Garlic | 0.187±0.005$^{ey}$ | 0.210±0.004$^{dy}$ | 0.333±0.006$^{cy}$ | 0.473±0.002$^{by}$ | 0.524±0.005$^{ay}$ | p<0.01 |
| Coriander | 0.171±0.012$^{ey}$ | 0.187±0.002$^{dz}$ | 0.234±0.012$^{cz}$ | 0.359±0.002$^{bz}$ | 0.477±0.024$^{az}$ | p<0.01 |
| Control | 0.278±0.005$^{ex}$ | 0.322±0.011$^{dx}$ | 0.674±0.023$^{cx}$ | 0.906±0.011$^{bx}$ | 1.110±0.003$^{ax}$ | p<0.01 |
| p value | p<0.01 | p<0.01 | p<0.01 | p<0.01 | p<0.01 | N = 6 |
| **Total plate counts (log cfu $g^{-1}$)** | | | | | | |
| Garlic | 2.153±0.008$^{ey}$ | 2.383±0.015$^{dz}$ | 2.837±0.017$^{cz}$ | 3.470±0.011$^{bz}$ | 4.523±0.008$^{az}$ | p<0.01 |
| Coriander | 2.180±0.011$^{ey}$ | 2.433±0.008$^{dy}$ | 2.926±0.012$^{cy}$ | 3.656±0.014$^{by}$ | 4.813±0.007$^{ay}$ | p<0.01 |
| Control | 2.276±0.014$^{ex}$ | 2.607±0.007$^{dx}$ | 3.240±0.005$^{cx}$ | 4.463±0.009$^{bx}$ | 5.830±0.013$^{ax}$ | p<0.01 |
| p value | p<0.01 | p<0.01 | p<0.01 | p<0.01 | p<0.01 | N = 6 |
| **Yeast and mold count (log cfu $g^{-1}$)** | | | | | | |
| Garlic | ND | ND | ND | 2.233±0.008$^{bz}$ | 3.143±0.012$^{az}$ | p<0.01 |
| Coriander | ND | ND | 2.330±0.011$^{c}$ | 3.223±0.009$^{by}$ | 3.946±0.013$^{ay}$ | p<0.01 |
| Control | ND | ND | 3.323±0.014$^{c}$ | 4.130±0.012$^{bx}$ | 5.473±0.007$^{ax}$ | p<0.01 |
| p-value | | | p<0.01 | p<0.01 | p<0.01 | N = 6 |

*p<0.01 = significance at 1% level, p<0.05 = Significance at 5% level, p>0.05 = Non-significant, Superscripts a, b, c, d, e differed significantly (row wise). ND = Not detected, Superscripts x, y, z differed significantly (column wise). N (number of observations) = 6

Table 3: Effect of different treatments on the Emulsion stability and cooking loss of chicken sausages (Mean±SE)

| Parameters | Garlic | Coriander | Control | p value |
|---|---|---|---|---|
| Emulsion stability | 94.56±0.25$^{a}$ | 93.18±0.17$^{b}$ | 91.76±0.34$^{c}$ | p<0.01 |
| Cooking loss | 13.46±0.41$^{c}$ | 15.24±0.13$^{b}$ | 16.75±0.32$^{a}$ | p<0.01 |

p<0.01 = significance at 1% level, p<0.05 = significance at 5% level, p>0.05 = Non-significant, Superscripts a, b, c differed significantly (row wise), N (number of observations) = 6

it reached highest, i.e., 6.166±0.012 for garlic, 6.093±0.007 for coriander treated sample and 6.076±0.008 for control, and then the values for all the treatments along with control decreased subsequently.

Emulsion stability of garlic treated chicken sausage was significantly (p<0.01) higher (94.56±0.25) than the coriander (93.18±0.17) and control (91.76±0.34) (Table 3).

Cooking loss of garlic treated chicken sausage was significantly (p<0.01) lower (13.46±0.41) than coriander (15.24±0.13) and control (16.75±0.32) (Table 3).

**Antioxidant activity:** TBA values indicated a highly significant (p<0.01) effects of treatments as well as storage period throughout the observation period (Table 2). The overall mean value of TBA for control was significantly (p<0.01) higher than garlic and coriander treated sausages. Moreover, there was a significant lower TBA value of the coriander treatment than the garlic treatment and control.

**Microbial analysis:** The total plate count values of all treatments ranged between 2.153±0.008 to 2.276±0.014 log cfu $g^{-1}$ on 0th day of storage which increased significantly to

5.830±0.013 log cfu $g^{-1}$ in control and 4.523±0.008 and 4.813±0.007 log cfu $g^{-1}$ in garlic and coriander treated sausages respectively on 21st day of storage (Table 2). Among all the groups the total plate count value of garlic treated sausage was found to be lowest followed by coriander and control. The Yeast and mold colonies were not detected on 0th and 3rd day in all groups but on 7th day, they were detected in control and coriander. After 7 days, there was significant increase ($p<0.01$) in yeast and mold count in all the groups during rest of the observation period. At the end of observation period, control and coriander treatment showed higher yeast and mold counts of 5.473±0.007 and 3.946±0.013 log cfu $g^{-1}$, respectively in compare to garlic treatment 3.143±0.012 (Table 2). Coliform count was nil in treatments as well as in control sample.

**Sensory properties:** The effect of different treatments on colour and appearance scores of sensory evaluation was found to be insignificant (Table 4), whereas a significant declining trend score was observed with the advancement of storage period. A non significant effect of treatments was observed on flavor scores. The overall mean value for flavor was found to be highest for the garlic with a mean score of 7.756±0.19 followed by coriander and control with mean score of 7.660±0.16 and 7.620±0.23, respectively at 0th day (Table 4). Higher flavor scores were maintained by treatment groups throughout the observation period. At 21st day of storage the flavor of all treatment groups including control became unacceptable.

The overall mean value for juiciness was found to be highest for garlic treatment followed by coriander and control. The test groups maintained the higher scores for juiciness throughout the storage period (Table 4). A significant ($p<0.01$) reduction in the juiciness score was observed in all the groups with the advancement of storage period. On 21st day of storage all the sausages sample were not acceptable for juiciness test. The texture of garlic group was found to be superior to coriander and control (Table 4). The overall mean value for overall acceptability was found to be highest for garlic treatment followed by control and coriander. The mean score for overall acceptability of coriander found to be least (Table 4).

**Physico-chemical properties:** The rise in the pH of the sausages irrespective of treatments in the early part of storage might be due to the mesophilic bacterial action on the protein molecule which results in more alkaline metabolite formation (Bachhil, 1982; Gill, 1983). The decreasing trend of pH has been supported by Papadima and Bloukas (1999) who recorded a decreasing trend in pH of Greek sausage during refrigeration storage and suggested that the decrease in the pH might be due to the action of psychrophilic bacteria which ferment the carbohydrate present in the binders and spices. This result is also congruent with the finding of Incze (1992) who stated that the decrease in pH is due to the production of organic acid mainly lactic acid during carbohydrate fermentation. This observation has also been collaborated with the findings of Biswas *et al.* (2006).

Hunt and Dalgleish (1994) opined that a high proportion of large oil droplets due to coriander were a good indication of the presence of large flocs and coalesced droplets hence provides a very unstable emulsion. Lower emulsion stability of coriander treated chicken sausage was also supported by Aluko and Mine (1998) who revealed that the poor emulsion forming ability of the coriander seed powder resulted in the presence of large size oil droplets, which are probably as a result of flocculation of smaller-sized oil droplets.

Lawrie (1998) described many factors which influences cooking losses like degree and distribution of fat, double versus single cooking periods, time and temperature of cooking and stage of doneness.

Table 4: Effect of different treatments on the Colour, Flavour, Juiciness, Texture and Overall acceptability of chicken sausages (Mean±SE)

| | Storage periods (day) | | | | | |
|---|---|---|---|---|---|---|
| Treatment groups | 0 | 3 | 7 | 14 | 21 | p-value |
| **Colour** | | | | | | |
| Garlic | 7.830±0.25$^{a}$ | 7.356±0.32$^{b}$ | 6.733±0.19$^{c}$ | 6.340±0.15$^{d}$ | 5.940±0.12$^{e}$ | p<0.01 |
| Coriander | 7.810±0.21$^{a}$ | 7.330±0.35$^{b}$ | 6.703±0.14$^{c}$ | 6.333±0.29$^{d}$ | 5.923±0.31$^{e}$ | p<0.01 |
| Control | 7.796±0.11$^{a}$ | 7.283±0.28$^{b}$ | 6.670±0.18$^{c}$ | 6.276±0.17$^{d}$ | 5.873±0.27$^{e}$ | p<0.01 |
| p value | p>0.05 | p>0.05 | p>0.05 | p>0.05 | p>0.05 | N=6 |
| **Flavour** | | | | | | |
| Garlic | 7.756±0.19$^{a}$ | 7.430±0.17$^{b}$ | 6.802±0.32$^{c}$ | 6.373±0.26$^{d}$ | NA | p<0.01 |
| Coriander | 7.660±0.16$^{a}$ | 7.340±0.24$^{b}$ | 6.736±0.16$^{c}$ | 6.303±0.22$^{d}$ | NA | p<0.01 |
| Control | 7.620±0.23$^{a}$ | 7.353±0.13$^{b}$ | 6.696±0.34$^{c}$ | 6.246±0.28$^{d}$ | NA | p<0.01 |
| p value | p>0.05 | p>0.05 | p>0.05 | p>0.05 | | N=6 |
| **Juiciness** | | | | | | |
| Garlic | 7.823±0.025$^{ax}$ | 7.376±0.012$^{bx}$ | 6.803±0.018$^{cx}$ | 6.343±0.012$^{dx}$ | NA | p<0.01 |
| Coriander | 7.580±0.032$^{az}$ | 7.206±0.008$^{by}$ | 6.743±0.047$^{cy}$ | 6.184±0.009$^{dy}$ | NA | p<0.01 |
| Control | 7.630±0.051$^{ay}$ | 7.176±0.042$^{by}$ | 6.567±0.027$^{cz}$ | 6.030±0.011$^{dz}$ | NA | p<0.01 |
| p value | p<0.01 | p<0.01 | p<0.01 | p<0.01 | | N=6 |
| **Texture** | | | | | | |
| Garlic | 7.763±0.018$^{ax}$ | 7.316±0.014$^{bx}$ | 6.923±0.012$^{cx}$ | 6.246±0.011$^{dx}$ | NA | p<0.01 |
| Coriander | 7.380±0.011$^{ay}$ | 7.083±0.012$^{by}$ | 6.723±0.009$^{cy}$ | 6.093±0.013$^{dy}$ | NA | p<0.01 |
| Control | 7.143±0.012$^{az}$ | 6.897±0.014$^{bz}$ | 6.403±0.008$^{cz}$ | 5.833±0.016$^{dz}$ | NA | p<0.01 |
| p value | p<0.01 | p<0.01 | p<0.01 | p<0.01 | | n=6 |
| **Overall acceptability** | | | | | | |
| Garlic | 7.670±0.035$^{ax}$ | 7.210±0.015$^{bx}$ | 6.783±0.021$^{cx}$ | 6.233±0.013$^{dx}$ | NA | p<0.01 |
| Coriander | 7.653±0.018$^{ax}$ | 7.123±0.017$^{by}$ | 6.496±0.032$^{cz}$ | 6.116±0.022$^{dy}$ | NA | p<0.01 |
| Control | 7.470±0.011$^{ay}$ | 6.846±0.012$^{bz}$ | 6.540±0.044$^{cy}$ | 5.956±0.016$^{dz}$ | NA | p<0.01 |
| p-value | p<0.01 | p<0.01 | p<0.01 | p<0.01 | | N = 6 |

*p<0.01=significance at 1% level, P<0.05= significance at 5% level, P>0.05=Non-significant, Superscripts a, b, c, d, e differed significantly (row wise). NA = Not acceptable, Superscripts x, y, z differed significantly (column wise). N: No. of observations.

**Antioxidant activities:** Lower TBA values in the treatment groups might be due to the antioxidant properties of garlic and coriander. Antioxidant efficacy of coriander in biological system and in foods is related with the ability to act as singlet oxygen quenchers, the highly reactive form of oxygen and interact with free radicals (Jorgensen and Skibsted, 1993). Antioxidant activity of garlic had been strongly supported by Salam *et al.* (2004) who tested fresh garlic for its antioxidant effect in raw chicken sausages stored at 30°C. After 3 weeks of storage, the sausage containing fresh garlic significantly (p<0.05) delayed the lipid oxidation in comparison with control. With the advancement of storage period, significant increase in the TBA value were observed irrespective of the treatments and control but the increment in treatment groups were much slower than that of control. This might be due to the increased lipid oxidation and production of volatile metabolites in the presence of oxygen during storage and aerobic packaging. This observation is in agreement with Brewer *et al.* (1992).

**Microbial analysis:** Lower TPC value in garlic treatment throughout the storage period might be due to the antimicrobial action of garlic and this antimicrobial action might be attributed to its active principle like allicin, Diallyl sulfide, Diallyl disulfide etc which are supposed to be strong antibacterial agents. Similar conclusion had been made by Rawat (2007). A significant increasing trend was also observed in TPC with the advancement of storage period irrespective of treatments

and control. The TPC values of sausages did not show significant differences between 0th to 3rd days of storage. But significant increase in TPC was noticed on 7th day onwards. This increase in TPC with the advancement of storage period might be due to multiplication of microorganisms during storage (Bawa *et al*., 1988). Similar results had been reported by Kondaiah *et al*. (1988) and Biswas *et al*. (2006).

Yin and Cheng (1998) reported the inhibitory effects of water-soluble extracts of garlic bulbs and green garlic on the growth of *A. niger* and *A. flavus*. Lower yeast and mold count in coriander treated sausage has been supported by the findings of Thyagaraja and Hosono (1996) who assayed the ability of coriander, pepper, cumin and asafetida to inhibit food spoilage molds *(Rhizopus azygosporus, Mucor dimorphosphorous, Penicillium commune* and *Fusarium* sp).

Coliform count was nil in treatments as well as in control sample. The reason behind this observation might be the hygienic measures followed in different steps during processing of the sausages or death of the organisms during smoking (around 60°C) as the thermal death point of the coliform organisms is 57°C. This result was in close agreement with the reports of Chattopadhyay (2008) and Sinhamahapatra (2005).

**Sensory properties:** Biswas (2002) noted that the gradual decrease in color scores stored at refrigeration storage might be due to pigment and lipid oxidation resulting in non enzymatic browning.

The deterioration of flavor scores might be due to development of oxidative rancidity and microbial deterioration in the product as efficacy of test ingredients reduced during storage period. Salam *et al*. (2004) reported that Sausage formulations containing fresh garlic had a significantly stronger flavor than the other samples.

Eyas (2001) indicated that the gradual decrease in juiciness score might be due to the loss of moisture from the product during refrigeration storage. Vedamurthy (1998) also observed similar decrease in juiciness of low fat chevon sausages as well as in control and in low fat frankfurters containing vegetable oil.

The variation in the texture might be attributed to the degree of dehydration of muscle proteins. A declining trend of texture score was observed with the advancement of storage time which might be due to release of moisture (Wu *et al*., 2000) and depletion of fat during storage (Biswas, 2002).

The declining trend of overall acceptability scores during storage was strongly supported by Biswas (2002) who opined that gradual decrease in overall acceptability scores might be due to decrease in values of other sensory attributes.

## CONCLUSION

Taking into account of all the above considerations, it can be concluded from the present investigation that in the preparation of chicken sausage, garlic and coriander can be used at 3% concentration level without affecting the quality and sensory attributes of the product and the sausages treated with garlic or coriander can be stored at refrigeration temperature for 14 days with good quality and overall acceptability. Moreover garlic possesses greater antimicrobial property than coriander and coriander possesses greater antioxidant activity than garlic at the same concentration level.

## ACKNOWLEDGMENT

Authors are grateful to the Vice Chancellor, Directorate of Research, Extension and Farms and Dean of the Faculty of Veterinary and Animal Sciences of West Bengal University of Animal and Fishery Sciences for their approval and permission to conduct the research work.

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