An Occurrence of Bloaters During the Finishing of Sweet Pickles [1], [2]

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DURING the past year, our attention was called to an isolated case of gaseous fermentation of sweet stock which had occurred during the finishing process. In this particular instance, about one-quarter of the stock (3,000-3,600 count size[3]) from a 40-bushel tank had resulted in "bloaters" or hollow cucumbers (See Fig. 1). Prior to the time that our initial observations were made, there had been an adjustment of the acid content by the addition of vinegar, hence it was not possible to determine the original acidity although it was known to have been low, possibly 15-16 grains acetic acid. Since the fermentation was over, there was no opportunity to make routine bacteriological observations. However, it was possible to make chemical determinations upon the fermented liquor as to end-products, as well as analysis of the gas from the bloaters, since the latter were still partially distended from gas pressure. Consequently, a two and one-half gallon container of cucumbers, covered with the original liquor, was taken from the upper portion of the tank for analysis.

Methods of Analysis

THE gas-filled cucumbers were opened under saturated brine solution and the escaping gas was trapped by displacement in an inverted glass funnel supplied with a short piece of rubber tubing and pinch clamp. The gas was analyzed in a modified Williams gas analysis outfit according to the procedure previously described.[4]

Determinations upon the liquor were made with respect to titratable acidity, volatile acids, alcohols and esters. The methods of analysis used were those of the Association of Official Agricultural Chemists.[5]

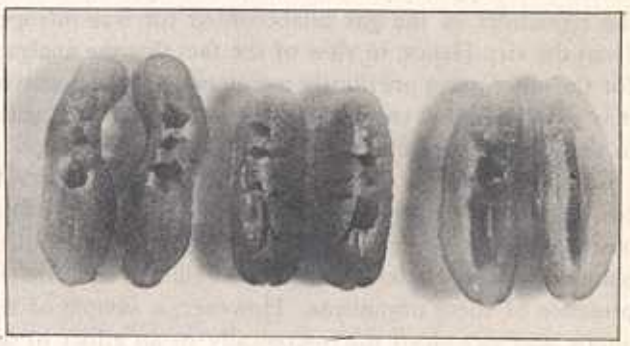

Figure 1. Typical examples of bloaters formed in sweet stock.

Results

THE results of the chemical determinations upon the fermented sweet liquor and the results of the gas analysis are shown in Table 1.

Table 1. Acid, Alcohol and Ester Content of the Fermented Sweet Liquor and Composition of the Gas from Bloaters or Hollow Cucumbers.

Titratable acidity as acetic acid	Volatile acids as acetic acid	Alcohols as ethyl alcohol**	Esters as ethyl acetate	Analysis of gas from bloaters		
				CO_2	H_2[†]	O_2
grains 19.3*	grains 18.5	pct. 0.51	pct. 0	pct. 91.1	pct. 0	pct. 1.6

*Final value at time of analysis; the liquor tested 21° Baumé.
** Percent by volume.
† Analysis for methane or other combustible hydrocarbons proved negative.

Because the vinegar content had been increased as a control measure when active gas evolution was noted, the values shown for titratable acidity and degrees Baume' do not represent the original acid and sugar content.

No significant difference is noted between the titratable acidity and volatile acid content. This indicates that the gaseous fermentation of the liquor was not accom-

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[2] Presented at the Technical School for Pickle and Kraut Packers, at East Lansing, Michigan, February 18, 19 and 20, 1941.
[3] Number per 45 gallon cask.
[4] Veldhuis, M. K. and Etchells, John L. Gaseous Products of Cucumber Fermentations. Food Research, 4, No. 6, p. 621-630. 1939.
[5] Association of Official Agricultural Chemists. Official and Tentative Methods of Analysis, 4th ed., Washington, D. C. 1935.

panied by the production of non-volatile acids such as lactic. It will be noted that an appreciable amount of alcohol had been formed and that esters were not found to be present.

The gas analysis values were based on determinations from two separate 100-cc. amounts of gas collected from the bloated cucumbers. The results show carbon dioxide to be the principal component of the gases from the interiors of the cucumbers. The analysis for hydrogen, methane, or other combustible hydrocarbons proved negative. The oxygen value (1.6 per cent) indicated what was suspected, namely, that the gas within the cucumbers, in some cases, was contaminated with small amounts of air which gained entrance during handling of the badly bloated stock through small longitudinal breaks in the surface of the cucumber tissue. Based on the amount of oxygen found, it can be readily assumed that the remainder of the gas unaccounted for was nitrogen from the air. Hence, in view of the fact that the analyses for the other gases previously mentioned proved negative, it is concluded that carbon dioxide was the sole gas within the bloated cucumbers.

Inasmuch as the fermentation proper had evidently ceased some time prior to our opportunity for the initial observations, it was not suprising that the usual routine plate counts for bacteria and yeasts failed to indicate the presence of these organisms. However, a sample of the liquor was examined microscopically in an effort to determine, if possible, what the predominating microflora might have been. The observations revealed a preponderance of yeast cells and few, if any, bacterial cells. The majority of the yeast cells at this stage measured 3.5 x 6.5 microns, being somewhat elongated; some were spherical, being 3.5 microns in diameter.

The microscopic findings, in conjunction with the chemical analyses, showing the production of carbon dioxide and alcohol and the absence of non-volatile acids, point strongly toward yeasts as being responsible for the gaseous fermentation of the sweet stock, resulting in the production of bloaters.

Such a fermentation in a sweet liquor somewhat low in acid content (15-16 grains acetic acid) would be analogous to that previously shown[6] to be brought about by yeasts in unpasteurized fresh cucumber pickle. In both cases the acid content would be in approximately the same range, since in the latter product the acid content usually finishes at about 15-17 grains acetic acid.

Bloater formation, as reported in this instance, is attributed to the fact that the pickles were finished at too low an acidity. It is generally recognized by commercial packers that sweet pickles should possess a final acidity of approximately 20 grains of acetic acid or higher. Fabian and Switzer[7] have clearly indicated that sweet pickles containing less than 20 grains of acetic acid will spoil unless benzoate of soda is added or unless the product is pasteurized.

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[6] Etchells, John L. and Goresline, Harry E. Methods of Examination of Fresh Cucumber Pickle. FRUIT PRODUCTS JOURNAL, *19*, No. 11, p. 331-335. 1940.

[7] Fabian, F. W. and Switzer, R. G. Classification of Pickles. FRUIT PRODUCTS JOURNAL, *20*, No. 5, p. 136-140. 1941.

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