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Estudio comparativo del Nitrito Residual en productos curados elaborados con carne de res, cerdo o pollo [1]

A Comparison Study of the Residual Nitrite in Cured Beef, Cured Pork and Cured Chicken Products

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Resumen

Un estudio fue realizado para comparar el efecto que diferentes tipos de carnes y la adición de fosfato tienen sobre el pH, nitrito residual y rendimiento de productos curados. Seis tratamientos con diferentes carnes (res, cerdo y pollo) con y sin la adición de fosfato (0, 0.5%) fueron preparados. Las carnes fueron tomadas de animales sacrificados el día anterior. A las carnes se les eliminó toda la grasa posible y se molió. Una porción fue mezclada con fosfato y el resto de los ingredientes, la otra porción fue mezclada con los ingredientes sin fosfato. Los resultados indicaron que el tipo de carne afecta significativamente el pH, rendimiento y contenido de nitrito residual de los productos curados. El pH fue menor en los productos elaborados con pechugas de pollo y mayor en los elaborados con cerdo. El rendimiento y el nitrito residual fueron mayores en los productos elaborados con pechugas de pollo y menores en los productos elaborados con carne de res. La adición de fosfato al 0.5% incrementó significativamente el pH, el rendimiento y los niveles de nitrito residual independientemente del tipo de carne utilizada.
Palabras claves: carnes rojas, carnes blancas, fosfato, nitrito residual.

Abstract

A study was conducted to evaluate the effect of different meats and addition of phosphate on pH, residual nitrite and yield of cured meat products. Six treatments with different meat (beef, pork and chicken) and with and without phosphate (0%, 5%) were prepared. Meats were taken from animals that were slaughtered the day before. Meats were trimmed out of all possible

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fat and grounded. One portion was mixed with phosphate and the rest of the ingredients. The other portion was mixed with the rest of the ingredients without phosphate. Results indicated that the type of meat significantly affected pH, yield and residual nitrite levels. pH was lowest in products out of breast chicken and highest in cured pork products. Yield and residual nitrite were highest in cured chicken products and lowest in beef products. Addition of phosphate at 0.5% level significantly increased pH, yield and residual nitrite levels regardless of the type of meat used.

Key words: Red meat, white meat, phosphate, residual nitrite

Introduction

Curing is a processing method used to increase the keeping qualities of meat. Nitrites are used in many countries as deliberate food curing additives. These serve to stabilize the color of cured meats (22), protect against the danger of botulism (19,20) and alter and improve its flavor (14). However, nitrite and the possibility of nitrosamine formation continues to be of major concern to the USDA and the food processor (7,15,8). Because of this situation both initial and residual levels of nitrite keep receiving considerable attention.

It has been shown that cured products prepared out of red muscle always contain more residual nitrite than those prepared out of white muscle from the same animal (12,16,1). This difference has been attributed to the higher pH found in red muscle. Lee et al (12), reported lower residual nitrite in cured products made out of red muscle only when the pH was adjusted to be the same as the white muscle from the same animal. The higher the levels of initial nitrite added to the formulation the higher will be the levels of residual nitrite in the final products independently of the type of meat used (13).

Decreasing the pH of a meat system will increase the rate of cured color formation (4). Knipe et al. (10), reported a decrease in color development when phosphate was used to increase emulsion stability. Addition of tripolyphosphate increased the residual nitrite content of frankfurters (16) and oven-roasted turkey breast (1).

Even though it is generally accepted that red muscle has higher pH than white muscle from the same animal, this in not always true when red and white muscle from different animal are compared. On the other hand muscle from different species may have some other intrinsic factors that may cause them to behave differently to the addition of nitrite.

This study was undertaken to measure the influence of different types of meat (beef and chicken) and phosphate on pH, residual nitrite and yield of cured products.

Materials and methods

Experimental design

A 3 X 2 factorial design was used to compare three types of meat (round beef, ham pork and chicken breast) and two levels of tripolyphosphate (0, 0.5%). There were fifteen replicates for each treatment.

Products manufacture

Meats from pork (leg), beef (round) and chicken (breast) from 24 h slaughtered animals were utilized to manufacture cured type products. Table 1 shows the formulation ingredients. After removing as much fat as possible, meats were ground through a 3.2 mm plate using a BOIA grinder (Model 8824). Representative samples for fat, moisture and protein determination were obtained. Four (4) kg of each meat were mixed in an Oster Food Processor with water, salt and sugar. The mixture was divided in four equal portions, two of them were mixed with phosphate at 0.5%, nitrite at 0.015% and erythorbate at 0.055% based on meat weight (it was assumed that each portion contained 1 kg of meat). The other two portions were mixed only with nitrite and erythorbate at the same level as before and were used as a control for phosphate. Each portions was steam cooked at 2 h after being stuffed in a 9.5 cm cellulose casing. Vapor cooking was as follows:

45 min at 60°C and then at 85°C until the internal temperature of the product was 68°C. Products were showered for 20 min and chilled (4°C) for 24 h. After chilling, products were weighed again and kept in refrigeration until nitrite analysis was performed.

Measurements

pH of the of the products was determined directly using a Metrom pH Meter model 620. Cook yield was calculated from weights taken before and after cooking. Residual nitrite

Table 1. Formulation ingredients of the different cured products

	Phosphate, %	
Ingredients, %	0	0.5
Meat	81	81
Water	16	16
Salt	1.9	1.9
Sugar	0.8	0.8
Erythorbate[a]	0.055	0.055
Nitrite[a]	0.015	0.015
Phosphate[a]		0.055

[a]Percentage based on the weight of meat

content of the products was determined on triplicate samples, using method of the Association of Official Analytical Chemists (AOAC, 1990), after 4 days of storage refrigeration at 4 °C. Absorbance at 540 nm was measured by duplicate with a spectrophotometer Carl Zeis (Model PMQII) Nitrite concentration was determined in the sample by comparison to a standard curve.

Statistical analysis

Data collected were subjected to ANOVA technique using SAS PROC GLM (18). Difference among means were detected using Duncan's Multiple Range Test (3).

Results and discussion

Mean values for pH of the final products as influenced by the different type of meat and different phosphate levels are shown in Table 2. It can be observed that cured chicken breast products presented the lowest pH (5.65) while pork cured products the highest (5.83), regardless of the addition of phosphate. When phosphate was added at 0.5% based on meat weight pHs of all meat products increased (P<.05). However, an interaction was observed (Table 3), indicating that even though significant, the units of pH increased was much lower in chicken (0.15) than in beef (0.20) or pork (0.19).

These results indicated that white meat out of chicken breast has lower pH than red meat out of either round beef or leg pork. It indicated also that the addition of phosphate to these types of meats produced significant variation of pH in all of them but less variation in chicken. Similar pH increases with sodium tripolyphosphate addition have been reported in pork frankfurters (17). These results also agreed with those reported by Prusa and Kregel (16) and Knipe et al. (10).

Table 3 shows the mean values for residual nitrite and yield of cured products as influenced by type of meat and phosphate. Cured products made out of chicken breast contained the highest level (P<.05) of residual nitrite (37.13) while those made out of beef had the lowest levels (12.32).

Our results seem to disagree with those reported by Lee et al. (12) and Prusa and Kregel (16). Both researchers worked with red and white

Table 2. Mean values for pH of cured products as influenced by type of meat and phosphate

	type of meat			Phosphate, %	
Characteristics	Beef	Pork	Chicken	0.0	0.5
pH	5.74[a]	5.83b	5.65c	5.65[a]	5.83b

[a,b,c]Means in a row within the same treatment having different superscripts are significantly different (P<.05)

Table 3. Mean values for residual nitrite and yield of cured products as influenced by type of meat and phosphate

	type of meat			Phosphate, %	
Characteristics	Beef	Pork	Chicken	0.0	0.5
Residual nitri.	12.32[a]	32.80b	37.13c	24.11[a]	30.72b
Yield	92.74[a]	94.09b	96.33c	92.43[a]	96.34b

a,b,cMeans in a row within the same treatment having different superscripts are significantly different (P<.05)

muscle out of the same animal, in both cases they reported less residual nitrite in cured products made out of white muscle. They explained their results based on the lower pH of white muscle.

Even though in our case the lowest pH was found in the cured chicken white meat products (Table 2) they presented the highest level of residual nitrite (Table 3). These results indicated that pH may explain the difference in residual nitrite only if the white and red meat used came from the same animal or same species. When meats of animals from different species are compared, then other factors seem to be more important. Lee et al. (12), reported that white muscle with a low pH produces a lower residual nitrite content than does red muscle with high pH from the same animal. However, when the pH was equalized by the addition of phosphate then results were the opposite. They explained these changes based on the higher myoglobin content of red muscle.

Various compounds endogenous to meat, like sulfhydryl compounds are known to react with nitrite and eliminate it (5). Consequently these are other factors important to consider when adding nitrite to meat from different species.

Our results may be explained based on the observation of Kira et al. (9), who concluded that heme ferrous iron, behaves as electron carrier in the reductive breakdown of nitrite. Since beef contains much more myoglobin than pork and chicken, then it is expected that there is more iron in beef than in the other meats. Lee et al. (11), also found significant lower residual nitrite in meat products containing added iron in the form of either ferrous or ferric ions.

It is likely that myoglobin may play a more important role, in residual nitrite levels, when compared with pH. The differences in myoglobin content found in meat from different species is much greater than the differences found in muscle from the same animal and that may have contributed to our results.

There were differences (P.05) in yield of the products manufactured with different type of meat (Table 3). Cured chicken products resulted in the highest yield (96.33%) while cured beef products produced the lowest (92.74%). This difference may be explained by the easier extraction of the myofibril proteins from chicken than from pork or beef.

Addition of tripolyphosphate at 0.5% level based on weight of meat increased residual nitrite and yield of the products regardless of the type of meat (Table 3). Phosphate is commonly used in the meat industry with the main purpose of increasing yield. Phosphate increases pH and consequently increases the extraction of myofibril proteins and that may account for the better yield.

The increase observed in residual nitrite may be also a consequence of the higher pH. Prusa and Kregel (16) reported an increase in pH and residual nitrite of turkey frankfurters when sodium trypolyphosphate was added. Ahn and Maurer (1) reported an increase in the amount of residual nitrite in oven roasted turkey breast when phosphate was added. Over all, it is accepted that nitric oxide (NO) formation from HNO is favorable in acid conditions.

Conclusion

When meats from different species are used to prepare cured products, pH does not explain the differences in residual nitrite content. It is likely that myoglobin content is more important, this may explain why cured beef products had lower levels of residual nitrite than cured chicken products. Addition of phosphate produced an increase in residual nitrite.

These results imply that different regulations may be used for nitrite when the cured products are made either from white or red muscle. Meat Processors should know that they may have more or less residual nitrite in a product depending on the type of muscle used.

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