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Evaluation of Antioxidant Effect of Spices and Condiment Mix as Nitrite Replacer in Chicken Mince

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ABSTRACT

The present study was carried out to compare the antioxidant effect of spices and condiments mix with nitrite added to chicken mince stored at 4±1^{0}C. The treatments include control (C), turmeric added @ 1000ppm (T), heated turmeric (120^{0}C for 15 min on hot plate added @1000 ppm (HT), turmeric @1000 ppm added along with 4% gingar and 4% garlic (GGT), meat masala (Agmark "Catch Masala") added @ 1000 ppm (MM) and sodium nitrite added @ 200 ppm (N).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. All the treatments showed better antioxidant effects than control. Among the treatments, the highest value of pH was found in GGT (5.95±0.02) and the lowest was found in T (5.86±0.04). In TBA, the lowest value was found in HT (0.55±0.09) and the highest was observed in T (0.65±0.11) among the treatments. The lowest PV among the treatments was found in HT (1.56±0.17) and the highest value was observed in N (2.03±0.21). The lowest FFA value was observed in HT (1.17±0.19) and T (1.58±0.33) had the highest FFA among the treatments. Heat treated turmeric and ginger garlic turmeric paste had the best antioxidant properties can be used as nitrite replacer for natural anti-oxidants in complex food like chicken mince.

Key words : *Fat oxidation, Garlic, Ginger, Heated turmeric*

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INTRODUCTION

Meat is a highly nutritious food eaten by human beings since time immemorial. It provides high quality protein, important minerals, vitamins etc. and is generally considered as nutrient dense food. Oxidation of lipids and muscle pigments is one of the main parameters of meat quality deterioration. Lipid oxidation can affect acceptability of food due to rancidity and may decrease the nutritional value by forming potential toxic products during cooking and processing (Maillard *et al*. 1996).

Various antioxidants like butylated hydroxytoluene (BHT) and butylated hydro-xyanisole (BHA), tocopherol, nitrite etc. are commonly used as antioxidants for preservation of meat products (Khalil and Mansour 1998) and are thus consumed in appreciable quantities by humans. Nitrite is having antibotulinal effect, also contributes cured flavor and cured color due to formation of nitric oxide myochrome [$(NO)_2$MC] in cooked meat (Douglas *et al*.1975). Nitrite is effective against lipid oxidation which is the major limiting factor for consumption of stored meat. Recently, one of the 10 universal guidelines for healthy nutrition published by the World Cancer Research Fund suggested to limit the intake of meat and especially to avoid nitrite cured meat (Demeyer *et al*. 2008). Added nitrite can react with secondary and tertiary amines of meat in acidic medium of stomach to form N- nitroso compounds which are toxic, teratogenic, mutagenic and carcinogenic.

Swan (1975) reported that there is a connection between nitrite and nitrate in food with anencephaly and spina bifida; hydrocephalus can also be induced in rabbits and dogs by sub lethal amount of nitrite. Several approaches have been attempted to replace nitrite in meat products in the past. They include the use of betalein, irradiation (Inas *et al*. 1982), sorbic acid (Vareltzis *et al*. 1984) and annatto (Zarringhalami *et al*. 2008), etc. But till date nitrite is widely used in processed meat. Thus there is a strong argument for the effective utilization of organic anti- oxidants from natural sources as alternative to prevent deterioration of foods via lipid and protein oxidation (Mc-Carthy *et al.* 2001). 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 1994). Hence, the present investigation was carried out to study the antioxidant effects of spices and condiments mix used as nitrite replacer in chicken mince.

MATERIALS AND METHODS

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 and slaughtered. The hot carcasses were kept in refrigerator at 4±1^{0}C for 24 hours. The chilled carcasses were deboned next day and lean meat was collected and then stored at -20^0 C till

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further use. Turmeric powder of "Agmark" grade was purchased containing 2.5% oleoresin content.

The deboned chicken was minced by passing twice through 9 mm and 4 mm plates of presterilized meat mincer (Sirman® TC-32, Italy). Then minced meat was divided into approximately six equal portions and assigned as the following treatments: control (C), turmeric added @ 1000 ppm (T), heated turmeric (120^{0}C for 15 min on hot plate added @1000 ppm (HT), turmeric @1000 ppm added along with 4% gingar and 4% garlic (GGT), meat masala (Agmark "Catch Masala") added @ 1000 ppm (MM) and sodium nitrite added @ 200 ppm (N). For HT, 1000 ppm of turmeric was weighed and then dissolved in water (10% by weight of chicken mince) as above and then boiled for 15 min on a hot plate (Tiwari *et al*. 2006). The LDPE bags containing inoculated chicken mince were sealed with the help of a sealer (Singhal®, HSP-200, India) and were stored at refrigeration temperature (4±1^{0}C). various physico-chemical properties like pH, TBA Tarladgis *et al.* (1960), peroxide value and FFA value (AOCS 1989) studies were carried out to compare the antioxidant properties against nitrite on 0, 3, 6 and 9th day of storage. The data obtained were analyzed by using ANOVA technique by Snedecor and Cochran (1989).

RESULT AND DISCUSSION

The analysis of variance indicated highly significant difference (P<0.01) in pH between treatments and between storage periods (table.1). However, interaction between treatment and storage period showed no significant difference (P<0.01). The pH values of control and treated samples increased over storage period. Addition of turmeric and nitrite did not have significant effect (P>0.05) on pH of chicken mince, whereas HT, MM and GGT group mince had significantly higher (P<0.01) pH when compared to control. The highest overall mean pH value among all the treatments was found in GGT. Mathew *et al.* (2008) found no significant difference in pH between control and 200 ppm nitrite added buffalo meat chunks stored at 4±1^{0}C for 20 days. Chan *et al.* (2002) also reported that turmeric added chicken mince had no significant difference (P>0.05) in pH during chilling storage (3±1^{0}C) for 9 days as compared to control. Naveena and Mendiratta (2001) reported significant (P<0.05) increase in pH of spent hen meat, when added with 3% ginger extract. Chicken meat balls added with 6% ginger showed significant increase (P<0.01) in pH during storage at -20±2^{0}C for 60 days (Reddy *et al.* 2005). Ockerman (1990) found that fresh garlic treatment in meat products resulted in significant increase in pH than other treatment of garlic oil and garlic powder addition in the preparation of Chinese style sausages. Therefore it is highly possible that ginger and garlic present in GGT treated mince samples might have increased the pH, not the T. Overall storage mean pH of chicken mince increased significantly (P<0.01) over storage period. Kumar and Sharma (2004) attributed the increase in pH during storage of low fat pork patties due to proteolysis by bacterial growth.

Table 1: pH values (Mean±SE) of minced chicken during storage

Storage days	Control (C)	Turmeric (T)	Heated turmeric(H)	Meat masala (MM)	Ginger + Garlic + turmeric (GT)	Nitrite (N)	Storage mean
0	5.75±0.01	5.76±0.01	5.85±0.01	5.83±0.01	5.88±0.02	5.83±0.02	5.82±0.02^A
3	5.83±0.01	5.81±0.02	5.88±0.01	5.89±0.01	5.93±0.02	5.87±0.02	5.87±0.02^B
6	5.92±0.02	5.87±0.01	5.93±0.01	5.95±0.01	5.97±0.01	5.90±0.02	5.92±0.02^C
9	6.07±0.04	6.01±0.03	6.01±0.02	6.03±0.03	6.02±0.02	5.98±0.03	6.02±0.05^D
Treatment mean	5.89±0.05^X	5.86±0.04^X	5.92±0.03^Y	5.93±0.03^Y	5.95±0.02^Y	5.89±0.02^X	

• Overall means bearing different superscripts between rows (A, B, C, D) and between columns (X, Y, Z) differ significantly (P<0.01).

TBA value is a measure of secondary lipid oxidation products like malonaldehyde, which is formed during oxidation of fat in meat (Olsen *et al.* 2005). HT and GGT had significantly higher (P<0.01) effect on rancidity having lower overall mean TBA value as compared to T, N and MM. However no significant difference (P>0.05) was found among T, MM and N and among GGT and HT. Han *et al.* (2000) recorded that 100 ppm nitrite treated ground pork sample stored at 5^{0}C showed higher antioxidative effect than control. The antioxidant effect of nitrite in cured meat is due to formation of strong complex with haem Fe which in turn prevents the release of non-haem Fe and helps in delaying of lipid oxidation (Gordon 1996). 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-

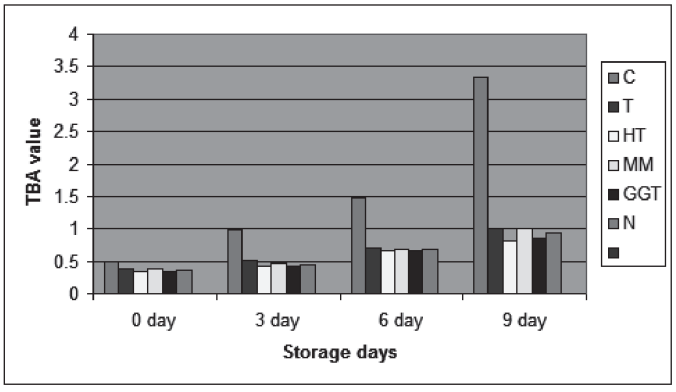
heated turmeric. Tiwari *et al.* (2006) found that heated turmeric (>100^{0}C for 10 min) was having higher antioxidant properties than non-heated turmeric. Reema *et al.* (2005) found significantly lower TBA value than control samples during storage of 2% ginger added chevon patties when stored at 0-2^{0}C for 28 days. 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 was because of increase lipid oxidation and production of volatile metabolites in the presence of oxygen.

Table 2 : TBA values (Mean±SE) of minced chicken during storage

Storage days	Control (C)	Turmeric (T)	Heated turmeric(H)	Meat masala (MM)	Ginger + Garlic + turmeric (GT)	Nitrite (N)	Storage mean
0	0.48±0.01^{a}	0.38±0.01^{b}	0.33±0.01^{c}	0.38±0.01^{b}	0.34±0.005^{c}	0.36±0.00^{c}	0.38±0.02^{A}
3	0.97±0.05^{d}	0.51±0.02^{a}	0.42±0.01^{cb}	0.476±0.01^{b}	0.42±0.01^{cb}	0.45±0.01^{b}	0.54±0.07^{B}
6	1.46±0.04^{e}	0.71±0.02^{gfh}	0.66±0.01^{hg}	0.69±0.01^{hg}	0.65±0.02^{h}	0.68±0.01^{gh}	0.81±0.12^{C}
9	3.34±0.09^{i}	1.00±0.01^{j}	0.81±0.02^{k}	1.00±0.02^{j}	0.84±0.02^{k}	0.94±0.011	1.32±0.03^{D}
Treatment mean	1.56±0.04^{Z}	0.65±0.11^{Y}	0.55±0.09^{X}	0.64±0.11^{Y}	0.56±0.09^{X}	0.61±0.11^{Y}	

- Overall means bearing different superscripts between rows (A, B, C, D) and between columns (X, Y, Z) differ significantly (P<0.01).
- Interaction means bearing different superscripts (a, b, c, d…..) differ significantly (P<0.01).

Fig. 1 : Effect of turmeric, nitrite, other spice treatments and storage period on TBA (mg malonaldehyde/kg) of minced



The overall mean peroxide value for N, T, HT, GGT and MM were significantly lower (P<0.01) than C. Highly significant difference (P<0.01) was found between HT, GGT, MM, T and N treated chicken mince. HT had significantly higher (P<0.01) antioxidant effect (lower overall mean PV) when compared to N, T, MM and GGT. N had significantly lower overall mean PV (P<0.01) than C, but had the highest overall mean PV among all other treatments. It may be because of composition of nitrite where one part of nitrogen is present in combination with two parts of oxygen (Beest 2006). Chan *et al.* (2002) averred that turmeric extract was an effective antioxidant in chicken mince stored at refrigerated temperature. Further, Liew *et al.* (2002) reported that turmeric had the highest antioxidant property in chicken balls during chilled storage for 10 days. Sreejayan *et al.*(1994) reported that curcumin is a potent inhibitor of lipid per oxidation catalyzed by Fe and its chelates in rat brain homogenate and rat liver microsomes. Suresh *et al.* (2007) recorded significant loss (27-53%) of curcumin during heat processing of turmeric by boiling for >10 min. In the present study heat processing of turmeric by boiling for 15 min showed significantly higher (P<0.01) antioxidant effect than non-heated turmeric. The phenolic groups of turmeric provides a labile hydrogen atom for abstraction by free radicals and get converted to phenoxyl radical which are unreactive, thereby terminating the lipid oxidation reaction. Higher antioxidant property of heated turmeric than non-heated turmeric might be due to this increase in phenolic compounds during heat processing. Dzudie *et al.* (2004) evaluated the antioxidant properties of ginger and found that beef patties containing 0.2% level of ginger essential oils showed the best characteristics in relation to lipid oxidation when compared to ground oil and animal fat. The peroxide values significantly (P<0.01) increased during refrigerated storage in all the treatments.

The overall mean FFA value for N, T, HT, MM and GGT were significantly lower (P<0.01) than C. HT and GGT had significantly lower overall mean FFA value than N, T and MM. However, there was no significant difference (P>0.05) between HT and GGT and among N and MM. Heat processing of turmeric was found to be more effective in reducing FFA value. Mathew *et al.* (2008) observed that nitrite treated buffalo meat chunks had significantly lower (P<0.01) FFA values than control and were acceptable up to 20 days, when stored at refrigeration temperature. Hameed *et al.* (2007) reported that dehydrated chicken chunks (smeared with turmeric followed by drying at 60^{0}C for 8 hours) packed in LDPE had significantly lower FFA value than control, when stored at

Table 3 : Peroxide values (Mean±SE) of minced chicken during storage

Storage days	Control (C)	Turmeric (T)	Heated turmeric(H)	Meat masala (MM)	Ginger + Garlic + turmeric (GT)	Nitrite (N)	Storage mean
0	1.36 ± 0.03^{ab}	1.14 ± 0.02^{cb}	1.05 ± 0.02^{c}	1.23 ± 0.03^{b}	1.10 ± 0.02^{ce}	1.30 ± 0.02^{cb}	1.19 ± 0.04^{A}
3	2.45 ± 0.06^{d}	1.68 ± 0.09^{fe}	1.46 ± 0.11^{f}	1.70 ± 0.07^{e}	1.65 ± 0.05^{f}	2.01 ± 0.02^{g}	1.82 ± 0.14^{B}
6	2.90 ± 0.03^{h}	2.01 ± 0.08^{i}	1.73 ± 0.08^{j}	1.95 ± 0.09^{j}	1.81 ± 0.04^{j}	2.20 ± 0.04^{i}	2.10 ± 0.15^{C}
9	3.66 ± 0.04^{j}	2.61 ± 0.06^{k}	2.01 ± 0.07^{l}	2.53 ± 0.05^{m}	2.15 ± 0.06^{l}	2.80 ± 0.05^{k}	2.63 ± 0.13^{D}
Treatment mean	2.59 ± 0.41^{Z}	1.86 ± 0.26^{X}	1.56 ± 0.17^{U}	1.85 ± 0.23^{W}	1.67 ± 0.18^{V}	2.03 ± 0.21^{Y}	

- Overall means bearing different superscripts between rows (A, B, C, D) and between columns (U, V, X, Y, Z) differ significantly ($P<0.01$).
- Interaction means bearing different superscripts (a, b, c, d…..) differ significantly ($P<0.01$).

room temperature for 60 days. The present study revealed that heat processing of turmeric significantly improved ($P<0.01$) it's effectiveness against development of FFA in chicken mince as compared to non-heated turmeric. Tiwari *et al.* (2006) found higher antioxidant properties in heat processed turmeric than non-heat processed turmeric under *in vitro*condition. Yeh and Lie (2001)studied the antioxidant properties of garlic and stated that exogenous addition of garlic and curry leaves activated crucial enzymes and protected the lipids of food against oxidation. Borek (2001) reported that isothiocynates present in ginger and garlic inactivated and modified several enzymes in meat like 3-hydroxy-3-methyl glutaryl CoA reductase, glutathione-S-transferase and catalase, resulting in prevention of lipid oxidation. 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) and Kanatt *et al.* (1998). Kanatt *et al.* (1998) reported that lipolysis of meat during storage by the action of tissue enzymes and lipolytic enzymes obtained from spoilage microorganisms led to the formation of FFA.

Table 4 : Free fatty acid values (Mean±SE) of minced chicken during storage

Storage days	Control (C)	Turmeric (T)	Heated turmeric(H)	Meat masala (MM)	Ginger + Garlic + turmeric (GT)	Nitrite (N)	Storage mean
0	0.98 ± 0.03^{ah}	0.73 ± 0.01^{bc}	0.63 ± 0.009^{c}	0.71 ± 0.02^{cd}	0.68 ± 0.01^{d}	0.76 ± 0.02^{cbd}	0.75 ± 0.07^{A}
3	2.22 ± 0.04^{e}	1.26 ± 0.05^{f}	1.00 ± 0.02^{ah}	1.14 ± 0.04^{g}	0.94 ± 0.02^{h}	1.20 ± 0.03^{g}	1.29 ± 0.17^{B}
6	2.83 ± 0.04^{i}	1.76 ± 0.01^{j}	1.35 ± 0.03^{g}	1.72 ± 0.08^{k}	1.33 ± 0.05^{g}	1.77 ± 0.07^{jkn}	1.79 ± 0.18^{C}
9	3.10 ± 0.03^{l}	2.56 ± 0.04^{m}	1.71 ± 0.05^{n}	2.29 ± 0.05^{o}	1.83 ± 0.09^{j}	2.04 ± 0.02^{p}	2.25 ± 0.19^{D}
Treatment mean	2.28 ± 0.40^{Z}	1.58 ± 0.33^{Y}	1.17 ± 0.19^{W}	1.47 ± 0.29^{X}	1.19 ± 0.21^{W}	1.44 ± 0.24^{X}	

- Overall means bearing different superscripts between rows (A, B, C, D) and between columns (W, X, Y, Z) differ significantly ($P<0.01$).
- Interaction means bearing different superscripts (a, b, c, d…..) differ significantly ($P<0.01$).

CONCLUSION

Spices and condiments used in Indian culinary practices are acting as natural antioxidants and prevent the lipid breakdown in meat.It can be concluded that heat processing made turmeric a better antioxidant than nitrite in complex food system like chicken mince. Ginger garlic turmeric paste does not only provide the flavor, even also prevent lipid oxidation and free radical formation. So ginger, garlic paste and heated turmeric has great potential to replace nitrite as strong natural antioxidants.

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