

Survival of *Salmonella* ser. Typhimurium in a Raspberry Beverage Preserved with Organic Acids

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Introduction:

- The United States Centers for Disease Control and Prevention (CDC) estimates that nearly 1 in 6 Americans (48 million) gets sick, 128,000 are hospitalized and 3,000 die of foodborne diseases each year.
- Salmonellosis contributes to 11% of domestically acquired foodborne illness yearly (1,027,561 cases)
- Latest trends show that there has been and increasing demand for preservative-free and all-natural food products. Distributors, retailers, and consumers demand clean food labels with “no added sulfite,” “preservative free,” or “all natural” claims.
- Large manufactures employ heat-based pasteurization to comply with federal food safety guidelines. Small manufactures on the other hand do not have the same capacity and require safe alternatives to heat-treatments by using chemical preservatives.

Methodology:

- A raspberry beverage (25% juice) was collected from a small beverage processor in northern Wisconsin.
- The beverage samples were challenged with a cocktail strain of *S. Typhimurium* (ATCC 10428, 13311) at a level of 7.5-log cfu/mL. The preparation of *Salmonella* ser. typhimurium was adapted from Chikthimmah, LaBorde, and Beelman (2003).
- Preservative treatments to beverages included
 - 1) Raspberry beverage control (no added preservatives) (RB)
 - 2) 0.03% (w/v) potassium sorbate and 11 ppm free sulfite (RB+So+Su)
 - 3) 0.03% (w/v) potassium sorbate (RB+So)
 - 4) 11 ppm free sulfite (RB+Su)
 - 5) 0.1% (w/v) sodium benzoate (RB+Ben)
 - 6) 0.05% (w/v) sodium benzoate and 0.03% potassium sorbate (RB+Ben+So)
- Samples were stored at two treatment temperatures: 3.6°C and 22°C and sampled on days 0, 1, 2, 3, 5, and 9.
- Samples were plated, using serial dilutions in buffered peptone water, on xylose lysine deoxycholate (XLD) to enumerate for *Salmonella*.
- Samples were also enriched following for detection of *Salmonella* at levels below detection limits with conventional plating procedures.

Objective:

The objective of this study was to validate an organic acid treatment for an acidified raspberry beverage challenged with cocktail strain of *Salmonella* ser. Typhimurium in a raspberry fruit beverage.

Results and Discussion:

Table 1. Survival of *Salmonella* in a raspberry juice beverage stored at 4°C with or without the addition of organic acids

Storage Time (days)	Salmonella populations (Log CFU/mL) at 4°C											
	RB, Control		RB+So+Su		RB+So		RB+Su		RB+Ben		RB+Ben+So	
	XLD	Enrich.	XLD	Enrich.	XLD	Enrich.	XLD	Enrich.	XLD	Enrich.	XLD	Enrich.
0	7.55	+	7.57	+	7.95	+	7.95	+	7.82	+	7.78	+
1	6.46	+	4.70	+	6.32	+	5.19	+	ND ¹	+	1.58	+
2	5.98	+	1.29	+	5.23	+	2.74	+	ND ¹	+	ND ¹	+
3	5.08	+	ND ¹	+	3.65	+	ND ¹	+	ND ¹	+	ND ¹	+
5	2.55	+	ND ¹	+	ND ¹	+	ND ¹	+	ND ¹	+	ND ¹	+
9	ND ¹	+	ND ¹	-	ND ¹	-	ND ¹	-	ND ¹	-	ND ¹	-
13	ND ¹	-										

¹ND, not detectable (<10 cfu/mL)

²Colony counts after enumeration and plating on XLD agar

³Qualitative counts after enrichment

Table 2. Survival of *Salmonella* in a raspberry juice beverage stored at 22°C with or without the addition of organic acids

Storage Time (days)	Salmonella populations (Log CFU/mL) at 22°C											
	RB, Control		RB+So+Su		RB+So		RB+Su		RB+Ben		RB+Ben+So	
	XLD ²	Enrich. ³	XLD ²	Enrich. ³	XLD ²	Enrich. ³	XLD ²	Enrich. ³	XLD ²	Enrich. ³	XLD ²	Enrich. ³
0	7.74	+	7.76	+	7.78	+	7.76	+	7.69	+	7.66	+
1	6.31	+	0.92	+	5.27	+	0.82	+	1.56	+	0.38	+
2	5.62	+	ND ¹	+	4.36	+	ND ¹	-	ND ¹	-	ND ¹	-
3	5.39	+	ND ¹	-	3.31	+						
5	4.62	+			ND ¹	+						
8	0.30	+			ND ¹	-						
9	ND ¹	+										
11	ND ¹	-										

¹ND, not detectable (<10 cfu/mL)

²Colony counts after enumeration and plating on XLD agar

³Qualitative counts after enrichment

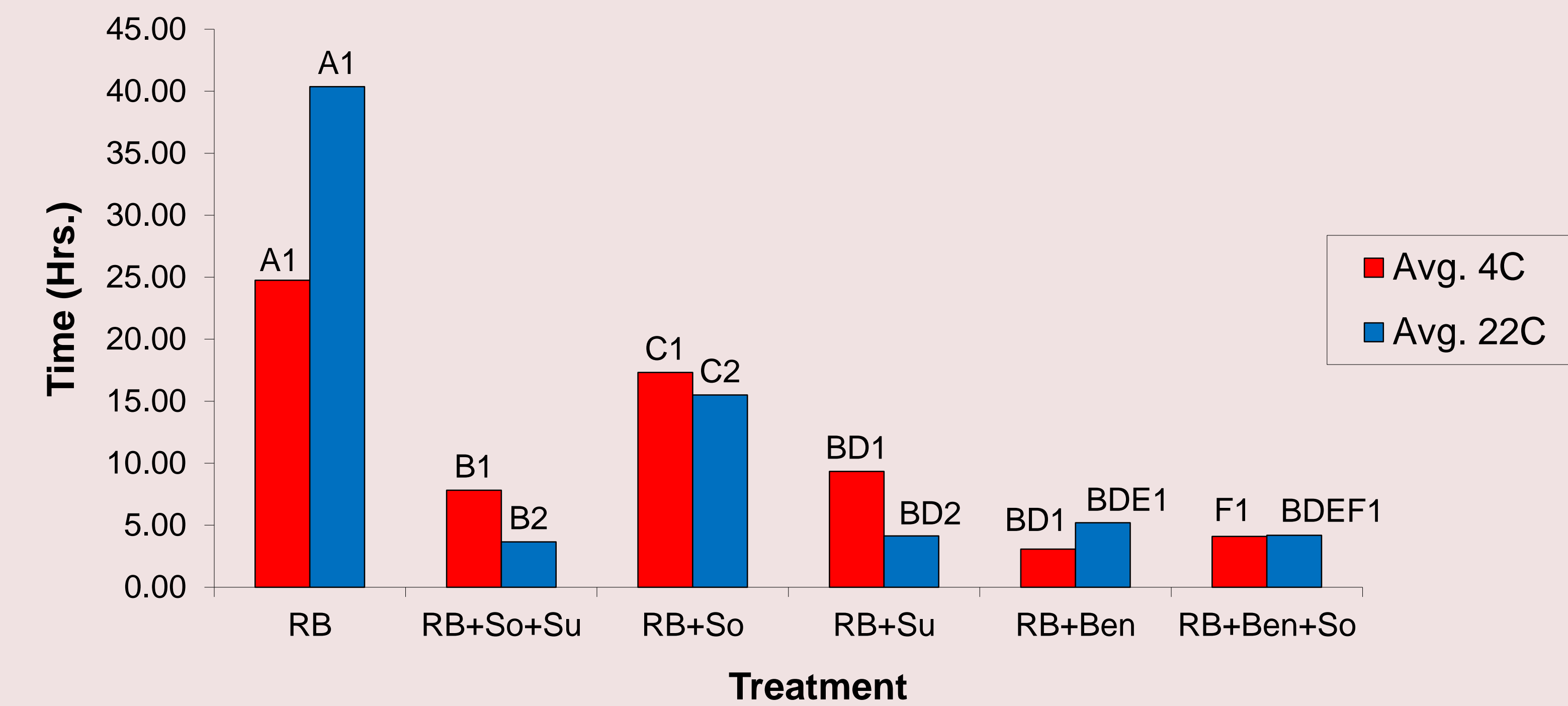


Figure 1. Calculated D-values for *Salmonella* in a raspberry beverage treated with organic acids. Different letters above bars indicate significant differences among treatments maintained under the same storage temperature ($p < 0.05$). Different numbers above the bars indicate significant differences among the same treatments maintained under the varying temperatures (temperature effect; $p < 0.05$)

- Populations of *Salmonella* declined during storage at 4 and 22°C for all treatments. The presence of preservatives significantly ($p < 0.05$) increase the rate of destruction (Table 1 and 2).
- Enrichment of raspberry beverage samples indicated the presence of injured *Salmonella* cells present in the juice after initial indications (enumeration) showed absence of *Salmonella* (tables 1 and 2).
- The length between zero counts on XLD and negative results for enrichment was longer for samples held at 4°C than for samples at 22°C. This would indicate the lower storage temperature is functioning as a protective mechanism for the *Salmonella* cell.

Conclusions:

- The use of organic acids significantly reduced populations of *Salmonella* ser. Typhimurium in all raspberry beverages.
- The strength of organic acids ranked from most effective to least effective are : benzoate, benzoate plus sorbate > sulfite > sulfite plus sorbate > sorbate.
- This research provides further evidence to non-thermal alternatives to pasteurization, mainly through the use of organic acids.

References:

- Centers for Disease Control and Prevention. (2012). CDC 2011 estimates. Retrieved from: <http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html>
- Chikthimmah, N., LaBorde, L. F., & Beelman, R. B. (2003). Critical factors affecting the destruction of *Escherichia coli* O157:H7 in apple cider treated with fumaric acid and sodium benzoate. *Journal of Food Science*, 68(4), 1438-1442.

