Lamb bacon: How the method of brine distribution and addition of a dry rub influences yields

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Abstract

This study was conducted to test the whether lamb breasts can substitute as the raw material in producing a bacon product. Due to the difference in fat saturation between pork and lamb, this research was used to test how successful lamb absorbs the brine in order to make bacon. The yield results of two different processing techniques, injection and tumbling, were compared along with comparing the affect of adding a dry rub of seasonings to the lamb surface. The 120 lambs breasts were split into four groups of 30. Each group received a different treatment: plain tumbled, plain injected, seasoned tumbled, and seasoned injected. The variables were measured for their raw yield, cook yield, pick-up yield, and slice yield. The results suggest that tumbling is a more efficient method to increase the overall yields compared to the injection method. The seasoning didn't seem to make much of an effect, except when it came to the slice yield. Overall, the lamb was able to pick up the brine and produce a sellable bacon product.

1. Introduction

Although bacon has grown in popularity over the years, there are many others who cannot enjoy the essence of bacon due to its pork origin. In an attempt to address this gap assembled the idea to apply the same processing and cooking techniques to a lamb breast rather than the traditional pork belly. This report discusses the difference in yields depending on the method of brine distribution, tumbling or injecting. Also, the application of an exterior seasoning rub was tested for any alterations between the yields as well.

The main concern about making this product was the composition and abundance of lamb fat compared to pork. Lamb fat is more present and saturated than what is found in pork (Wood, 2004). Lamb has a higher ratio of saturated fatty acids to polyunsaturated fatty acids because of fermentation and the microbes within the rumen. The microbes break down the fatty acid provided in the grain diet into monounsaturated and saturated fatty acids, whereas, pork has a lower saturated fatty acid to polyunsaturated fatty acid ratio because of their lack of a rumen and monogastric digestive system (Wood, 2008). Since there is a higher concentration of fats within lamb muscle than pork, lamb will also tend to be more repellent towards water due to the hydrophobic relationship between fat and water. With this in mind, the concern that lamb would not have the ability to pick up as much brine needed in order to distribute the ingredients properly came into question.

Along with questioning lambs' ability to pick up the full amount of intended brine, the method of introducing the brine to the breast was chosen to be a tested variable. The two techniques in this experiment were tumbling and injecting. Based on previous studies, tumbling has been the more effective method to distributing brine because the process is able to extract more proteins (Katsaras, 1992). An overall increase of protein extraction promotes a more even distribution of the brine throughout the muscle. The rolling of the breasts in the tumbler will massage the muscle, breaking up the connective tissue structure of the endomysium and sarcolemma. Also, the tumbling will help increasing the brine percentage picked up by destroying the muscle fibers. The destruction of the muscle fibers creates more binding sites for the brine to attach to the proteins (Katsaras, 1992). In comparison, injection only penetrates the muscle through a row of eight needles across the length of the breast. The method of injection is not much of a physical intervention as tumbling, therefore would expect to be slightly less effective in brine distribution yields.

The final variables tested were the addition of an external rub to the lamb breasts, between being inoculated with brine and the smoking process. The reason behind suggesting the dry rub will have a positive effect on the yields within this research is due to the relationship salt soluble proteins have with water retention. Previous studies have suggested that the addition of salts to processed meats increases the amount of water held within the meat due to the salt tying up the salt soluble protein ends (Desmond, 2006). Based on previous research conclusions, it is predicted that the application of a dry rub will increase the meats ability to reach a higher and more consistent brine pick up, therefore higher yield results. The lamb breasts without the seasoning will lose more water based on the lesser amount of salt soluble protein attachments. Also, since the tumbled, seasoned lamb breasts will undergo seasoning within the tumbler compared to hand application to the injected, seasoned lamb breasts, it is more likely that the tumbled group will have higher yields because of a mechanically, more even method of distribution.

2. Materials and Methods

2.1. Raw Material

Lamb bacon is made from lamb breast without the ribs or intercostal meat, 209 (Lamb). This cut is comparable to making bacon from the pork belly. The materials,

120 breasts total, were shipped from Superior Farms in Dixon, CA to California Polytechnic J and G Lau's Meat Processing Facility and stored at 36 °F.

2.2. Brine

Using a pickle formulating Excel spreadsheet, the amount of each ingredient needed for the brine mixture is produced (Table 1). The ingredients are calculated based on the percent pump the raw materials are intended to receive, which is 12% (Table 2). Once formulated, the ingredients are measured and mixed into the water in descending order; phosphate, salt, sugar, pink cure, and sodium erythorbate.

2.3. Method of Brine Distribution

2.3.1. Tumbling

Tumbling is one of the test factors within this experiment. Sixty breasts were weighed for the tumbling method. Based on this weight, the needed amount of brine is to be calculated by multiplying the amount of raw materials by 0.12. Based on the 146.65lbs of lamb breast, 17.60lbs of brine was needed to add to the tumbler in order to fulfill a projected, full 12% pump. Once placed into the tumbler, the barrel was vacuum-sealed at –15barr pressure and set to rotate at 5 revolutions per minute for 1 hour and 24 minutes. Once finished tumbling, set tumbler into the storage cooler at 36°F for 24 hours.

2.3.2. Injecting

Following the same formulation to calculate the amount of brine needed for the tumbled batch, the remaining 146.50lbs, 60 breast plates of raw materials were separated into five plate batches and according weights were calculated to verify the amount pumped by the injector. Each batch of five lamb breasts was sent through the injector at a 1barr pressure pump. At this pressure each batch needed to pass through the injector a second time in order to reach a full 12% pump.

2.4. Seasoning

The other main factor within this study was the factor of applying a dry rub to the outside of the raw material before smoking. Thirty breasts were selected from each the tumbled and injected batches to be seasoned with a dry rub including spice, dehydrated garlic, natural cane sugar, soybean oil (processing aid), spice extractive, citric acid. A 1lb package of seasoning was split between the two groups in relation to the weight of each batch. Therefore the

injected batch received 0.49lb of dry rub and 0.51lb for the tumbled batch. As for applying the rub, the injected batch had the seasoning hand rubbed onto the surface while the remaining seasoning was added into the tumbler and tumbled to evenly apply the rub.

2.5. Smoking

The breasts were hung by bacon combs and loaded onto a smoke truck. In order to allow the smoke to evenly cover the breasts, they were hung with enough free space to allow the smoke to flow between each breast. The unseasoned batch filled one smoke truck and was cooked first, hours after inoculation. As for the seasoned batch of breasts, they were cooked separately 24 hours after the unseasoned batch was cooked. Although cooked separately, all breasts underwent the same cook cycle in the smokehouse (Table 3). Before starting the cycle, the smoke truck would be carted into the smoke house and the calibrated thermometer will be placed into largest tagged breast of each batch. In order to reach a fully cooked, ready-to-eat product the bacon was set to cook for at least 37 minutes at 135°F to reach full lethality level with a 7-log reduction of the original bacterial load (Appendix A).

2.6. Slicing

Once the bacon was fully chilled, each slab was sliced into bacon slices. Two standard spin blade, deli meat slicers were used in this process to slice the slabs of bacon. Each slicer was set to produce bacon slices of $1/10^{th}$ of an inch in thickness. Once each slab was fully sliced, the acceptable slices were separated from the ends and pieces. The ends and pieces for this experiment were defined as any piece that did not look suitable for retail sales (Figure 1). These pieces were too skinny, short, or torn apart during the slicing process and were separated from the qualified slices.

2.7. Product Yield Indexes

2.7.1. Raw Yield Index

The Raw Yield Index is the calculated percentage of how much raw weight was lost throughout the process from original raw weight to final chilled weight. These values were calculated using the following equation:

$$y = \frac{(Weight\ of\ Cooked\ Slab)}{(Raw, Unpumped\ weight)}$$

2.7.2. Cook Yield Index

The Cook Yield Index is the calculated percentage of how much weight was lost throughout the cook cycle. This index compares the pumped weight that entered on the smoke truck to the chilled weight after the cook cycle. These values were calculated using the following equation:

$$y = \frac{(Weight\ of\ Cooked\ Slab)}{(Raw, Pumped\ weight)}$$

2.7.2 Bacon Slice Yield Index

The Bacon Slice Yield Index is the calculated percentage of how much of the slab was able to slice into acceptable bacon slices compared to ends and pieces. This index demonstrates how much of the slab taken out of retail commission. These values were calculated using the following equation:

$$y = \frac{(Weight\ of\ Acceptable\ Slices)}{(Weight\ of\ Whole\ Slab)}$$

2.8. Statistical Analysis

The slicing yields were analyzed as a two-way ANOVA using the variables, tumbled vs. injected and seasoned vs. unseasoned, in SigmPlot 12.0.

3. Results and Discussion

3.1 Raw Yield

Based on the results displayed in the table above, there is no difference in the percentages between the different methods of processing (Table 4). Although, the tumbled variation of brine distribution resulted in having a more positive influence on the total raw material retention compared to the injected variation. Along with noticing an association of higher percentages with the tumbled group, the results also suggested that applying the seasoning to the surface of the lamb prevented further drip loss.

3.2 Cook Yield

In comparison to Table 4, the cook yield (Table 5) focuses on the weight difference between a soaked lamb breasts to a fully cooked breast. When cooking bacon, the cooked product needs to reduce back to its initial green weight in order to be considered a legitimate and

qualified cured product (Processing, 1995). Raw yield demonstrates how the breasts dipped just below their original weights. In comparison, cook loss addresses the amount lost during the cook cycle after being enhanced and soaked in the brine. The cook yields across all variables, tumbled, injected, seasoned or plain are each within a tenth of a percent of each other. Including the results collected on raw yield, the cook yield suggests that the method of enhancement and the addition of a dry rub does not have as much of an impact of drip loss within the cooking process alone, but more of an effect on the product as a whole.

3.2 Pick-Up Yield

Rather than focusing on how much was lost like the results from raw yield and cook loss, the pick-up yields focus on the product's gain during the brine distribution process. These results are to focus on the method of inoculation rather than any retention influenced by the seasoning. As stated in the methods, the ideal final percent pick up was 12% for all lamb breasts in this study. Based on the results in Table 6, the tumbled groups were, on average, two tenths of a percent shy of reaching the complete 12%. Whereas, the injected groups were over two percent short of the full pump. The lack of difference between the plain and seasoned supports the reasoning that the application of the dry rub does not make a considerable difference. Overall, these results are in favor of the tumbling method in order to inoculate the most amount of brine compared to injecting.

3.3 Slice Yield

The last yield calculated was slice yield (Table 7), to measure how much each slab of bacon will produce if reference to acceptable retail slices rather than ends and pieces that are typically set aside. Seasoned bacon produced significantly more slices than the plain bacon ($P=0.005$). However, there was no difference in how the breasts were enhanced.

Overall, in order to gain a clearer and more definite idea of which differences or combinations influenced the yields tested in this project, each individual lamb breast would need to be weighed at each difference step throughout the process in order to have more data to collect and compare. With the larger supply of data, the results can be analyzed in a more quantitative manner. Although the data was not able to produce the intended results entirely, the general idea discovered is that lamb breast plates can pick up enough brine to produce a bacon product. Another point raised through this experiment was whether or not tumbling the raw materials with the seasoning allowed the seasoning to distribute more evenly helping maintain a higher yield

than the injected seasoned breasts.

Conclusion

After assessing all the results collected from this research, it can be said that it is possible to commercially produce a lamb bacon product. The addition of lamb to the bacon family will allow companies to reach out to more of the niche markets that might be restricted due to culture or diet. The results conclude that tumbling is a more effective and efficient approach to enhancing the lamb breasts compared to the injection method. Along with finding out the difference in effectiveness between methods, we also can conclude that adding seasoning to the outside of the lamb breast will slightly increase the yields. The seasoning made more of an impression when looking at the slice yields, providing more sliceable product from a single slab of bacon.

Appendix

Table 1. The amount of each ingredient used to make up the brine.

Pickle Formulation:		
Water	**27.6 lbs.**	**78.26%**
Salt	**3.9 lbs.**	**10.99%**
Sugar	**2.2 lbs.**	**6.20%**
Phosphate	**0.9 lbs.**	**2.50%**
Pink Cure	**0.6 lbs.**	**1.60%**
Sodium Erythorbate	**0.2 lbs.**	**0.45%**

Table 2. The amount of each ingredient in the final cooked product.

Final Percentages:	
Lamb	**98.580%**
Water	**1.110%**
Salt	**0.156%**
Sugar	**0.088%**
Phosphate	**0.035%**
Pink Cure	**0.023%**
Sodium Erythorbate	**0.006%**

Table 3. The complete set cook cycle the breasts underwent.

Stage	Time (min.)	Oven temp. (F)	Core temp. (F)	% RH	Damper	Blower	Options	Notes
1	15	135	0	0	0	100	Smoke	
2	65	135	0	0	0	20	Smoke	
3	1	165	135	0	0	50	Smoke	Hold until core is 135°F
4	45	165	135	0	0	50		Hold core at 135°F
5	5	0	0	0	100	100		Exhaust
6	3	0	0	0	0	0	Alarm	Alert

Table 4. The calculated raw yield percentages, comparing the amount of product lost throughout the cooking process compared to the initial raw weight based on the total weights of each batch.

	Raw wt	Cooked wt	Raw Yield
Plain Tumbled	73.30	71.35	97.34%
Seasoned Tumbled	73.30	71.99	98.21%
Plain Injected	75.20	71.95	95.68%
Seasoned Injected	71.20	68.35	96.00%

Table 5. The calculated cook yield percentages comparing the amount of product was lost throughout the cooking process compared to the soaked weight based on the total weights of each batch.

	Raw wt	Enhanced wt	Soaked wt	Cooked wt	Cook yield
Plain Tumbled	73.30	82.09	82.00	71.35	87.01%
Seasoned Tumbled	73.30	82.09	81.95	71.99	87.85%
Plain Injected	75.20	86.14	82.55	71.95	87.16%
Seasoned Injected	71.20	79.74	78.25	68.25	87.35%

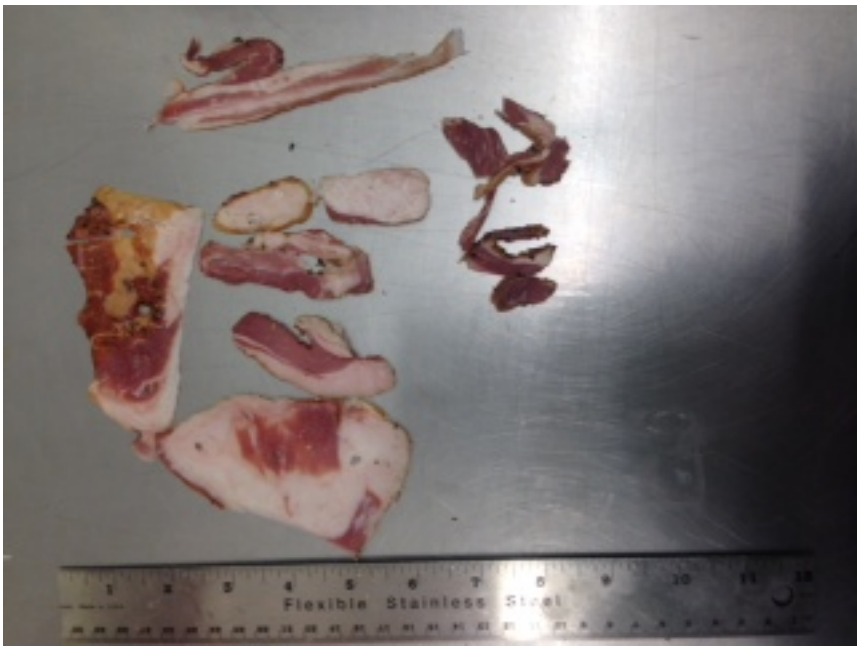
Table 6. Focusing on the amount of brine picked up by the lamb breasts, this table compares the percentage of brine that remained within the breast.

	Raw wt	Enhance wt	Soaked wt	% Pickup
Plain Tumbled	73.30	82.09	82.00	11.87%
Seasoned Tumbled	73.30	82.09	81.95	11.80%
Plain Injected	75.20	86.14	82.55	9.77%
Seasoned Injected	71.20	79.74	78.25	9.90%

Table 7. This table compares the breakdown of how much of the breast slices into retail acceptable product or set aside as ends and pieces from the finished, cooked slab.

	Slice % yield	Ends/Pcs yield	Total yield
Plain Tumbled	83.63%	15.82%	99.44%
Seasoned Tumbled	88.43%	11.12%	99.54%
Plain Injected	78.91%	20.57%	99.48%
Seasoned Injected	86.52%	13.04%	99.56%

Figure 1. This image is to demonstrate what was considered ends and pieces and ultimately separated from the qualified slices.



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