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Effect of Graded Levels of Lemongrass (*Cymbopogon citratus)* on Oxidative Stability of Raw or Cooked Pork Patties

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Abstract: The antioxidative potential of ground lemongrass (*Cymbopogon citratus*) was evaluated at graded levels on raw and cooked pork patties, under refrigeration for 9 and 6 days for raw and cooked respectively, in a 5 x 2 x 4 factorial experiment. In 200 g pork patties 0, 0.5, 1 or 1.5% lemongrass was added and a reference control was prepared with 200 mg α-tocopherol acetate in 200 g pork patties. Results showed that raw pork patties with lemongrass had lower TBARS values than the control or α-tocopherol treated pork patties. Raw pork patties treated with any level of lemongrass had lower TBARS values than their cooked counterparts. Addition of 1.5% lemongrass was effective in reducing lipid oxidation in raw patties under refrigeration. Lemongrass can conveniently replace synthetic antioxidant such as BHA, BHT and TBHQ that consumers have worry for due to their health safety.

Key words: Lemongrass, α-tocopherol acetate, lipid oxidation, raw or cooked pork patties

INTRODUCTION

Lipid oxidation is one of the major problems encountered in meat processing industry leading to quality deterioration, manifesting in adverse changes in colour, flavour and nutritive values couple with accumulation of deleterious compounds causing various human diseases, such as cancer, atherosclerosis and heart problems (Nawar, 1996; Cordon, 2001; Wasowicz *et al*., 2004; Choi and Lee, 2009). Lipid oxidation is an important determinant of shelf life of meat and meat products. Meat deterioration starts following animal slaughter. Pork is an excellent source of protein, but it is very high in lipids thus making it susceptible to oxidative deterioration. The control of lipid oxidation in fresh and processed meat products is the focus of meat scientists. The addition of synthetic antioxidants such as 3-tert-butyl-4-methoxyphenol (that is, butylated hydroxyanisole, BHA); 2, 6-di-tert-butyl-4-methlphenol (that is, butylated hydroxytoluene, BHT) and Tert-Butylhydroquinone (TBHQ) has been used extensively in the meat industry to ensure product preservation and shelf life improvement (Khalil and Mansour, 1998; Byrd, 2001). However, due to the toxicological effects of synthetic antioxidants, consumers have shown preference for the use of natural antioxidants (Namiki, 1990; Madhavi and Salunkhe, 1996; Byrd, 2001; Johnston *et al*., 2005). α-Tocopherol is a lipid soluble natural biological antioxidant which scavenges oxygen and protects against oxidation of double bonds in Poly Unsaturated Fatty Acids (PUFA) (Nunez de Gonzalez *et al*., 2008). In recent times several studies have been carried out on the antioxidant potentials of naturally occurring plant extracts such as ginseng, aloe vera, sage, rosemary, tea catechins, fenugreek, soya protein, mustard and plum (McCarthy *et al*., 2001; Nunez de Gonzalez *et al*., 2008).

Lemongrass (*Cymbopogon citratus)* is a perennial, aromatic tall tropical grass that is commonly used as herbs for flu, headache, malaria, coughs elephantiasis, pneumonia digestive problems, diarrhea, stomach upsets and vascular disorders (Ozer *et al*., 1995). It is also used as a stimulant, diuretic, antispasmodic and a mild irritant (Simon *et al*., 1984). The plant grows in a dense clump up to 2 meters in diameter and has leaves up to 1 meter long, with densely tufted fibrous roots. The fresh stalks and leaves have a clean lemon-like odour. The oil of this plant is sherry coloured with pungent taste, it has citral as the principal constituent. Other constituents of the oil are terpineol, β-myrcene, citronellol, limonene, geranoil, dipentene, methyl heptenon and nerol (Simon *et al*., 1984). Ojo *et al*. (2006) report that lemongrass and green tea inhibited paracetamol-induced lipids peroxidation in rats. Little research has been carried out on this particular cheap and common plant as an antioxidant in meat or meat products, thus this study was designed to evaluate the antioxidative potential of lemongrass in both raw and cooked pork patties and to also determine the optimum level of its use.

MATERIALS AND METHODS

The lemongrass leaves were harvested from homes in Tanke area, a neighbourhood of the University, Ilorin. The leaves were rinsed with water, chopped and then

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oven dried at 40°C for 2 days. The dried leaves were finely ground in a dry cup grinder.

Four kilogram pork meat (ham) was bought from a reputable meat shop. The skin, bones and fat trimmings were manually done; the meat was then cut into small pieces before mincing in a food processor (National MK-5080M Matsushita Electric Industrial, Japan). Into 200 g minced pork meat 0, 0.5, 1 or 1.5% of lemongrass powder was added and mixed thoroughly. A positive reference control was prepared by mixing 200 mg α-tocopherol acetate with 200 g minced pork meat. Each treatment was prepared for both raw and cooked and was subdivided into 20 g wrapped in cellophane and formed into patties using a locally fabricated patty mould designed by the Faculty of Engineering, University of Ilorin. The samples for cooking were done in a microwave oven for $1^{1}/_{2}$ min. All the samples were stored in a refrigerator for 9 or 6 days for raw or cooked respectively. Evaluation was done at 3 or 2 days interval for the raw and cooked samples respectively.

Analysis of lipid oxidation: Thiobarbituric Acid-Reactive Substances (TBARS) assay was performed in triplicates using the method of Pikul *et al.* (1984).

Statistical analysis: The study was a 5 x 2 x 4 factorial experiment with antioxidant (control, 0.5, 1, 1.5% lemongrass or 200 mg α-tocopherol) meat state (raw or cooked) storage days (9 or 6 evaluated at 3 or 2 days intervals for raw or cooked respectively). Each treatment was replicated 3 times. Data were subjected to Analysis of Variance (ANOVA) using the Genstat 5 program (Pane *et al.*, 1987). Fishers Least Significant Difference (LSD) test ($p<0.05$) was used to separate the treatment means.

RESULTS AND DISCUSSION

The addition of 0.5, 1 or 1.5% lemongrass to raw pork patties produced a significantly ($p<0.05$) lower TBARS values than the control or 200 mg α-tocopherol treated pork patties (Fig. 1). The reduced TBARS values recorded for raw pork patties with increasing concentration of lemongrass could be due to a synergistic effect with the endogenous antioxidant enzyme (especially catalase) in the tissue (Rhee *et al.*, 1996; Pradhan *et al.*, 2000). The 200 mg α-tocopherol treated raw samples had the highest TBARS values though this was not significantly ($p>0.05$) different from the control. This indicates that the antioxidative effect of α-tocopherol is weaker than that of lemongrass at any level of inclusion in raw pork patties. However, the opposite was the case in cooked pork patties as added α-tocopherol recorded the least ($p<0.05$) TBARS values which was only matched statistically by the 1% lemon grass. This contradicts the report of Higgins *et al.* (1998) that direct addition of α-tocopherol did not significantly ($p>0.05$) affect lipid oxidation in cooked turkey meat, as exogenous α-tocopherol added postmortem can only be

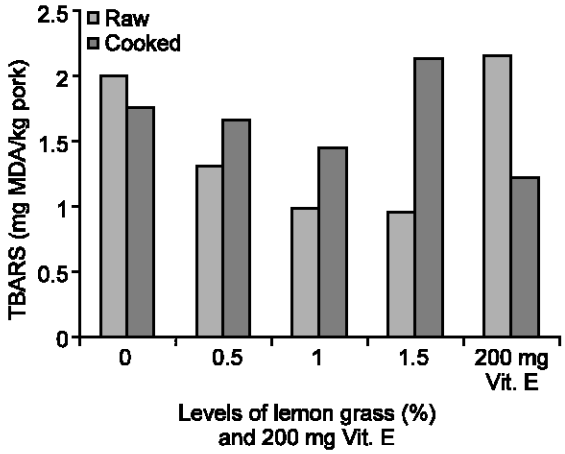

Fig. 1: Effect of graded levels of lemon grass (%) or 200 mg α-tocopherol acetate on oxidative stability of pork meat

incorporated into the neutral fraction thus having a low inhibition on oxidation. The cooked pork patties with 1.5% lemongrass inclusion had surprisingly the highest TBARS of 2.14 mgMDA/kg meat which was higher ($p<0.05$) than any other treatment including the control. The cooked pork patties with any level of added lemongrass had higher ($p<0.05$) TBARS values than their corresponding raw samples. Different reasons have been given for the higher TBARS values observed for cooked pork patties over the raw patties these include (1) disruption of muscle membrane systems (thus, leading to loss of structural integrity) which occurs during cooking, thus exposing membrane lipids to lipid oxidant catalysts, (2) increase in ionic iron concentration from heat-induced release of protein-bound iron after cooking,(3) inactivation of antioxidant enzymes in meat due to cooking,(4) the formation of the hypervalent ferrylmyoglobin (or activated metmyoglobin during cooking (Harel and Kanner, 1985; Asghar *et al.*, 1988; Rhee, 1988; Mei *et al.*, 1994). But the reverse was the case with the 200 mg α-tocopherol treated and the control meat samples. Liu *et al.* (1994) observed that the antioxidant effect of α-tocopherol in cooked meat was less than that of the raw meat. This contradicts our observation in this study as addition of exogenous α-tocopherol significantly ($p<0.05$) reduced lipid oxidation in cooked pork patties than the raw. Nunez de Gonzalez *et al.* (2008) report an increase in TBARS of precooked sausage pork patties treated with dried plum refrigerated or frozen over the raw. Ahn *et al.* (2002) report that rosemary and α-tocopherol retarded oxidation during and immediately after cooking, lemongrass could not be said to play such a role here.

The effect of storage days was also found to have a significant ($p<0.05$) on the oxidative stability of both raw and cooked pork patties (Fig. 2). In the raw pork patties,

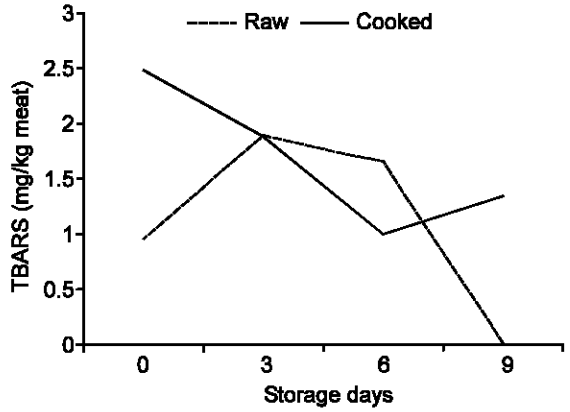

Fig. 2: Effect of storage days on oxidative stability of raw and cooked pork patties

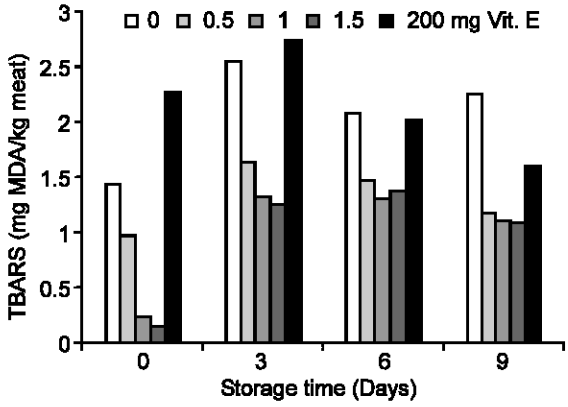

Fig. 3: Relationship of graded levels of lemongrass or 200 mg α-tocopherol acetate and storage days on oxidative stability of raw pork patties

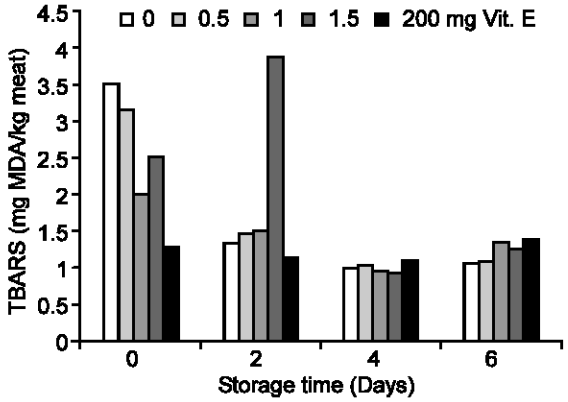

Fig. 4: Relationship between graded levels of lemon grass or 200 mg α-tocopherol acetate and storage days on oxidative stability of cooked pork patties

lipid oxidation increased sharply from the beginning till day 3, it then began to reduce steadily from day 6 to day 9. But in the cooked pork patties a decrease in oxidation was noticed from day 2 to day 4 by day 6 it has started to rise.

The effect of graded levels of lemongrass or 200 mg α-tocopherol and storage days on oxidation of raw pork patties is shown on Fig. 3. Both addition of lemongrass or α-tocopherol and storage time were found to influence ($p<0.05$) oxidation of raw pork patties. Interaction of these two factors was also noticed ($p<0.05$). The antioxidant effect of lemongrass was very pronounced on raw pork patties on day 0, with the meat patties treated with 1.5% lemongrass recording the least TBARS values which was not statistically different from those with 1% lemongrass. The raw pork patties treated with α-tocopherol had TBARS values that were significantly ($p<0.05$) more than other treated meat patties including the control on day 0 but were not significantly ($p>0.05$) different from the control on day 3. However, by day 6 of storage the antioxidative potential of α-tocopherol has started to manifest in raw patties this continues till day 9 where its TBARS values were not significantly ($p>0.05$) different from the raw pork patties treated with lemongrass. Oxidation was observed to increase sharply on day 3 irrespective of the treatment, but by day 6 a decline in oxidation was seen with the α-tocopherol, control and 0.5% lemongrass included patties. On day 9 of storage while all the treated meat patties were experiencing reduction in rancidity the control samples were in increasing in oxidation. Raw pork patties treated with any level of lemongrass was significantly lower ($p<.0.05$) than the control or 200 mg α-tocopherol treated pork patties throughout the storage period except on day 0 when the 0.5% lemongrass treated meat was not statistically different from the control.

Figure 4 shows the effect of graded levels of lemongrass or 200 mg α-tocopherol and storage days on oxidative stability cooked pork patties. There was an interaction between antioxidant agents and storage days. On like the raw pork patties the antioxidant potential of α-tocopherol was more effective in the cooked pork patties. The varied effect of α-tocopherol observed in this study could probably be attributed to the reasons given by Huang *et al.* (2005) that α-tocopherol could act as an antioxidant or as a prooxidant depending on the test system, the concentration, the oxidation time and the method used to determine lipid oxidation. The high TBARS values observed on day 2 for cooked pork treated with 1.5% lemongrass (3.87 mg MDA/kg meat) which was significantly higher ($p<0.05$) than any other treatment could not be explained. McCarthy *et al.* (2001) report on the antioxidant properties of tea catechins used at 0, 0.01, 0.05, 0.10, 0.25, 0.50, or 1% level in fresh or previously frozen pork patties that the optimum working concentration of tea catechins ranged from 0.25-1% (2500-10,000 mg/kg) and that optimum concentration of tea catechins was 0.25% (2500 mg/kg).

Mitsumoto *et al*. (2005) report a lower concentration of 400 mg tea catechins per kg of meat to work well in retarding the development of rancidity. In this study it was observed that raw meats were more prone to lipid oxidation than the cooked meats stored under the same storage conditions, except on day 0.

Conclusion: Inclusion of lemon at any level (0.5, 1 or 1.5%) was found to inhibit lipid oxidation better than exogenous 200mg α-tocopherol acetate in raw pork patties under refrigeration. Lemongrass inclusion at 1.5% in raw pork patties was found to more effective than 200mg α-tocopherol acetate. Treating cooked pork with any antioxidant agent did not improve lipid stability during the storage period examined.

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