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Bacterial Profile of Vacuum Packed Meat Products in Association with pH and Nitrite Content

Thesis presented by

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Abstract

(**Key words: Vacuum, chicken roast, turkey roast, salami, nitrite, TVBN, TBARS**)

Forty samples, ten each from vacuum-packed roast chicken, roast turkey, roast beef and Salami were collected from different production lots of major Egyptian meat processing plants within the validity period. The samples were examined to determine bacterial count, nitrite content, pH, TVBN and TBARS content. Chicken and turkey roast samples generally had moderate sensory panel scores with significant ($p<0.05$) differences between different processing plants. On the other hand all roast beef and salami samples had very low sensory panel scores with non-significant difference between the different processing plants. The mean pH of chicken roast, turkey roast, beef roast and salami was 5.32, 5.33, 5.08 and 4.84 respectively with significant differences between the different processing plants. The mean values for TVBN were 15.35, 13.60, 13.02 and 28.80 (mg/100g) respectively. All chicken roast and beef roast showed acceptable TBARS values (below 0.5-1.0 mg malonaldehyde/kg meat), while products of half from turkey roast and only one of salami processing plants exceeded this limit. Residual nitrite content different significantly between investigated samples from different processing plants. The mean values were 11.62, 19.49, 8.19 and 4.48 ppm for chicken roast, turkey roast, beef roast and salami respectively. Different bacteriological groups of examined samples were high except *Staph aureus* which detected only in roast beef and salami. Three batches of Salami sausage (three independent replicates each) were performed to explore the effect of nitrite when added in different concentration (50, 75 and 100 ppm) on bacterial quality of sausages. Sensory analysis of exprimentally produced fermented sausage showed no differnces in all panel scores with significant enhancement of sausage color by increase nitrite concentraions. pH values of vacuum packed-salami processed with different amount of nitrite showed a significant and gradual decrease during fermentation period followed by a significant and gradual increase during storage at 4°C for three months. Results of TBARS and TVBN content of vacuum packed-salami showed gradual increasing during fermentation and storage with different concentration of nitrite. Generally both TBARS and TVBN level was lower with using high nitrite level. Moreover, increase addition of nitrite lead to decrease bacterial counts of experimentally produced fermented sausages. In addition to, both fermentation and storage period lead to significant decrease of mesophilic aerobic, total Staphylococci and *Staph aureus*.

Dedication

To My family
My husband and my kids

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INTRODUCTION

Consumption of meat products has increased globally**.** Most people prefer meat products than fresh meat because of the high cost of fresh meat moreover and rapid preparation of meat products**.** Recently, production of poultry meat products increased to meet the changing consumer demand. Generally, meat and poultry products are perishable foods especially if they are not stored under proper conditions resulting in growth of both spoilage and pathogenic bacteria**.** To overcome this problem, many methods can be used for extension the shelf life of these products. Meat curing and using of a vacuum packaging are considered the most important issues for production of high quality cured meat products with long shelf life.

Meat curing includes addition of common salt, nitrite and sometimes nitrate to fresh meat which retards production of *Clostridium botulinum* toxin and fat oxidation **(Parthasarathy and Bryan, 2012; Sindelar and Milkowski, 2012).** Nitrite has an inhibitory action on the growth of other microorganisms, however, nitrite has not any inhibitory effect on lactic acid bacterial **(Nielsen, 1983)** which is responsible for spoilage of cured meat products **(Dykes et al., 1991).** Therefore, cured meat products should be vacuum packed.

Vacuum packaging has a potent relationship with nitrite through creation of an anaerobic condition at the product’s surface, which prevents growth of spoilage organisms including lactic acid bacteria. The pH value of vacuum-packed cured meat products affects the keeping quality of such products because at high pH (above 6.0), growth of several types of spoilage bacteria is favoured **(Spooncer, 2014).**

Higher pH value also has a negative impact on bacteriostatic action of nitrite **(Dordevic et al., 1980).** High pH value retards the reduction of nitrate into nitrite resulting in a rapid product deterioration. That means there was a complementary action between bacteriostatic effect of nitrite, vacuum packaging and pH value of cured meat products. Therefore, the aim of this work is to:

1. Study the quality of different types of vacuum-packed cured meat products.
2. Study the effect of rate of addition of nitrite on quality attributes of salami in relation to vacuum-packaging and pH value during refrigeration storage.

REVIEW AND LITERATURE

Dennis et al.(1990) developed a rapid HPLC/UV procedure for the determination of nitrate and nitrite in cured meats, and found that the mean nitrite and nitrate content in bacon was 24.0 and 43.0, whereas the mean values in ham were 56.0 and 22.0 mg/kg^{-1}respectively.

Gill and Molin (1991) stated that the gaseous atmosphere of the vacuum package is likely to change during storage where concentration of oxygen decreased and carbon dioxide increased due to from metabolism of the product or the microorganisms.

Shahidi and Hong (1991) stated that nitrite retards the development of rancidity during storage, whereas develops meat flavour and colour, stabilizes the oxidative state of lipids in meat products and it also preserves both spicy and smoky flavors.

Shahidi and Pegg (1991) reported that the primary function of nitrite is the production of the characteristic pink colour of cured meats, which is desired by the consumer and is usually indicative of quality of cooked products.

Dykeset al. (1991) stated that vacuum-packaging is among the common methods used for preservation of cooked meat products. Lactic acid bacteria form the major component of the microbial population on various types of vacuum-packaged cooked sausages. The increase in CO_2 concentration found in packages during storage can be attributed to metabolic by-products of the heterofermentative lactobacilli and leuconostocs.

Dainty and Mackey (1992) found that the sour taste of certain vacuum-packed meat products had been attributed to the production of methanethiol and dimethyldisulfide by Enterobacteriaceae or by certain lactic bacteria rather than to the production of acids.

Korkeala et al.(1992) stated that nitrite is known mainly for its antimicrobial activity against spore formers; however, it has a limited effect against lactic acid bacteria at concentrations less than 200 mg/liter^{-1}, but at 400 mg liter^{-1} inhibition is more pronounced.

Lücke (1994) established that decline in the pH value plays an important role in the inhibition of undesirable bacteria, rate of conversation of colour, and formation of desired flavour in fermented meat products.

Lundquist (1994) stated that the vacuum packaging process involves putting the product in a bag, and the air is then evacuated without addition of any other gas. The bags used in vacuum packaging are made from a flexible plastic film that has low gas and water vapour permeability and the plastic film generally adheres closely to the product.

Pearson and Tauber (1996) found that nitrite has long been recognized as one of the most useful and powerful ingredients in meat processing. The functions of nitrite in meat curing is to stabilize the colour of the lean tissues, to contribute to the characteristics flavour of cured meat, to inhibit growth of a number of anaerobic food poisoning and spoilage microorganisms and to retard development of rancidity.

Cassens (1997a) reported that only 10-20% of the added nitrite could be analytically detected in cured meat immediately after processing. Residual nitrite content of cured meats taken from a Metropolitan supermarket was found to be 7 ppm for bacon, 6 ppm for sliced ham and 4 ppm for hot dogs.

Cassens (1997b) stated that residual nitrite levels in cured meat products gradually declined due to oxidation and light-induced fading over the storage period. Nitrite can cause the formation of carcinogenic N nitrosamines in cured products due to its reaction with secondary amines and amino acids in muscle proteins. Furthermore, residual nitrite in cured meats may form N nitrosamines in the gastrointestinal tract.

Molly et al. (1997) found that changes during sausage ripening are complex because they are caused by microorganisms, meat enzymes and a biotic reactions such as fat oxidation. In the first 24 hours of a typical sausage fermentation (20–25°C), oxygen is consumed by meat enzymes, and nitrite reacts with myoglobin to form met-myoglobin. Salt, in conjunction with nitrite, anaerobiosis and low temperature during equilibration, inhibits growth of the gram-negative bacteria present in the raw material. As the sausage temperature increases, lactic acid bacteria form lactic and some acetic acid.

Pérez-Rodríguez et al. (1997) tested nitrite and nitrate levels of vacuum-packaged frankfurters from four commercial brands over 145 days' storage at 3°C, and found a good correlation between nitrite and nitrate levels and storage time, where residual nitrite concentrations decline over time during storage.

Van Loon (1998) stated that nitrate and nitrite are usually added to processed meat products to protect against microorganisms that can cause food poisoning, such as Clostridium botulinum. Nitrate, although more stable than nitrite, can act as a reservoir for nitrite. In addition, nitrate can readily be converted into nitrite by microbial reduction. Nitrite and nitrate contents in ham was 11.6 and 5.4, whereas in salami it were 108.0 and 98.5 mg/kg^{-1} respectively.

Siu and Henshall (1998) reported that nitrite may react with secondary amines to form nitrosoamines, a class of carcinogens; therefore, both nitrate and nitrite need to be monitored to ensure the quality and safety of meat products. They added that recoveries of nitrate and nitrite were greater than 90%, where nitrite and nitrate contents in salami were 108.0 & 98.5 in salami and 11.6 & 5.4 mg/kg^{-1} in ham respectively

Pegg and Shahidi (2000) established that suppressing the formation of lipid oxidation products was another development in revealing other properties of nitrite. Above all, the antimicrobial role of nitrite, together with salt, had a major influence on the popularity of nitrite/nitrate in food preservation.

Samelis et al. (2000) found that product type strongly affect the growth rate and the composition of the spoilage lactic acid bacteria during refrigerated storage of cooked, cured meats, sharing their packaging conditions. Growth of lactic acid bacteria under vacuum was more prolific on the product in the order: ham, turkey breast, mortadella and bacon. The authors also observed a very good correlation between growth of lactic acid bacteria and some intrinsic factors, such as the product pH, moisture, salt and cooking method. When ham was stored in air, yeasts and mainly *Brochothrix thermosphacta* became important members of the spoilage association.