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Evaluation of Celery Juice Powder as a Natural Curing Agent for Tocino

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ABSTRACT

Artificial food preservatives are a key consideration for consumers purchasing cured meat products, which often contain sodium nitrite, a curing salt known to produce carcinogenic nitrosamines. To address health concerns, ongoing research seeks natural alternatives that maintain product quality. This study investigates the potential of celery juice powder as a natural curing agent for tocino, leveraging its nitrite content. Despite vegetables being recognized as natural nitrite sources, their use is limited due to potential impacts on color and flavor. Celery juice powder has emerged as the preferred natural nitrite source. According to USDA guidelines, celery juice powder can adhere to regulatory limits while effectively curing meat products. A 2k factorial design experiment was conducted, incorporating four treatments generated through Yates' table and the Design Expert application. Analysis of variance (ANOVA) and linear regression were employed to evaluate the significance and relationships of factors affecting nitrite levels in cured tocino. Results demonstrate the statistical viability of celery juice powder as an alternative curing substance, contributing valuable insights into its practical application in the food industry.

INTRODUCTION

Cured meat products, like sausages and bacon, have always been on top of the most bought food products. The curing of meat is an ancient process initially started by the Sumerian culture. People believed that the salt used to preserve meat was contaminated with saltpeter (Potassium nitrate) in the early times. As a result, saltpeter-treated meat became popular, primarily for its desirable reddish color and longer storage life.

Consequently, studies conducted in the late 1800s proved that nitrate has favorable properties for preserving meat. Subsequent experiments discovered that nitrate-reducing bacteria convert nitrate to nitrite.

The United States Department of Agriculture (USDA) has set regulations on the usage of Sodium nitrite for different cured products and curingwhich has additional regulations because of other factors for the formulation of nitrosamine. The USDA had established standard limits on sodium nitrite - 120 ppm (0.012%) for bacon, 200 ppm (0.02%) for dry-cured bacon, less than or equal to 156 ppm (0.0156%) for cured meats like ham, not more than 625 ppm (0.0625%) for dry-cured meat products (Sullivan, 2016).

Additionally, Potassium and Sodium nitrate/nitrite are approved food additives in the European Union, with limits of 150 mg/kg in meat products. Adding an extra 50-60 ppm to the meat could ensure longer preservation. As the salt inhibits the growth of Clostridium (Cl.) Botulinum, where nitrite improves the microbial safety of meat products. (Siekmann *et al.*, 2021)

Meanwhile, various reports highlighted concerns about the potential of the curing substance to produce nitrosamines, which are carcinogenic substances. Moreover, in recent years, research on the development of curing methods has been ongoing, focusing on eliminating nitrosamines (Lijinsky & Epstein, 1970).

In addition, the World Health Organization associated carcinogenicity with the consumption of processed meat products and red meat. Studies suggested that the intake of 50 grams of processed meat daily heightens the risk of colorectal cancer by 18%.

As a result, the belief that organic foods are safer remained in the market. Consumers prefer to spend 10% to 40% more to avoid chemical additives, owing to concerns about exposure to synthetic nitrate. As a result of the increased demand for natural alternatives, various studies have been conducted to discover artificial nitrate substitutes.

Natural nitrate or nitrite sources include various vegetables, although their use is limited due to their colors and flavors attributes. Nitrate is abundant in vegetables; however, the amount varies depending on the type (Lorenz, 1978).

According to Sebranek (2006), celery juice powder was the best substitute for curing salt, producing up to 2,114 ppm nitrate. He also noted that is compatible with meat products as it does not affect the desired physicochemical property. The concentration for the use of celery juice powder as a curing substance is only ¼ to ½ of the ingoing sodium nitrite (Sullivan, 2016).

Tocino is a known cured meat product in Pampanga, Philippines, because of its sweet or sour taste that satisfies the desired taste of the consumers. A Kapampangan native, Mrs. Lolita Hizon, was asked by her neighbor, a

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meat vendor, to help cook the unsold meat during the end of market day. As this regularly happens, she eventually came up with the formula in making Tocino that caused the birth of Pampanga's Best Tocino - a meat processing company, now known as Pampanga's Best, Inc - a multi-million meat processing corporation.

Therefore, this paper examined the potential of celery powder as an alternative curing salt for Tocino. Celery powder solution must be prepared prior to the Tocino making process. Four treatments were used to identify the effect and interaction between the celery powder and the curing period of the meat. Then, the treatments underwent a colorimetric test method to analyze their respective nitrite content.

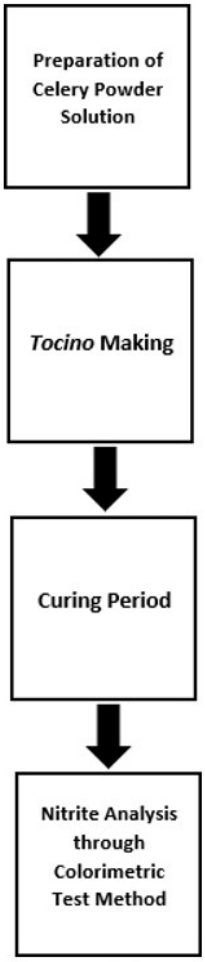

Figure 1: Experimental Procedure

Problem

This paper aims to address the following problems:

1. To what extent does the curing time affect the nitrite content?
2. What level of curing time will produce an acceptable amount of nitrite?
3. What minimum amount of celery powder and curing time is needed to meet the standard nitrite content?

The above problems are postulated on the following hypotheses:

1. The curing time significantly contributes to the amount of nitrite content of the processed meat.
2. The optimal level of the curing time that produces the acceptable amount of nitrite is the lowest level of the factor to be tested in the experiment.
3. There are interactions between the factors.

METHODOLOGY

The study utilized the 2k factorial design as the experimental framework. Moreover, during the experiment, the use of the Colorimetric test method (AOAC Official Method 935.48, Xylenol Method) specified the nitrite content of each treatment. (Wood *et al.*, 2000)

Table 1: Factors and Levels

Factors	Low Level	High Level
(A) Amt. of Celery Powder (g)	-1 (0.5g)	1 (1g)
(B) Curing Time (days)	-1 (1)	1 (2)

Factors and Level

Experimental Procedures and Setup

The ingredients to be used with their amounts held constant are meat (250 g), salt (8 g), refined sugar (45 g), water (15 ml), and pineapple juice (15 g) (Manalo & Benedicto, 2014). The amount of celery powder will have two levels based on the total weight of meat - low level (0.2% or 0.5 g) and high level (0.4% or 1 g) (Sebranek & Bacus, 2007). The study will start with the preparation of the celery powder by mixing it with water and salt.

Moreover, the mixture will then be combined with the meatand added refined sugar and pineapple juice. The curing time will also have two levels at refrigerated temperature – low level (1 day) and high level (2 days) (Manalo & Benedicto, 2014).

Table 2: Treatments and Concentration

Treatment	Specifications
1	Amt. of celery powder: 0.5g Curing time: 1 day
2	Amt. of celery powder: 0.5g Curing time: 2 days
3	Amt. of celery powder: 1g Curing time: 1 day
4	Amt. of celery powder: 1g Curing time: 2 days

After the specified curing period, 5g of sample per treatment underwent the colorimetric test method, known specifically as AOAC Official Method 935.48, Xylenol Method. The nitrite analysis process lasted for six (6) hours. Four (4) treatments were made for the experimental runs with two replicates each.

Findings

The experiment exhibit eight (8) results of nitrite content from different levels of the two factors.

Result of Experiment

Table 3: Yates Table and Results

Std.Order	Run	Amt. of Celery Powder (g)	Curing Time (day/s)	Nitrite Content (ppm)
4	1	1	-1	0.2487
6	2	-1	1	0.2421
5	3	-1	1	0.2424
8	4	1	1	0.2440
7	5	1	1	0.2439
2	6	-1	-1	0.2452
1	7	-1	-1	0.2454
3	8	1	-1	0.2487

Analysis of Variance (ANOVA)

The Analysis of Variance indicates that all the factors are significant in the amount of nitrite content of cured meat. The model F- value also implies that the model is significant.

Table 4: ANOVA Table

Source	Sum of Squares	DF	Mean Square	F Value	Prob > F	
Model	4.487E-005	3	1.496E-005	854.67	< 0.0001	Signifi cant
A	1.300E-005	1	1.300E-005	743.14	< 0.0001	Signifi cant
B	3.042E-005	1	3.042E-005	1738.29	< 0.0001	Signifi cant
AB	1.445E-006	1	1.445E-006	82.57	0.0008	Signifi cant
Pure Error	7.000E-008	4	1.750E-008			
Cor Total	4.494E-005	7				

Curing Time (B) has the highest effect in the response, followed by the Amount of Celery Powder (A), and then, the interaction of the Two factors (AB) based on the half normal plot (Figure 5). Also, no violations were done on the ANOVA theory based on the results of different studentized diagnostic procedures (Figure 6).

Regression Model

Regression results have confirmed and expound the results in the analysis of variance. The adjusted R-squared decreases from 99.84% to 99.73%. The decrease indicates that the current setup of the model is well-designed, and other inputs will have no value in the model.

The linear regression model designed for this experiment is as follows:

Y = 0.25 + 1.275E-003 * A - 1.950E-003 * B - 4.250E - 004 *A* B

where:

Y = Nitrite Content

A = Amount of Celery Powder

B = Curing Time

The coefficients in the regression equation indicate that (A) is directly proportional to the resulting factor (Figure 2). On the other hand, as (B) will increase, the nitrite content will decrease (Figure 3).

CONCLUSION

This study statistically proved that the factors used significantly affect the nitrite content in Tocino using a natural substance - the celery juice powder.

Nitrite is a time-dependent variable that depletes quickly, upon use, for the next 24 hours and depletes slower the succeeding time before the standard curing time is met (Merino *et al.*, 2015) that, causes (B) to have the highest effect on the response. This also causes the interaction of the two factors to be indirectly proportional to the response.

It was also showed that the celery juice powder is rich with nitrite based on the results of the experiments. It is significant to consider the study, stated in the introduction, to use only

¼ to ½ concentration of celery juice powder based on the standard of ingoing nitrite to meet the regulatory limit on the use of nitrite in curing meat products.

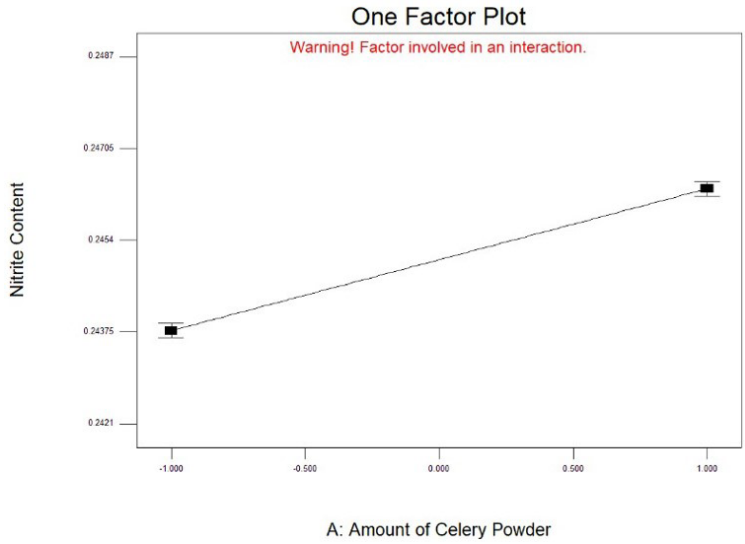

Figure 2: One Factor Plot – Amount of Celery Powder

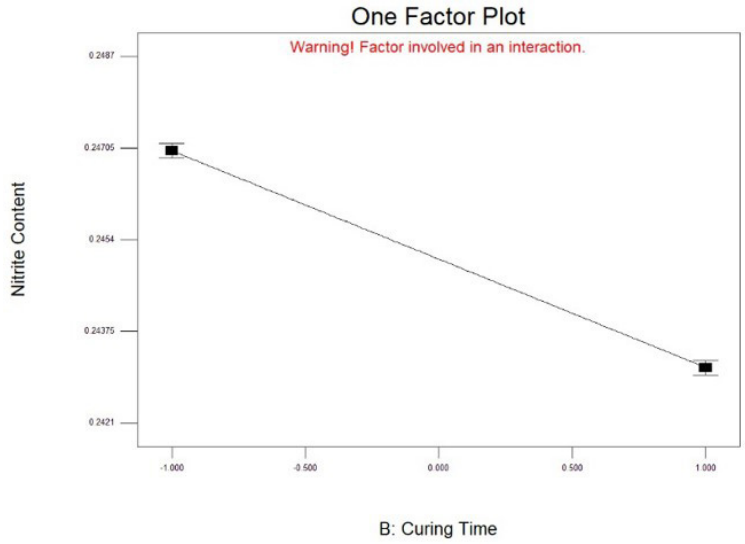

Figure 3: One Factor Plot – Curing Time

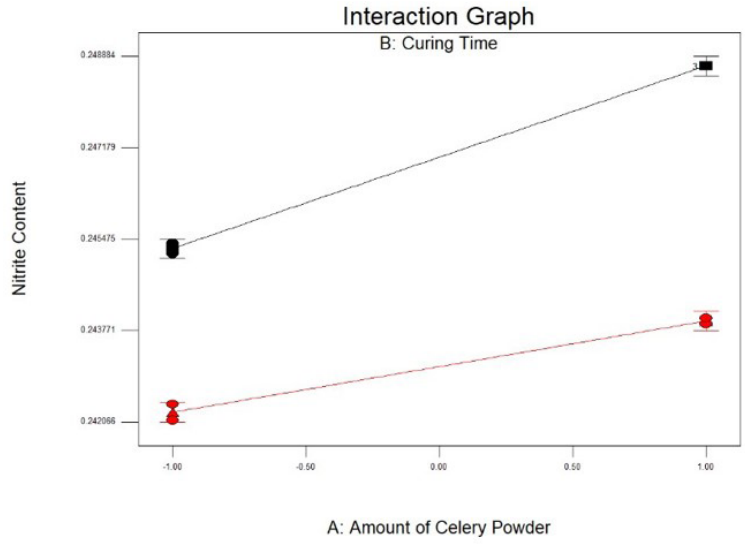

Figure 4: Interaction Graph

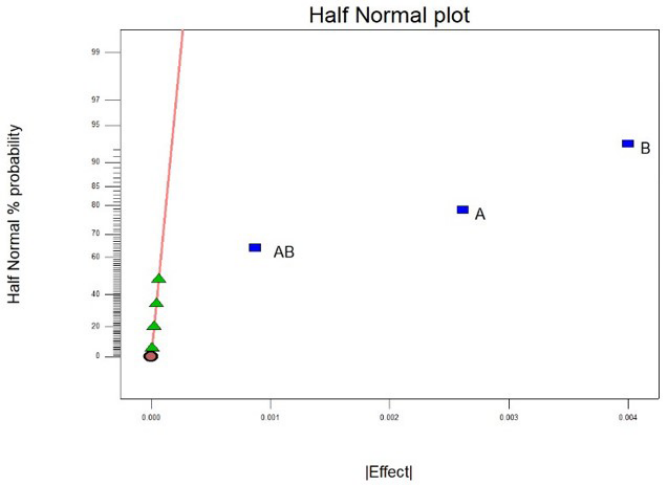

Figure 5: Half Normal Plot

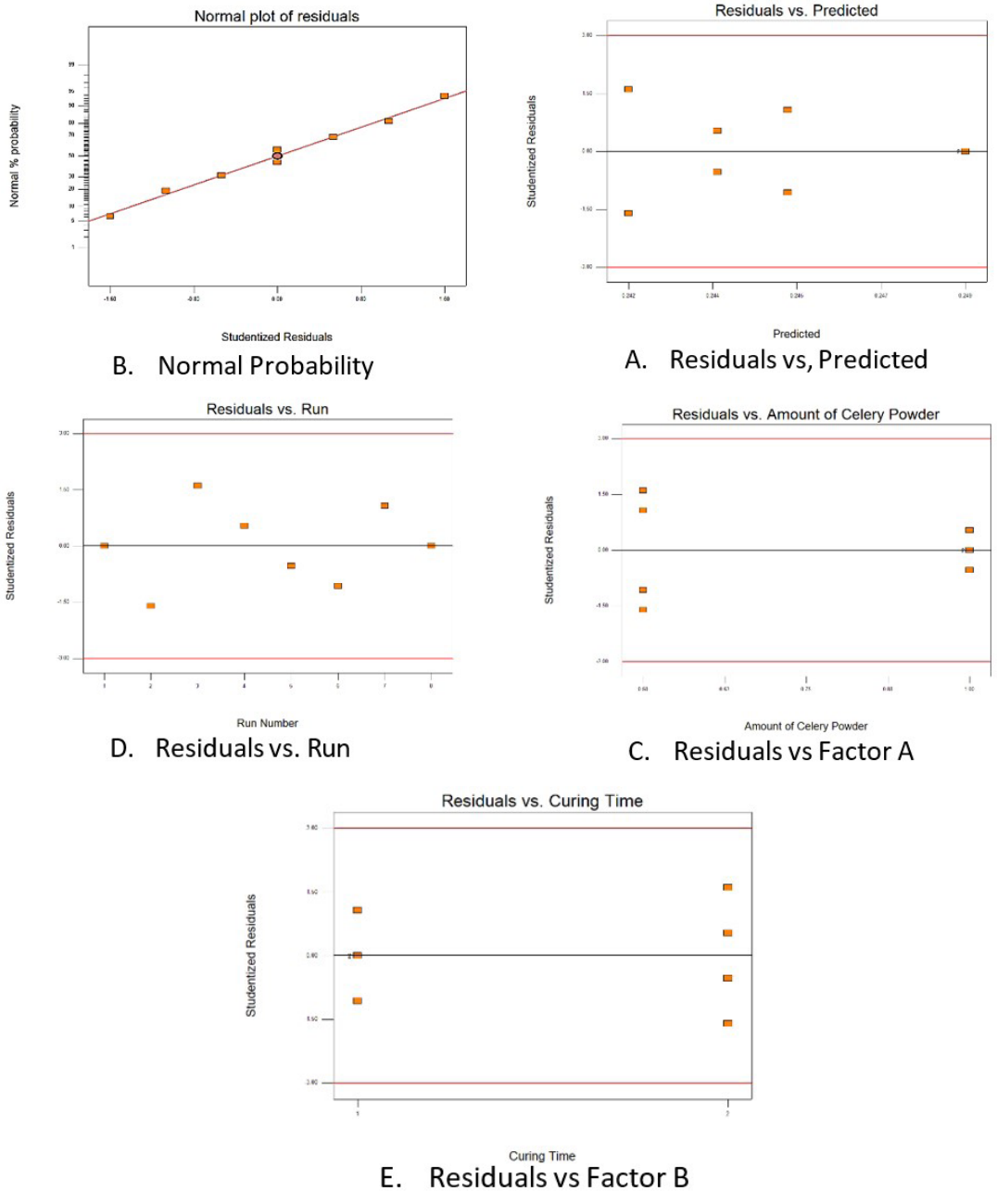

Figure 6: Diagnostics (Studentized)

REFERENCES

Djeri, N., & Williams, S. K. (2014). Celery juice powder used as nitrite substitute in sliced vacuum packaged turkey bologna stored at 4°C for 10 weeks under retail display light. *Journal of Food Quality, 37*(5), 343-350. https://doi.org/10.1111/jfq.12103.

Gipe McKeith, A. (2014). Alternative curing. *Pork Information Gateway*. Retrieved from https://porkgateway.org/resource/alternative-curing/

Manalo, M., & Benedicto, A. (2014). Effects of different humectants in the physico-chemical properties of ready-to-eat (RTE) tocino. *DLSU Research Congress*. Retrieved from https://www.dlsu.edu.ph/conferences/dlsurc/proceedings/2014/Microbiology-Biotechnology/MBT-1.pdf

Merino, L., Dernerud, P. O., Toldrá, F., & Ilbäck, N. (2015). Time-dependent depletion of nitrite in pork/beef and chicken meat products and its effect on nitrite intake estimation. *Food Chemistry, 176,* 77-84. https://doi.org/10.1016/j.foodchem.2014.12.001

Pampanga's Best, Inc. (n.d.). History. Retrieved from https://www.pampangasbest.com/history/#.YU12O7gzaUl

Ramachandraiah, K., & Chin, K. B. (2021). Antioxidant, antimicrobial, and curing potentials of micronized celery powders added to pork sausages. *Food Science of Animal Resources, 41*(2), 293-302. https://doi.org/10.5851/kosfa.2021.e22

Siekmann, L., Plötz, M., & Krischek, C. (2021). Alternative curing methods. *Topical Collection on Bacteriology*. Retrieved from https://link.springer.com/journal/11356/topicalCollection/AC_75b1e36c5a2517590124c98e1e2f36f6/page/1

Sindelar, J., & Milkowski, A. (2011). Sodium nitrite in processed meat and poultry meats: A review of curing and examining the risk/benefit of its use. *American Meat Science Association*. Retrieved from https://meatscience.org/docs/default-source/publications-resources/rmc/2011/sodium-nitrite-in-processed-meat-and-poultry-meats.pdf

Sullivan, G. A. (2016). A comparison of traditional and alternative meat curing methods. *American Meat Association*. Retrieved from https://www.meatassociation.com/docs/default-source/education/amif/technical-resources/2016/curing-methods.pdf

Wood, R., Foster, L., Damant, A., & Key, P. (2004). Analytical methods for food additives. *Woodhead Publishing in Food and Science Technology*.

Yong, H. I., Kim, T.-K., Choi, H. D., Jang, H. W., Jung, S., & Choi, Y.-S. (2021). Clean label meat technology: Pre-converted nitrite as a natural curing. *Food Science of Animal Resources, 41*(1), 1-13. https://doi.org/10.5851/kosfa.2020.e97