

BAG-IN-BOX TECHNOLOGY:

Sensory Quality of Pickles Produced From Process-Ready, Fermented Cucumbers

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ABSTRACT

Currently, most fermented cucumbers contain high levels of salt that must be washed out post-fermentation, creating a large volume of waste. Process-ready (PR) cucumber fermentations are carried out at a sufficiently low salt level, so no salt removal is required prior to making the finished products. This results in much less waste, as well as retention of lactic acid and other fermentation products in the PR fermented cucumbers. Our objectives were to evaluate the flavor impact of the additional lactic acid in PR fermented products, and to prepare and evaluate fresh-pack products using filtered fermentation brine (FFB) as an acidifying agent. Descriptive sensory analysis and measurements of consumer acceptability ("liking") were used to evaluate several pickle products prepared from PR fermented cucumbers and brine for individual flavor characteristics, as well as overall quality and acceptability. PR fermented cucumbers were successfully used for sweet and dill pickle products without salt and acid removal. All products tested were of high quality in both flavor and texture. Additionally, sourness equal to commercial products was achieved with substantially less vinegar. PR pickle products, which were balanced in acidity, and commercial products were liked equally. Furthermore, fresh-pack dills prepared with FFB (25% of total jar volume) as an acidulent were liked as well as those acidified with vinegar alone, indicating potential for use of all the products of the PR cucumber fermentation.

INTRODUCTION

Sensory quality of pickle products derived from the process-ready (PR) system using bag-in-box (BIB) technology for cucumber fermentation (Fleming et al., 2002) is essential for the success of this low-waste technology. Currently, most fermented cucumbers contain high levels of salt that must be washed out post-fermentation, creating a large volume of waste. Before 1940, all commercially prepared pickles in the U.S. were preserved by fermentation (at high salt levels) and contained lactic acid. The cucumbers were desalted, but some lactic acid remained, depending upon the extent of leaching needed to reduce the salt to an acceptable level in the product. Vinegar (acetic acid) was added to many finished products from de-salted brine-stock and has been the primary acidulent for pasteurized "fresh-pack" (beginning in the 1940's) and refrigerated (beginning in the 1960's) pickles. PR cucumber fermentations are carried out at a low salt level, so no salt removal is required prior to making the finished products. This results in much less waste, as well as retention of high concentrations of lactic acid and other fermentation products in the fermented cucumbers.

Early pickle flavor research showed that, while acetic acid was generally more favorable for making pickles, small amounts of lactic acid gave a more desirable overall flavor (Fabian and Wadsworth, 1939a, 1939b, 1939c). Lactic acid was not suitable as the sole acidulent in sweet pickles or relish. However, sweet pickles were made successfully with the addition of small amounts of lactic acid, and consumers actually preferred sweet pickles with an acetic:lactic

ratio between 4:1 and 9:1 over sweet pickles made with acetic acid alone. Additionally, a combination of lactic and acetic acids gave better-flavored, processed dill pickles than either acid alone (e.g., 1:0.2, 0.8:0.4, and 0.6:0.6 % acetic:lactic, respectively).

More recently, basic studies have been done to evaluate the taste properties of various acids in solution. Astringency of acids was directly related to pH and was not influenced by anion species (type of acid). Sourness of acids, however, was dependent on concentration, pH, and anion species (Sowalsky and Noble, 1998; Kallithraka et al., 1997; Lawless et al., 1996; Corrigan and Lawless, 1995; Rubico and McDaniel, 1992; Hartwig and McDaniel, 1995). At equivalent pH and concentration (wt/vol), acetic acid was perceived as the most sour acid, and lactic acid was found to be the least sour of several organic acids tested (Hartwig and McDaniel, 1995). However, when pH is not controlled, adding lactic acid lowers the pH more than adding the same amount of acetic acid, resulting in a more difficult comparison of the acids.

Taste interactions are also very important in making pickles. It has been known for years that the balance between salt, acid, sugar, and spicing is essential to desirable pickle flavor (Fabian and Wadsworth, 1939a, 1939b, 1939c; Pangborn and Vaughn, 1958). Basic flavor studies have shown that sweetness masks sourness to varying degrees, depending on the concentrations of sweetener and acid (Calvino and Garcia, 1998; Bonnans and Noble, 1993, 1995; Tuorila et al., 1993; King et al., 2000; Schifferstein and Frijters, 1990). Pangborn and Vaughn (1959) showed that adding 2% sucrose to dill pickles reduced undesirable flavors from high acidity and increased desirable flavors by enhancing spice flavors. Fabian and Blum (1943) also observed that even a sub-taste threshold level of sweetener decreased both salt and acid perception. Even aromas can alter the perception of sweetness and sourness (Stevenson et al., 1999; Baldwin et al., 1998).

Given the complex nature of pickle flavor and reported differences in flavor between acetic and lactic acids, research was conducted to evaluate the sensory qualities of products made from our pilot system BIB technology. We wished to determine how the entire contents of the bag could be used to make high quality finished products. Our objectives were to evaluate the flavor impact of the additional lactic acid in fermented products, and to prepare and evaluate fresh-pack products using filtered fermentation brine (FFB) as an acidifying agent.

MATERIALS AND METHODS

Pickle Products

Several types of pickles, including sweet pickle chips, hamburger dill chips, genuine dills (processed dills), fresh-pack dills, and fresh-pack bread and butter chips, were prepared from PR, fermented cucumbers and brine (Table 1). All products were prepared according to standard formulas and pasteurized. Some products were prepared with FFB (Fasina et al., 2002) as an acidulent. The chemical composition of the FFB is given in Table 2.

SENSORY QUALITY OF PICKLES

Table 1. Pickle products made and evaluated from process-ready (PR) cucumber fermentation.

Product type	Treatments			
	Cucumber source	Cover brine	Additional acetic acid	Sweetener
Sweet pickle chips	Fermented	Fresh	0, 33, 50, 67, 100% standard vinegar added	30 or 45% (wt/vol) HFCS ²
Hamburger dill chips	Fermented	Fresh	None or reduced vinegar to account for increased concentration of lactic acid	None
	Fermented	FFB ¹ (17 or 38%)		None
Genuine dills (processed dills)	Fermented	Fresh	None	None
	Fresh	FFB (38%)	None	None
Fresh-pack dills	Fresh	FFB (10, 25 or 38%)	Reduced vinegar to account for increased concentration of lactic acid	1.75% (wt/vol) HFCS
Fresh-pack bread and butter	Fresh	FFB (12%)	Reduced vinegar to account for increased concentration of lactic acid	32% (wt/vol) HFCS

¹FFB = filtered fermentation brine used in varying amounts according to product type (% = percentage of total jar volume).
²HFCS = high fructose corn syrup

Table 2. Composition of filtered fermentation brine (FFB) used for making pickles.

pH	3.52
Salt (%)	1.98
Lactic acid, % (mM)	0.92 (102.5)
Acetic acid, % (mM)	0.38 (64.3)
Calcium (as CaCl ₂), % (mM)	0.33 (30.0)

Instrumental Analysis

Chemical analyses of the finished products included pH and high pressure liquid chromatography (HPLC) for lactic acid, acetic acid, glucose, and fructose (McFeeters, 1993). Texture was evaluated using a Stable Micro Systems TA-TX2 Texture Analyser (Texture Technologies Corp., Scarsdale, NY), and maximum force (N) was recorded for 15 slices per jar.

Sensory Analysis Test Methods

Descriptive panel for sweet pickle analysis. Twelve volunteers from the Department of Food Science at North Carolina State

Table 3. Descriptive analysis reference sample attributes and established intensities.

Attribute	Definition	Sweet pickle chips (scale 0-14)	Fresh-pack dills chips (scale 0-15)	Hamburger dill (scale 0-15)
Sweetness	Taste stimulated by sucrose and other sugars such as fructose, glucose, etc.	10	1	0
Sourness	Taste stimulated by acids such as citric, malic, lactic, acetic, etc.	7	7	12
Saltiness	Taste stimulated by sodium salts such as NaCl and in part by other salts such as KCl	1	10	12
Spiciness	Combination of flavors elicited by sweet pickle spices in solution	7	NA	NA
Dill	Flavor elicited by dill oil	NA ¹	7	9
Vinegar	Aromatic flavor characteristic of vinegar or acetic acid	NA	3	5
Astringency	Shrinking, puckering, drying, or roughing of the tongue or other tissues of the mouth by substances such as alum or tannins	3	3	6
Bitterness	Taste stimulated by substances such as caffeine, quinine, and hop bitters	0	0	3.5
Overall intensity	The overall impact of the combined attributes of the product, reflecting the complexity of the flavor	NA	8	12
Other/Off-flavor	This scale was added in order for panelists to account for any different flavors or off-notes that may present themselves in the samples that are not a normal characteristic of pickle products	0	0	3.5 (musty/dirty)
Crunchiness	Sound, feeling, and release of moisture associated with chewing raw vegetables	9	NA	9
Firmness	The amount of effort or force that it takes to bite through the pickle slice	NA	NA	6

¹NA=not applicable.



ABOUT THE COVER:

Bulk storage in brine has been an economic means of extending the processing season of pickling cucumbers since before the 1930's (1). When larger sizes of cucumbers began to constitute a higher proportion of the crop in the 1960's, bloater formation resulted in buoyancy force sufficient to rupture tank heading timbers (2), but purging of CO₂ from the brine reduced bloater damage and buoyancy forces within the tank (3). However, use of high concentrations of salt in brine storage requires washing of the excess from the brine-stock before conversion to finished products, which requires the use of aeration ponds to biodegrade the organic matter (4), but still results in problems in the handling of salt and other non-biodegradable wastes. The use of fiberglass and polyethylene tanks (5) has reduced salt leakage that was prominent with wooden tanks (1-3), but relatively high salt concentrations are still used to serve as insurance against vagaries of nature due to tanks being open to the atmosphere. Closed tanks have been considered by the industry (6), but various factors have resulted in modernized brine yards of open-top, fiberglass and polyethylene tanks and a waste handling system (7). This issue of the journal is devoted largely to summarizing efforts to design and test a pilot system (8) for preserving "process-ready," brined cucumbers with improved quality and reduced wastes, and with intended benefits to the producer and processor of pickling cucumbers.

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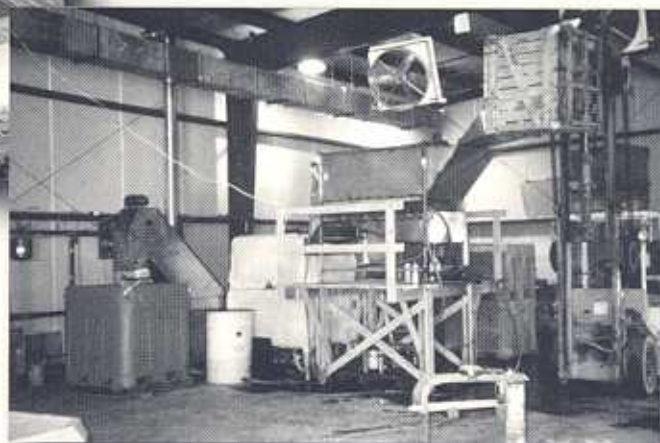
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SCIENCE

Bulk Storage in Brine Since the 1930's



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research relating to
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