COMPARATIVE STUDY OF HEAT TREATMENT ON ANTIOXIDANT AND MICROBIAL PROPERTIES IN CHICKEN MINCE

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Received: 23-03-2012 Accepted: 17-10-2012

ABSTRACT

An investigation was carried out to study the effect of heat treatment on antioxidant and antimicrobial properties of turmeric added to chicken mince stored at 4± 1°C. Physico-chemical properties viz. pH, thiobarbituric acid values (TBA) and free fatty acid values (FFA) were evaluated on 0, 3, 6 and 9th day of storage. Antimicrobial studies viz. Total viable count and Clostridium sporogenes count were carried out on 1, 4, 7 and 10th day of storage. Highly significant difference (P< 0.01) was noticed between treatments and between storage periods in pH (5.922± 0.03-HT as compared to C-5.898± 0.05), TBA (0.559± 0.09- HT as compared to C-1.569± 0.04), FFA (1.176± 0.19-HT as compared to C-2.284± 0.40), TVC (log CFU/g) (7.588± 0.73-HT as compared to C-8.583± 0.49), Clostridium sporogenes count (log CFU/g) (8.102± 0.65-HT as compared to C-8.681± 0.74). It can be concluded that heat treated turmeric can be more potent antioxidant and antimicrobial in various perishable food like chicken mince. It is also effective against Clostridium sporogenes and TVC.

Key words: Clostridium sporogenes, Heat treated turmeric, Turmeric, TVC.

INTRODUCTION

Food safety is a major concern of the food industry worldwide. A large number of chemical additives are added to food for attaining safety and quality. They include antioxidants, antimicrobials, flavour enhancers, stabilizers etc. Butylated Hydroxy Toluene (BHT), Butylated Hydroxy Anisole (BHA), nitrite, polyphosphate, ascorbate, tocopherol are some of them. However, several reports suggested that chemical additives can have adverse effects on human health especially when consumed over long periods (Demeyer et al., 2008; Vareltzis et al., 1984; Swan, 1975 and Inas et al., 1982). Hence, modern day consumer demand food which is microbiologically safe and free from chemical additives. There have been renewed vigorous scientific efforts in utilizing phytoproducts rather than synthetic chemicals in food for addressing food safety issues. Inhibitory activity of spices and their derivatives on the growth of bacteria, yeasts, fungi and microbial toxins synthesis has been well reported (Khanna, 1999; Negi et al., 1999; Sethi and Meena, 2004). Turmeric is one of the spices widely used in Indian culinary practices and reported to possess multifunctional roles. One of the alkaloids of turmeric, curcumin, possesses antioxidant, antimicrobial and therapeutic properties (Sreyajan et al., 1994). Curcumin and other curcuminoids inhibit the growth of Staphylococcus aureus, Salmonella paratyphi, Trichophyton gypseum and Mycobacterium tuberculosis in concentration of 1 in 640000 (Khanna, 1999). Turmeric is used in curry powder, chicken bouillon, sauces, gravies, dry seasoning, baking mixtures, processed cheese, pickles, relishes, breeding soups, beverages and confectioneries (Peter, 1999). Curcumin, demethoxy curcumin and bis-demethoxy curcumin are highly effective antioxidants, inhibitors of lipid oxidation, leukotriene biosynthesis, 5-lipoxygenase, cyclooxygenase, AOS scavengers and are able to prevent increase in free radical generation or their accumulation in the body. Several studies reported on antioxidant and antimicrobial effect of turmeric (Khanna, 1999; Negi et al., 1999; Kumudavally et al., 2005 and Srinivas
et al., 1992). But a few studies took into account the effect of heat treatment during cooking on the antioxidant and antimicrobial activity (Tiwari et al., 2006; Suresh et al., 2007 and Chandrana et al., 2005).

Meat products consumption is increasing rapidly in India and other developing countries and especially processed chicken products are becoming increasingly popular. Chicken mince is a starting material for many such products which is highly perishable low acid product having high water activity and short shelf life even under refrigerated conditions. Specially, Clostridium botulinum type E causes biological hazard under refrigeration conditions in meat and meat products. Hence, the present investigation was carried out with the objective to study the effect of heat processing on antioxidant and antimicrobial properties of turmeric in chicken mince.

**MATERIALS AND METHODS**

The experiment was carried out in the department of Livestock Products Technology. Live birds were procured from Instructional Poultry Farm (IPF), Nagla, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar and were brought to the Department of Livestock Products Technology. Slaughtering and dressing was carried out following standard procedure under humane conditions. The hot carcass was kept in refrigerator at 4± 1°C for 24 hours. The chilled carcasses were deboned next day and lean meat was collected and stored at -20°C till further use. Turmeric powder of “Agmark” grade was purchased from the local market and used in the experiment. It contained 2.5% oleoresin content determined by ether extraction method. All the chemicals used in the study were of analytical grade and procured from Hi Media laboratories (P) Ltd, Mumbai. The culture media used in the study were procured from Hi Media Laboratories (P) Ltd, Mumbai and Tulip Diagnostics (P) Ltd, Goa, India. Low density Polyethylene (LDPE) bags were sourced from local market and sterilized by exposing to U.V. light for 30 minutes before use.

**Preparation of standard bacterial inoculums:** The following standard pure cultures viz. Clostridium sporogenes (MTCC - 1349), was procured from Microbial Type Culture Collection Centre, Institute of Microbial Technology, Chandigarh, India and used in the study. The culture was revived under aseptic conditions as per the instructions.

**Preparation and portioning of meat mince:** Approximately 1.8 kg of boneless chicken was defrosted before use. The deboned meat was minced by passing twice through 4mm plate of presterilized meat mincer (Sirman® TC-32, Italy). Minced neat was divided into approximately three equal portions and assigned to following treatments: Control (C), Turmeric dissolved in water, added @ 1000ppm to chicken mince (T) and Heated turmeric (boiled for 15 minutes on hot plate; dissolved in water, added @ 1000ppm to chicken mince (HT).

Turmeric (1000ppm to chicken mince) was weighed accurately and dissolved in water (10% by weight of chicken mince) and then incorporated in chicken mince thoroughly by kneading or massaging for uniform distribution. For heated turmeric, 1000ppm of turmeric was calculated, accurately weighed and dissolved in water (10% by weight of chicken mince) as above and boiled for 15 minutes on a hot plate. The rate of heating was kept uniform between replications. Each treatment (C, T and HT) portion was further sub divided into two parts of approximately 300g; one part for studying antioxidant and physico-chemical properties and the second part for microbiological studies.

The portion of minced chicken intended for the microbiological studies was subdivided into two parts, accurately into 100 g portions; one part for TVC and another for Clostridium sporogenes count.

**Incorporation of bacterial inoculum in minced chicken:** The broth containing known concentration of Clostridium sporogenes stored in refrigerator was serially diluted with normal saline to approximately10^7 bacterial colonies per ml. One ml of inoculum was added to 100 gram of minced chicken (taken in sterilized LDPE bags) and thoroughly mixed by kneading so that a final concentration of approximately 10^5 CFU/gram of mince could be obtained. The concentration of bacterial culture was kept deliberately high.

**Packaging and storage:** The LDPE bags containing inoculated chicken mince were sealed with the help of a sealer (Singhal®, HSP-200, India) and stored at refrigeration temperature (4±1°C) till further analysis. The mince portions assigned for studies
on antioxidant and physico-chemical properties were also sealed in LDPE bags and stored at refrigeration temperature (4±1°C) as above until further analysis. The following physico-chemical (AOAC, 1992) and antioxidant studies were carried out on 0, 3, 6, and 9th day of storage and antimicrobial (APHA, 1984) studies were carried out on 1, 4, 7 and 10th day of storage. A total of 6 replications were carried out with each analysis done in duplicate.

Statistical analysis: The data obtained was analyzed by using ANOVA technique by Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

pH: pH is an important intrinsic factor which influences the growth of microbes in meat (ICMSF, 1980). The mean pH values and standard error are shown in Table 1. The analysis of variance indicated highly significant difference (P<0.01) was observed in pH between treatments and between storage periods. However, interaction between treatment and storage period showed no significant difference (P>0.05).

Addition of turmeric (T) did not have significant effect (P>0.05) on pH of chicken mince, where as heated turmeric (HT) treated mince had significantly higher (P<0.01) pH when compared to control (C). Chan et al. (2002) reported that turmeric added chicken mince did not show significant difference (P>0.05) in pH during chilling storage (3±1°C) for 9 days as compared to control. Results of this study are in agreement with Chan et al. (2002). Biswas et al. (2006) found no significant difference (P>0.05) in pH between control and spices mix which contained ginger, turmeric and other spices treated chicken mince stored at refrigeration temperature. Overall storage mean pH of chicken mince increased significantly (P<0.01) over storage period. Sachdev et al. (2002) found that there was significant increase in pH due to prolonged storage of cooked chicken at room temperature for 1 week and 4 weeks at freezing temperature. Kumar and Sharma (2004) attributed the increase in pH during storage of low fat pork patties to proteolysis due to bacterial growth. Vijaykumar and Biswas (2006) reported significant increase (P<0.01) in pH of enrobed cooked duck cutlets stored at refrigeration temperature for 21 days.

Thiobarbituric acid (TBA) value (mg malonaldehyde/kg): TBA value is a measure of secondary lipid oxidation products in meat (Olsen et al., 2005). The mean pH values and standard error are shown in Table 1. The analysis of variance (ANOVA) indicated highly significant difference (P<0.01) between treatments, between storage periods and interaction between treatments and storage periods. The overall mean TBA value for chicken mince treated with T and HT were significantly lower (P<0.01) when compared to C. HT containing chicken had significantly higher (P<0.01) antioxidant effect (lower overall mean TBA value) when compared to T. The lower TBA values in treatments might be due to antioxidant properties of turmeric.

Lean and Mohamed (1999) reported strong antioxidant activity by turmeric in butter cakes than control samples. Curcuminoids in turmeric scavenge free radicals at the cost of becoming free radicals themselves. These second hand free radicals are unreactive products and are short lived, so the lipid oxidation reaction is terminated. The present study revealed that heat processed turmeric had significantly higher (P<0.01) antioxidant effect than non heated turmeric. Tiwari et al. (2006) found that heated turmeric (>100°C for 10 minutes) was having higher antioxidant properties than non heated turmeric. The overall mean TBA values significantly (P<0.01) increased during refrigerated storage in all the treatments. Nayak and Tanwar (2005) attributed the increase in TBA values with the advancement of storage period to increased lipid oxidation and production of volatile metabolites in the presence of oxygen.

Free fatty acid (FFA) value (% Oleic acid): FFA value is a measure of hydrolytic rancidity in foods. The mean pH values and standard error are shown in Table 1. A highly significant difference (P<0.01) in FFA values between treatments, between storage periods and interaction between treatment and storage periods was reported.

The overall mean FFA value for chicken mince containing T and HT were significantly lower (P<0.01) than C. HT treated chicken mince had significantly (P<0.01) lower overall mean FFA value than T. Therefore, heat processing of turmeric was found to be most effective for reducing FFA values.
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatments</th>
<th>Storage period</th>
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<tr>
<td></td>
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<tr>
<td>pH</td>
<td>C</td>
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<td></td>
<td>T</td>
<td>5.763±0.01</td>
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<td></td>
<td>HT</td>
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<td>C</td>
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<tr>
<td>TBA</td>
<td>C</td>
<td>0.488±0.005&lt;sup&gt;b&lt;/sup&gt;</td>
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<td></td>
<td>T</td>
<td>0.387±0.008&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>HT</td>
<td>0.336±0.006&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Storage mean</td>
<td>C</td>
<td>0.403±0.06&lt;sup&gt;A&lt;/sup&gt;</td>
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<td>FFA</td>
<td>C</td>
<td>0.981±0.03&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>T</td>
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<td></td>
<td>HT</td>
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<td>Storage mean</td>
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<tr>
<td>Total plate count</td>
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<td>6.282±0.04&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>Storage mean</td>
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<tr>
<td>Clostridium sporogenes count</td>
<td>C</td>
<td>6.337±0.04&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>T</td>
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<tr>
<td>Storage mean</td>
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<td>5.559±0.56&lt;sup&gt;A&lt;/sup&gt;</td>
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Overall means bearing different superscripts between columns (A, B, C, D) and between rows (X, Y, Z) differ significantly (P<0.01)

Interaction means bearing different superscripts (a, b, c, d, …) differ significantly (P<0.01)
in minced chicken mince among all three treatments. Hameed et al. (2007) reported that dehydrated chicken chunks (smeared with turmeric followed by drying at 60°C for 8 hours) packed in LDPE had significantly lower FFA value than control, when stored at room temperature for 60 days. Chan et al. (2002) observed that turmeric had significantly higher (P<0.05) antioxidant effect in minced poultry meat compared to control during storage at 3°C for 9 days.

Overall storage mean FFA value of chicken mince increased significantly (P<0.01) during storage periods in all treatments. Similar results were found by Yetim et al. (2006). Kanatt et al. (1998) stated that lipolysis of meat during storage by the action of tissue enzymes and lipolytic enzymes obtained from spoilage micro organisms led to the formation of FFA.

**Total viable count (TVC):** The mean pH values and standard error are shown in Table 1. A highly significant difference (P<0.01) was observed for TVC in between treatments, between storage periods, where as significant difference (P<0.05) was found in interaction between treatments and storage periods.

The overall mean TVC (log CFU/g) for chicken mince containing T and HT were significantly lower (P<0.01) when compared to C. Addition of HT to chicken mince resulted in significantly (P<0.01) lower overall mean total viable count than unheated T. Khanna (1999) reported that Curcumin and other curcuminoids inhibit the growth of various bacteria like Staphylococcus aureus, Salmonella paratyphi, Trichphyton gypseum and Mycobacterium tuberculosis in concentration varying from 1 in 20000 to 1 in 640000. Heat processed turmeric was found to be significantly more effective (P<0.01) than non heated turmeric in terms of lower TVC of chicken mince in the present study. This is an agreement with Chandrana et al. (2005) who reported that antibacterial activity of heat treated extracts of turmeric; ginger and mangoginger were greater than that of unheated extracts of these spices alone and in combination.

Overall storage mean for TVC increased significantly on storage periods for all treatments. Froning et al. (1971) reported that total microbial count increased significantly in turkey frankfurters during refrigeration storage.

**Clostridium sporogenes count:** The mean pH values and standard error are shown in Table 1. The result indicated a highly significant difference (P<0.01) in Clostridium sporogenes count between treatments, between storage periods and interaction between treatments and storage periods. The treatment mean of Clostridium sporogenes count of chicken mince containing HT and T were significantly lower when compared to C. Huhtanen (1980) observed that a minimum inhibitory concentration of 125 ppm each of extract of nutmeg, bay leaf and white and black pepper was required for inhibiting Clostridium botulinum by disc diffusion method.

In the present study, turmeric was found to be more effective than heat processed turmeric against Clostridium sporogenes. Suresh et al. (2007) and Prathapan et al. (2009) reported that heat processing of turmeric significantly decreased the curcumin content. Curcumin and hydroxy-curcumin are the most potent antimicrobial components present in turmeric. So, decrease in curcumin during heat processing might be responsible for decreased antimicrobial activity of heated turmeric against Clostridium sporogenes. Storage mean of Clostridium sporogenes count increased significantly (P<0.01) on all storage days.

**CONCLUSION**

It can be concluded that heat processing made turmeric a better antioxidant in complex food system like chicken mince. Heat processing enhanced the antimicrobial activity against total viable count. Turmeric and heated turmeric had significantly higher activity against Clostridium sporogenes as compared to control. However, heat processing reduced the antimicrobial effect of turmeric against Clostridium sporogenes. Antimicrobial effect of turmeric against Clostridium perfringens was increased by heat processing.
REFERENCES


