Black-Out Preparations in the United States

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Fluorescence lends itself to night protection because it is an excellent form of cold light. The argon bulbs used to activate the fluorescent materials are also practically cold light, in contrast to the incandescent bulb, which generates infrared or heat waves. Airplanes equipped with apparatus for the detection of infrared rays could use this as a means of orientating themselves. Argon bulbs would not betray their presence, because they generate very little infrared.

In the event of war the traffic problem must be given serious consideration, because bombing succeeds best when it destroys factories and dislocates the normal life of a city.

Television depends for its success upon the use of luminescent materials that can transform electron energy into visible light. It is within the realm of possibility that wars of the future may be won with rays of unseen light. The day may not be too far distant when reconnaissance planes will hover over battlefields and broadcast by television the over-all picture of a battle being fought, so that commanders may watch every move of their forces and direct them more effectively.

Other rays of unseen light that enter into our defense picture are Hertzian, infrared, and x-rays. Without doubt, the years to come will bring forth many methods, not known at the present time, of using these rays for defense.

Chemical Industries Anticipate Personnel Reduction

Although 473,326 workers are scheduled to be hired in 26 defense industries during the last half of 1941, the industrial chemicals group expects a reduction. Estimates made by 9,908 companies in defense categories at the request of the United States Employment Service indicate that current personnel of 4,672,675 will be increased by over 10 per cent. The 416 industrial chemicals firms reporting, which currently employ 155,017 employees, predict 253 will be laid off by the end of the year. Only one other industry—motorcycles, bicycles, and parts—looks for a decrease in this period.

The fireworks (explosives) industry anticipates a 60 per cent gain with addition of only 1,500 workers, but largest increases to forces are scheduled by the shipbuilding and aircraft industries which will hire a net of 106,814 and 131,044 persons for percentage rises of 44 and 41, respectively.

Ethyl Alcohol from Fermentation of Lactose in Whey

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In growing certain lactose-fermenting organisms for an investigation of their lactase-yielding possibilities, it was noticed that the rates of attenuation of the media were different and that some gave more alcohol than might have been expected from statements in the literature concerning *Torula*. Because of the desirability of finding useful outlets for cheese whey, more data upon this fermentation were sought as part of the general project of developing uses for whey.

The organisms used were *Torula cremoris* American Type Culture Collection No. 2512; *Torulopsis sphaerica*, American Type Culture Collection No. 2504 (these two were isolated and described by Hammer and Cordes, *4*); *Torula lactosa*, American Type Culture Collection No. 7014; yeast, American Type Culture Collection No. 2702; and kefir yeasts, Nos. KY 2, 6, 8, and 10. The kefir yeasts were isolated in this laboratory, but as their morphology has not as yet been completely studied they may be identical. The literature appears to contain no descriptive material for any of these organisms except the first two.

The culture media in which the alcohol was first determined were made by adding to filtered cheese whey 100 grams of lactose hydrate, 1.0 gram of monoammonium phosphate, and 0.7 gram of ammonium sulfate per liter. The media were warmed upon a steam bath until the lactose had dissolved and finally were autoclaved. No sugar determinations were made upon media used for culture purposes. The pH was generally about 5.1, and the Brix about 16°.

After 10 or 11 days at room temperature (about 26° C.) the attenuations of the media, as measured in degrees Brix, were very different:

Table I. Fermentation Data on Culture Media

Culture No.	Attenuation, ±0.1° Brix	Attenuation Minimum		Theoretical Yield
	° *Brix*	° *Brix*	*Days*	%
2512	1.5	....	..	83.6
KY 6	1.5	....	..	78.5
7014	1.5	....	..	76.3
2504	8.9	7.2 to 8.9	11	25.3
KY 10	1.5	....	..	..
KY 8	1.5	....	..	78.5
2702	10.0	2.7	17	..

These data show that the fermentation rates differ appreciably. The slowness of two of them seems to be due to different causes. With No. 2504, since about one half of the original sugar always remained, it was possible that hydrolysis had occurred and only the glucose had been fermented; no sugar crystals other than lactose were found in the residual liquor after evaporation. Another possibility that seems to fit such facts as are at present known is that concentrations of alcohol above 2.5 per cent by volume are toxic to the organism.

The alcohol content of these culture media was determined by fractionally distilling 1.5 liters of the filtered media, after adding a small quantity of hardened fat to minimize foaming, and noting the specific gravity of the distillates. The percentages of the theoretical yield shown in Table I were computed on the assumption that one mole of lactose hydrate gives four moles of ethyl alcohol. This is analogous to the customary assumption for sucrose. Larger batches (20 gallons) were then fermented to obtain more specific data. In these experiments 5 liters of whey were used as culture media to inoculate larger mashes of the aerated, "feed-in" type, which consisted of whey and mineral salts. The pitching yeast was subsequently separated by centrifuging, filtering, and washing on large Büchner funnels, all in conventional manner.

Analytical Methods

Lactose. Lactose was determined polarimetrically. Three times the normal weight (3 × 32.857 grams, *3*) was weighed into an 100- to 110-cc. flask, made up to 100 cc. with distilled water, clarified by adding from 5 to 10 cc. of mercuric iodide solution (*1*), and made up to a final volume of 110 cc. The clarified solution was filtered and then polarized in a saccharimeter. Some of the filtered wheys from a filter press were clear enough to polarize directly without clarification with mercuric iodide. In these cases the lactose determination always gave lower results by several tenths of a per cent than the samples clarified with mercuric iodide. All analytical figures given in Table II refer to clarified whey.

Alcohol. Alcohol was determined in the distillates by cooling them to 60° F. (15.56° C.) and determining their specific gravity by means of a hydrometer cali-

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Ethyl Alcohol from Lactose Fermentation

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brated at this temperature. The corresponding per cent of alcohol, by volume, was taken from an appropriate table (*2*).

No supplementary tests upon the quality of the alcohol have been made, since they would serve no purpose at this stage. Casual organoleptic tests seem to show that the alcohol is of high quality, but in any case only those tests should be used which would be used on an alcohol of the the same strength from other sources.

Fermentation

The mash was a filtered or unfiltered sweet rennet cheese whey. In general the whey was brought to a pH of about 4.5 with sulfuric acid, after removal from the cheese curd, heated to boiling, and filtered through a filter press with Filter-Cel. This gave a clear filtrate more resistant to infection than a less acid solution. The whey was then cooled, and after addition of 0.013 per cent of ammonium sulfate it was pitched with the organism to be used in a quantity to complete the fermentation in the required time at the temperature used. The fermentation was generally complete when the attenuation of the mash reached a Brix of about 1.3°. The end of fermentation was also checked with a saccharimeter which showed a small negative rotation. The alpha-naphthol test was found too sensitive for use. The spent mash was at times run through a centrifuge to separate yeast before it was distilled.

The data covering organisms used are given in Tables I and II.

Distillation

The acid spent mash was distilled in what was equivalent to a small pot still until about 25 per cent of the original volume had come over and the specific gravity of the distillate equaled 1.0 at 60° F. This first distillate contained about 14 per cent of alcohol by volume and was generally redistilled from an alkaline solution in a laboratory still.

The difficulty experienced during the distillations because of foaming was partially overcome by the use of a hydrogenated fat as a defoaming agent. The results of these larger runs are shown in Table II.

Discussion

The economic practicability of fermenting the lactose in whey to ethyl alcohol will be dependent upon local operating conditions.

Jacobs and Newton (*5*, p. 63) express the opinion that "costs of the fermenting, refining, and miscellaneous equipment used in conventional alcohol processes can be established only indirectly". However, the economic practicability of a process may sometimes be established by inference.

Over 12,000,000 gallons of sulfite liquor, which like whey has a low sugar content, were processed for ethyl alcohol in 1937. The sulfite liquors do not average over 3 per cent of fermentable sugars, while whey, with the exception of that from cottage cheese, never contains under 4.5 per cent of lactose. In addition, whey contains riboflavin, which makes the slops remaining after fermentation of value for stock feed.

While the cost of whey assembled for fermentation is uncertain, it is probable that its advantage over molasses would be in lower cost of raw materials, which is the largest unit cost in any fermentation process, and continuous availability. Its disadvantage is in the higher steam cost, which would be about three times that of distilling a molasses mash. The cost of alcohol production from molasses, exclusive of materials, is given by Jacobs and Newton (*5*) as from 3.5 to 7.5 cents per gallon of 95 per cent alcohol.

No cost comparison with starchy materials such as corn seems appropriate, since they must first be saccharified at a considerable cost.

Jacobs and Newton (*5*) in their study on agricultural products (other than whey) as sources of ethyl alcohol assume an 85 per cent recovery of the theoretical yield, which is somewhat higher than the yields so far obtained with whey as reported in Table II. In any case, the above data may serve as a basis for further experimental work.

There are available in this country over 3,000,000 short tons of whey (in addition to the whey that is dried and sold as such), and, since this should have at least 4.5 per cent of lactose, it is equivalent to 137,000 short tons of fermentable sugar. This is, of course, scattered among some 5,000 cheese or casein establishments having outputs varying from a few thousand to over 50,000 pounds of whey per day. This distribution of raw material is no worse than the wide distribution of alcohol consumers.

Literature Cited

(1) Assoc. Official Agr. Chem., Official and Tentative Methods of Analysis, 4th ed., p. 266 (1935).
(2) *Ibid.*, Table 19, p. 644.
(3) Bur. Standards, *Circ.* 44, p. 81 (1918).
(4) Hammer and Cordes, Iowa Agr. Expt. Sta., *Research Bull.* 61 (1920).
(5) Jacobs and Newton, U. S. Dept. Agr., *Misc. Pub.* 327 (1938).

Cellulose Ester Patent

Henry Dreyfus, a director of the Celanese Corp. of America, has been granted Patent 2,261,237 which relates to the production of organic esters of cellulose, such as cellulose acetate, from wood pulp.

According to the invention wood pulp is treated with a solution of sulfuric acid in such proportion as to incorporate a small amount of the acid (about 25 per cent) in the pulp. The acetylation of this acid containing wood pulp, after removal of the residual water, is found to yield cellulose acetate of improved clarity and solubility.

Table II. Fermentation Data on Alcohol Mashes

Expt. No.	Organism	Whey Used: Weight, Lb. (Gal.)	Whey Used: Lactose hydrate content, %	Weight of Pitching Yeast, Grams (Lb.)	Final Distillate: Volume, Cc.	Final Distillate: Alcohol by volume, %	Final Distillate: 100% alcohol equivalent, Cc.	Theoretical yield, %	Weight of Separated Yeast, Grams	Fermentation Time, Hours	Fermentation Temp., ° C.
1[a]	*Torula cremoris* A. T. C. 2512	169 (20)	4.62	500 (1.1)	4160	44.0	1830	80.3	720	21.7	30 to 32
2[b]	*Torula cremoris* A. T. C. 2512	165 (20)	4.95	500 (1.1)	4280	41.7	1785	75.0	...	48.0	......
3[c]	*Torula lactosa* A. T. C. 7014	168 (20)	5.31	570 (1.25)	3820	46.37	1771	68	770	24.0	35 to 36
4[d]	*Torula lactosa* A. T. C. 7014	259 (30)	4.91	500 (1.1)	5660	44.68	2525	68	...	40.8	32 to 37
5[e]	Yeast A. T. C. 2702	171 (20)	5.12	750 (1.65)	4470	43.5	1945	75.8	...	24.0	......

[a] Filtered whey; pH 4.5; fermented in closed milk cans; initial specific gravity 6.8°, final 1.2° Brix; specific gravity of slops 3.3° Brix.
[b] Unfiltered whey; pH 5.3; initial specific gravity 7.3°, final 2.3° Brix. Yeast not separated.
[c] Filtered whey; pH 4.5; initial specific gravity 7.5°, final 1.2° Brix; some mycoderma; distilled without fat; riboflavin in slops 1.3 micrograms per cc.
[d] Unfiltered Roquefort cheese whey; pH 5.35.
[e] Filtered Swiss cheese whey; initial specific gravity 7.2°, final 1.2° Brix.