USE OF BIOPRESERVATIVE TO ENSURE MICROBIOLOGICAL SAFETY IN BACON

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I. INTRODUCTION

The Portaria SDA nº 748, enacted by the Brazilian government on February 8, 2023 [1], regulated the identity and quality standards for bacon. It stipulates that for bacon intended for storage at room temperature, the permissible maximum water activity (*aw*) level is set at 0.85. This standard is grounded in the understanding of the growth dynamics of *Staphylococcus aureus*, a bacterium notorious for its potential to produce harmful enterotoxins. However, adherence to this *aw* value impacts the physicochemical composition and sensory attributes of bacon produced in Brazil. Consequently, there arises a necessity to explore alternative methodologies that can effectively mitigate the growth of *S. aureus* without compromising the prescribed *aw* levels and the requisite storage temperatures for retail distribution. The objective of this study is to devise a novel treatment approach, involving the indirect incorporation of a biopreservative produced in an axenic fermentation system with *Lacticaseibacillus paracasei*, to inhibit the growth of *S. aureus* in bacon.

II. MATERIALS AND METHODS

Bacon samples were manufactured at BRC Ingredientes Ltda, located in the city of Rio Claro, state of São Paulo, Brazil. Three distinct processing methods were performed to obtain bacon with various *aw* levels. The brine formulation of each treatment is showed in Table 1.

Table 1. Brine formulation for producing bacon with various water activity level.

Ingredients	Dry Salting	Immersion Salting	Injection Saltin
Water/ice		74.0 %	74.0 %
Bacon blend[a]	20.0 %	5.0 %	5.0 %
Sodium chloride	34.0 %	15.0 %	15.0 %
Curing salt[b]	3.5 %	1.0 %	1.0 %
Sucrose	20.0 %	5.0 %	5.0 %

[a]52.1 % of sodium chloride, 34 % of sodium tripolyphosphate, 12 % of sodium erythorbate, and 1.9 % of sucrose.
[b]90 % of sodium chloride, 6 % of sodium nitrite, and 4 % of sodium nitrate.

To obtain a sample group B1, with an *aw* value approximating 0.85 using the dry salting method, the powder mixture was blended onto pork belly at a ratio of 1:6, followed by cold storage at 7ºC for 6 days. For sample group B2, aiming for an *aw* value close to 0.92 through the immersion salting method, pork bellies underwent complete immersion in brine for 2 days at 7°C, followed by an additional 3 days of cold storage at 7°C. Lastly, to produce sample group B3, with an *aw* value exceeding 0.95, pork bellies were injected with a 20.6 % of brine solution and then cold-stored at 7°C for 24 hours. The pieces were subsequently cooked in an oven at 70°C for 40 minutes, 75°C for 40 minutes, and a final 4-hour period at 80°C. Each sample group was subdivided into three subgroups: a blank group without treatment (B), a control group with 1.0 % of sterile water (C), and a treatment group with 1.0 % of biopreservative (T). Both water and biopreservative were introduced into the packaging to hurdle microbial growth at the product-package interface. The challenge test was performed according to the protocol of the method *MicroLab_ShelfLife* at various temperature profiles [2]. The upper limit of 6.0 log cfu/g was considered to indicate the end of the shelf-life.

III. RESULTS AND DISCUSSION

The *aw* values of the bacon produced by dry, immersion and injection brine salting methods were 0.859, 0.938, and 0.968, respectively. The results of the challenge test are shown in Table 1.

Table 1 – Duration of bacon produced with various water activity.

			Treatments								
	Incubation conditions		Dry salting			Immersion salting			Injection salting		
	Temperature (ºC)	Time (dias)	B1-B	B1-C	B1-T	B2-B	B2-C	B2-T	B3-B	B3-C	B3-T
in-vitro trial (Log cfu/g)	7	0	3,71	3,88	3,79	3,66	3,76	3,81	3,66	3,76	3,81
		4	3,89	3,99	3,80	3,95	4,01	3,81	3,95	4,01	3,80
		6	4,37	4,45	3,82	4,42	4,14	3,81	4,42	4,14	3,79
	36	4	4,70	4,80	< 2,60	4,59	4,66	3,80	4,59	4,66	3,82
		6	6,49	6,61	< 2,60	6,42	5,12	3,80	6,42	5,12	3,85
	Storage temperature profile										
*Ngrowth - (Log cfu/g/day)**		*Cold a 7 ºC*	0,2982	0,2771	-0,0100	0,3064	0,2078	0,0000	0,4839	0,8433	0,0001
		Cold with abuse	0,3429	0,3214	-0,0150	0,3473	0,2360	0,0000	0,5839	0,9493	0,0002
		Room at 25ºC	0,4800	0,4572	0,0002	0,4724	0,3224	0,0000	0,6574	1,4323	0,0000
*Ndeceleration - (Log cfu/g/day)***		*Cold a 7 ºC*	0,0983	0,0888	-0,0050	0,1057	0,0712	0,0000	0,2833	0,4432	0,0000
		Cold with abuse	0,1375	0,1310	0,0001	0,1354	0,0924	0,0000	0,2847	0,5943	0,0000
		Room at 25ºC	0,1223	0,1146	-0,0060	0,1239	0,0842	0,0000	0,2483	0,6432	0,0000
*Durability (days)****		*Cold a 7 ºC*	21	12	*indefined*	22	11	*indefined*	20	10	745
		Cold with abuse	18	10	*indefined*	18	10	*indefined*	17	10	619
		Room at 25ºC	15	7	*indefined*	1	7	*indefined*	14	7	245

* Daily growth of the microbial population (log cfu/g) in the exponential growth phase. ** Daily microbial population growth (log cfu/g) in the deceleration phase. *** An upper limit of 6.0 cfu/g of *S. aureus* was considered to indicate the end of the durability.

The findings suggest that solely reducing *aw* levels to 0.85 might not adequately impede the growth of *S. aureus* on bacon surfaces. This concern is exacerbated with retention of water within the packaging, as showed in group control. Conversely, promising outcomes were observed by indirect application of the biopreservative to inhibit the growth of *S. aureus* at the product-packaging interface.

CONCLUSION

The application of the biopreservative at the interface between the product and the packaging demonstrated superior efficacy in inhibiting the growth of *S. aureus* compared to the reduction of *aw* values.

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