The effect of substituting sodium nitrite, with sodium acetate on microbial, physiochemical and sensory characteristics of meat products

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ABSTRACT

In recent years, sodium nitrite has been considered as an unrivaled additive, due to its capability to deal with clostridium botulinum and its positive effect on the color of meat products. However, it leads to the production of nitrosamine carcinogens. Lately, the application of organic acids and their salts have been more considered due to their natural and appropriate antimicrobial properties. Antimicrobial effect of lactate in meat and meat products was studied and its effect against many spoilage microorganisms and disease has been demonstrated. Lactate and sensory properties of products such as color, improve texture and taste, and also exhibit antioxidant effect. The effect of sodium lactate on production of Clostridium botulinum Botulism is confirmed and authorized. Sodium lactate reduces the population of bacteria and spore-bearing anaerobic in meat during storage, providing further effects than nitrite. Lactate effect on the formation of nitrous myoglobin from matt myoglobin in meat-curing system has been studied. Sodium lactate, allows the re-shaping of oxymyoglobin from reduced dioximyoglobin that leads to the formation of durable reddish color in meat. Recent research has shown that hydroxy hemoglobin correlates with nitrate reductase activity that forms nitric oxide in biological systems. Microbial growth has been more significantly decreased when lactate is added to meat products, compared to nitrite, and lactate shows a better performance as an antimicrobial. Sodium lactate has been proved to cause no change in the sensory characteristics of the product and slight improvement in the flavor. The only flaw is the inability to form a pinkish red as is accepted as the common color of prepared meat products using nitrite. In this paper, the effects of adding sodium lactate to meat products and examination of its effect on the sodium nitrite was addressed. The following paper is looking for a method that would achieve the best results by reducing nitrate and increasing sodium lactate at the same time.

Keywords - Meat sausage, sodium lactate, sodium nitrate

I. INTRODUCTION

In recent years, the demand for cooked and ready-to-eat food has been enhanced due to its ease of use. Many microorganisms which have survived after the thermal process, can cause undesirable changes in the product and multiply during storage, and increase the health risk. (Bingol & bostan, 2007). Application of antimicrobial elements is one of the common ways to maintain microbial safety and increase the shelf life of food products. Due to their efficiency and usefulness, nitrates and nitrites are preferred in conjunction with Clostridium botulinum which are the most important food borne pathogens, and also effect the color of the product (Pegg et al, 2005). Since thousand years ago, production of processed products had possibly started with curing with salts of potassium nitrite. Nitric oxide is reduced form of nitrite and nitrate and is responsible for color and flavor forming reactions of the processed meat and is also capable of participating in antimicrobial and antioxidant activities and stabilizing the color. (Vasavada & Cornforth, 2005 And Brooke et al, 2011) However this material leads to the production of carcinogens nitrosamine, causing digestive diseases such as stomach cancer (Garcia et al, 2010). One of the main properties of food components is to cause no adverse sensory changes in the final product (Smaoui1 et al,
Lately, the application of organic acids and their salts have been more considered due to their natural and appropriate antimicrobial properties. Lactic acid and its salts (acetate) are suggested to be added as food additive. Because they naturally exist in meat and fermented products, and influence many pathogenic microorganisms and spoilage factors, while nsuring no health risks and no negative impact on sensory characteristics. Sodium and potassium lactate are extensively applied as ingredients in fresh and processed meats. Adding a small amount of sodium or potassium lactate, salt and water can improve taste and color, as well as meat tenderness and providing antimicrobial and antioxidant activities (Kim et al., 2009a & 2010 and Mancini et al., 2009). Lactate can minimize the oxidation of fats and stabilize color of products. (mancini et al., 2010) United States Department of Agriculture (USDA) authorized the addition of sodium or potassium lactate up to 8/4% maximum, to prevent microbial growth in meat and poultry products. As the second leading cause of quality devaluation in meat products, oxidative rancidity is one the effective elements especially in products with high fat content. (Cheng et al., 2007). Usage of lactate and vinegar increases the authenticity and freshness and reduces undesirable flavors and rancidity until 14 days (Bradley et al, 2011) lactate improves pro sensory characteristics such as color, texture and taste, demonstrate the antioxidant activity (kim et al, 2010a) also increases reducing activity of matt myoglobin by increment of reducing substrate (NADH). (Rodriguez, 2011)

Researchers conducted, mainly are emphasized on nitrate removal by sodium lactate and other alternative materials so that the biological results obtained in all cases, show that sodium lactate indicates a better performance than sodium nitrite, although in all cases the color of the product was unsuitable as natural color of heated meat. (Enver et al 2007, Smaoui et al 2011 and Seydim et al 2006).

II. EFFECT OF SODIUM NITRATE AND SODIUM ACETATE IN MEAT PRODUCTS

The use of nitrite and nitrate in meat products factories commonly implicate processing. (Oxford Dictionary 2000) Other words, like curing meat can also be used for this task. Nitrate and nitrite are used in cured meat products. In most countries they are used as assistance of sodium and potassium and the remaining amount can be controlled or used according to the rules and laws. Nitrite is an effective substance that acts primarily as a deterrent for some; MO. Nitrite is added to meat paste and to some extent, is oxidized by oxygen and conversed into nitrate. Therefore acts as an antioxidant. Part of nitrite binds to myoglobin, and form heat stable pigment nitrous myoglobin (Honikel, 2008). Nitrite can form carcinogenic nitrosamine in the acidic environment in the stomach. In the first three decades of the nineteenth century, a large number of deaths occurred due to nitrite poisoning in meat products, so that Germany government came up with nitrite limitation laws as the solution to the problem.

![Figure 1 - Terms of nitrosamine formation and chemical reactions, only two types of amines are able to form nitrosamine. The amines of first type immediately break into alcohol and nitrogen; tertiary amines are not able to form nitrosamine (Honikel, 2008). Antimicrobial effect of lactate in meat and meat products was studied and its effect against many spoilage microorganisms and disease is proven. Lactate and sensory properties of products such as color, improve texture and taste, and also exhibit antioxidant effect. It was observed that sodium lactate minimizes the loss of taste, and palatability during storage is increased with increment of 1% sodium lactate. It was observed that 1% sodium lactate retains the red color of the pork sausages while increasing the salty taste of the meat. The differences in color between samples containing nitrite and sodium lactate have been observed. In samples containing sodium nitrite pinkish red color was visible, while the natural color of cooked meat were observed in samples containing sodium lactate, so that depending on the type of consumer, that might be a bad combination (Jensen et al, 2003).

The significant effect of sodium lactates in meat products is its ability to increase the shelf life. The product containing 8/1% sodium lactate did not show
any corruption at the end of 60th day when compared with a control group that demonstrated corruption on the 30th day while applying no preservative. In samples containing 6/0% and 2/1% sodium lactate changes in texture and color were observed after 45 days and 60 days (Bingol & bostan, 2007). Retention of meat and poultry products can increase up to 30 to 150% by application of sodium lactate. It is specified that the usage of sodium lactate in fresh pork sausages is effective in maintaining low bacterial counts and increases shelf life is about two weeks longer than the control group. It is reported that sodium lactate increases the shelf-life of products such as ham and sausages approximately for 1-2 weeks. Besides, addition of 1.2% sodium lactate increases durability of the Swiss Sliced chickens respectively, 3 to 4 times more than before.(using air atmosphere packaging and temperature at 5 to 7) (Cubina, 1995).

The anti botulism effect of sodium lactate on Clostridium botulinum has been confirmed. Sodium lactate reduces the population of bacteria and spore – bearing anaerobic in meat during storage, providing further effects than nitrite. Yeasts isolated from meat products show 10 times the resistance to sodium lactate. Sodium lactate is determined to show no significant impact on yeasts, while molds are delayed up to 30 days (Bingol & bostan, 2007). Furthermore, in a research conducted by (Apostolidis et al, 2008), Water-soluble phenolic extracts of oregano and Nagorno Qath were tested in combination ratio of 50:50 with 2% sodium lactate in the concentration of 750 ppm, which led to the best results. Function of phenol of these two plants justifies their usage instead of proline. Proline accelerates the growth of bacteria and when it is associated with sodium lactate, can act as a multilayer shield against bacteria. Effect of rosemary extract and sodium lactate on the quality of vacuum-packed ostrich meat containing 2% sodium lactate and 2/0% rosemary extract was evaluated that resulted in quite sensible aerobic bacteria reduction in samples. But in the case of lactic acid bacteria and Brochothrix Thermosphacta, combination of rosemary and sodium lactate, is more effective than sodium lactate alone from the start day to the sixth. Although sodium lactates works well as bacterial inhibitors and antioxidant factors in ostrich meat. Sodium lactate and rosemary illustrate a better microbial results compared to the time they are used alone, that shows the Synergistic effects of these two items. Thus, sodium lactate, alone or in combination with rosemary extract can maintain good chemical quality of the product and reduce microbial growth and increase shelf life of ostrich products in the cold storage. (Atif C. Seydim et al, 2006). Concentration of 7/2% sodium lactate has a greater effect than 7/1% sodium lactate in fresh pork and turkey sausage. It is notable that the aerobic and anaerobic bacteria are reduced with increasing concentrations of sodium lactate. High levels of lactate ions may change the reaction of pyruvate to lactate, which is closer to the thermodynamic equilibrium (Vasavada et al, 2003). In addition, sodium lactate salt that acts as a fragmented acid, which passes through the membrane of bacteria causing the acidic intracellular environment (Carpenter & Bradbent 2009). An investigation found that intracellular pH and cell metabolism may be quickly reduced by denaturation of the cell bodies and cell death occurs (Bradley et al, 2011). Therefore, adding sodium lactate is suggested to lower the water activity and hence reduces microbial growth. Many researchers have reported that sodium lactate did not change the pH and water activity effect is the only reason for the microbial growth delay (Vasavada et al, 2003). According to (Gonzalez-fandoseal 2009), system buffering acid capacity seems to be effective in keeping pH low. It was found that sodium lactate helps to maintain pH stability during storage periods due to the buffering capacity of the material. Chemical changes, microbial effects and sensory characteristics of chicken cured by lactic acid in various concentrations of 1%, 8/0, 6/0, 5/0 3/0, 2/0, and sodium lactate at 3% and 5/2, 2 , 5/1, 1 have been studied in 4 cases. Results indicate that both types of compounds fight against the proliferation of spoilage microorganisms such as Staphylococcus aureus, Salmonella spp, Pseudomonas, Enterobacteraeae, psychrophilic and aerobic bacteria. In this study, sodium lactate did not change the organoleptic properties of the final product, and addition of sodium lactate improves the usual taste of the meat as well as minimizing the flavor loss during storage. 1% sodium lactate improves pleasant taste, but no improvement is seen in 1 to 2%. (Smaoui1 et al, 2011). The sensory characteristics did not change with the addition of sodium lactate and taste of the samples slightly improved. Compared with the pinkish red color of the samples containing sodium nitrite, samples containing lactate maintained natural meat color. Sodium lactate delays microbial growth, which depends on its concentration. Sodium lactate will not cause a change in the PH during storage is effective
in microbial quality. The study found that adding sodium lactate to the sausages improved the microbial quality which depends on the concentration used, resulting in long shelf life and better antimicrobial effect than sodium nitrite. (Bingol & Boston, 2007).

III. EFFECT OF LACTATE ON FORMATION OF NITRIC FROM MYOGLOBIN AND NITROUS MATT MYOGLOBIN

Myoglobin is the main protein responsible for meat color. Although, other "Heme" proteins such as hemoglobin and cytochrome C may be involved in the formation of color of beef, lamb, pork and chicken (mancini & hunt, 2005) the Effect of lactate on formation of nitric from myoglobin and nitrous Matt myoglobin was observed in cured meat system performing 2 experiments, to determine the effect of lactate on the nitrites in processed meats. In the first experiment, the 8 models are used to study the reaction between compounds containing nitrite and lactate to determine the effects of each compound on the activity of reducing matt myoglobin. Except lactate, nicotine amide adenine dinucleotide (NAD), L - lactate dehydrogenase (LDH) or phenazine Methosulphate (PMS), did not lead to reduction activities. The second experiment utilizes the meat combination to assess the lactate (% 6 or 4, 2, 0), nitrite (ppm 156 or 0) and packaging (exposed to oxygen or vacuum) effect on remaining nitrite, meat color and pH. Addition of lactate reduces residues nitrite.

Both experiments support the hypothesis that lactate, produces NADH that results in detraction of Matt myoglobin to dioxo myoglobin (Brooke et al, 2011). Lactate improves color stability in vacuum packaging and packaging with high oxygen. (Mancini et al, 2009). This could be due to increased activity of reducing Met myoglobin by the NADH produced by lactate dehydrogenase (Kim et al, 2009b) or by the reaction between lactate and myoglobin (Mancini et al, 2009). The difference in spread internal color and biochemical characteristics of cooked steak increases by both D, L lactate, which shows that the coupling reactions of lactate-LDH may be a potential mechanism for the spreading the color of flesh containing lactates (kim et al, 2010b). Higher concentrations of these materials also reduce the hemoglobin which subsequently reacts with nitrite to produce more nitric oxide, resulting in reducing the concentration and then accelerating nitrite curing reaction ( Brooke et al , 2011 ). Reducing agents such as sodium sorbate or sodium ascorbate, and reducing product of pH, significantly increase the reduction of nitrite to nitric oxide in processed meat (2008 and Honikel).

Sodium lactate, allows the re-shaping of oximyoglobin from reduced dioximyoglobin, which leads to the formation of durable reddish color in meat which is customer satisfactory. (2005, Mancini & Hunt). . Recent research has shown that hydroxy hemoglobin activities correlate with nitrate reductase activity that forms nitric oxide in biological systems. (Hendgen-Cotta et al , 2008 ) In addition, direct reaction between dioxy myoglobin and nitrite, lead to formation of nitric oxide and at the same time, the production of nitrous myoglobin is suggested as a reaction occurring during meat curing. Nitrite reduction to nitric oxide is associated with oxidation of dioxymyoglobin in meat systems. It can be assumed that the addition of lactate to the meat will increase myoglobin reduction capacity to produce more dioxymyoglobin. Nitric oxide is more formed subsequently and proceeds reduction in residual nitrite and develops nitric oxide production to increase meet processing reactions in the presence of lactate (brooke et al, 2011).

Limited research was carried out on the effect of lactate on the normally processed meat color when lactate is used as an antimicrobial agent. Thus, this research aims to identify and assess the effect of lactate on nitrous myoglobin formed by the reaction of LDH - LDH in model systems (Experiment 1), and processed meats (Experiment 2).

Nitrite reduction in the presence of lactate has been observed that confirms the further production of nitric oxide from lactate much more than nitrite and myoglobin. As a result, the addition of lactate in processed meat is a common approach of bacterial control that conceivably has brought about the completion of the reaction of nitrite reduction to nitric oxide and improves processing color.

IV. CONCLUSION

According to the studies microbial growth has been more significantly decreased when lactate is added to meat products, compared to nitrite, and lactate shows a better performance as an antimicrobial. Sodium lactate has been proved to cause no change in the sensory characteristics of the product and slight improvement in the flavor. The only flaw is the inability to form a
pinkish red as is accepted as the common color of prepared meat products using nitrite. (Bingol & bostan, 2007) However, problems with taste occur at high concentrations (2%) (Williams and Phillips, 1998). In this paper, the effects of adding sodium lactate to meat products and examination of its effect on the sodium nitrite was addressed. The following paper is looking for a method that would achieve the best results by reducing nitrate and increasing sodium lactate at the same time. The hope is that the meat products industries can develop and evolve through these effortless and inexpensive preservatives.

REFERENCES


