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DE82 021053

FINAL TECHNICAL REPORT

CATTAIL-TO-ALCOHOL PROJECT

In November of 1980, two test plots of cattail bog were identified lying adjacent to a county road on the Reservation. The exact location was # 144-Range 40 W-N 114 Section 5 in Mahnomen County. These sites were measured at 10 ft x 12 ft in size, and the cattail growth counted in four foot square increments. This information was duly recorded by the Reservation biologist.

In the next step plots were excavated by using a long reach back hoe. The excavation were made to a depth of 12 to 15 inches, which resulted in the harvest of the complete cattail plant including 80% of the rizohmes (root). Before excavation the bog was firm enough to support a 160 lb person. Some much was observed during exavation. Forty eight hours (48) after the excavation, the havest test site had completely filled with water to the level of original soil line on top of the bog.

These sites were monitored periodically for one year. After one year (November 1981) it was noted that approximately 10% regrowth had appeared. This would indicate that re-harvesting of plots would have to take place after a minimum of two years of regeneration.

In the spring of 1981, construction was started on a still. The still consisted of a main distillation tank wiht agitation, two distillation columns packed with berl saddles, a condensation section and receiving tank. The heat was supplied by a wood fired boiler and transfered to the fermentation tank through hot water coils under and around the tank.

DISCLAIMER

The tank and distillation columns were insulated and the temperature monitored at several locations thru the installation of temperature gauges. The entire system operates under a vacuum. The still is designed to distill alcohol made form several different feed stocks.

The first batch of cattails scheduled for distillation was started on August 27th 1981. The entire plant including tops and rizohmes were used for this distillation. The cattails had been harvested with a back hoe and washed with water using an ordinary garden hose. A commercial enzyme was used on the initial batch. This enzyme is from the Biocon Company.

The cattail feed stack used was ground in a commercial type garbage disposal. This was very time consuming as the feed stack plugged in the grinder. A method was devised to pre rough grind the feed stock before grinding in the disposal. This method was more successful since water could be run with the feed stock at the time of disposal grinding, however it was difficlut to control the water and feed stock mix. A method was then divised to measure the amount of water entering the fermentation tank.

As the distillation process was started, it was found that with the liquid and feed stock in the tank, the hot water heat circulating pump was too small and did not force the hot water thru the coils at a large enough volume. This pump was replaced with a larger one.

Since the first batch was not successful, a second attempt was made, using only the lower part of the cattail plant (Rizohme). These were also pre-ground before going thru the disposal grinder. This batch was also started with Biocon enzymes. During monitoring of the process it was found that the fermentation process started, but then stopped entirely.

This batch was diposed of and a new batch started using enzymes recommended and furnished by Mills Laboratory. The process started and then stopped as inthe previous batch. After several unsuccessful attempts of fermenation, a sample of the feed stock was sent to the University of Minnesota Bio-Chemistry Department for analysis. The findings by the University staff was massive contamination of micro-organizims.

Since we were trying to determine the feasibility of commercialy producing alcohol from cattails, we tried to operate in this manner some what consistant with that goal. This was perhaps too ambitious considering the experimental nature of cattail fermentations.

At this point, contact was made with Mr. Jim Gabrielson of Plymouth, Minnesota who had previously done extensive work with the fermentation and distillation of cattails to alcohol.

The final outcome of the work done with Mr. Gabrielson is described in the attached. technical report.

We find that it was completely feasible to distill alcohol from cattails, with the proper use of anti-biotics, and proper grinding of the feed stock.

The main problem remaining is the method of harvesting the cat-tail plant.

To date, a proper harvesting machine has not been developed to successfully harvest the whole plant including the rizohme which is the main source for alcohol production.

During the course of the project at White Earth, all harvesting was done by hand. This would not be economically feasible in a commercial operation. The University of Minnesota is presently involved in the

development of a harvesting machine, but at the present time this machine is in the experimental stages and has not been proven too successful.

In the final analysis, the cattail to alcohol project has proven that there is an abundant supply of cattail feed stock on the White Earth Reservation, and that this could be developed into a cash crop for the Reservation residents after the harvesting techniques had been developed, and that the crop does not compete for land normally used in the production of accepted agricultural products.

The project also has proven that it is possible to obtain high grade alcohol from the cattail plant. Refinement of the project will make this economically feasible.

REPORT OF EXPERIMENTAL RESULTS

by

JAMES E. GABRIELSON

Prepared For:

White Earth RBC

FEBRUARY 2, 1982

On January 26, 1982, Mr. Rick Lauderdale brought cattail rhizomes from White Earth to me in Plymouth. We separated the rhizomes from the roots or bottoms of the attached stocks. Then we removed the outer, fiberous part and used only the hard core of the rhizomes. This is where I believe the starches and sugars are concentrated.

The cores were ground in a kitchen food mixer (Wearing blender type), dried in a microwave oven and reground. The product was nearly the size of flour.

The material was split into two fractions and cooked. One batch was cooked with 2% of the dry weight as barley malt and the other with 0.4% of the dry weight as a commercial amylase (Taka-therm). These materials were added to improve the liquefaction. These two tests were designated as "malt" and enzyme test.

January 27, 1982

Cooking:	"Malt"	"Commercial Enzyme"
Rhizome, gm	244	244
Malt (ground), gm	5	--
Taka-therm, gm	--	1
pH	5.0 (after H_2SO_4 addition)	6
Water	634 gm	732 gm
7:50 pm	Start Heating	
8:20 pm		Start Heating
8:40 pm	180°F	160°F
	stir	stir
9:15	160°F	150°F
	stir	stir
9:50	190°F	190°F
	stir	stir
Water added	250 ml	250 ml
Iodine test	No Starch in Liquid	No Starch in Liquid
	No Starch in Solid	No Starch in Solid
11:30		Add 400 ml Water
		H_2SO_4 to pH 4
		Add 1.2 gm diazamine
		in oven at 140°F

	"Malt"	"Commercial Enzyme"
12:30	Add 400 ml cold water 2.4 gm Fungal amylase 10 gm Diatase in oven at 140°F	
	January 28, 1982	
6:30 am	Remove from oven Add 125 mg Tegopen	Remove from oven Add 125 mg Tegopen

The part from 11:30 on, above, was to convert the starch to sugar.

At this point, 8:30 pm, 1/28/82, the two fermentations were started. The CO_2 generated was caught in an inverted bottle filled with water. When the CO_2 displaced much of the water, the bottle was removed and weighed. By the total weight of water displaced over the course of the fermentation, the CO_2 produced was calculated. From this the alcohol produced was calculated.

8:30 pm	Make to 3.9 lb (13% rhizomes)	Make to 3.9 lb (13% rhizomes)
7:30 start yeast	5 gm yeast 5 gm sugar 100 gm water	5 gm yeast 5 gm sugar 100 gm water
	5 gm nutrient	5 gm nutrient
9:00	start fermentation	start fermentation
11:00 - 1	Place in 100°F water bath	Place in 100°F water bath
	Bottle Weight	Bottle Weight
1:00	6 lb	9 lb 2 oz
2:17	6 lb	4 lb
2:36	9 lb	8 lb 4 oz
3:51	4 lb 8 oz	3 lb 4 oz (empty)
4:53	3 lb 14 oz	3 lb 4 oz (empty)
5:52	3 lb 12 oz	6 lb 12 oz
7:00	3 lb 4 oz (empty)	not weighed
7:55	3 lb 6 oz	not weighed
8:38	6 lb	10 lb 12 oz
9:24	8 lb 9 oz	None
1/31/82 9:23	7 lb 10 oz	None

Full bottle weight 11.625 lb

total 11 bottles 62.93 lb
11x11.625 = 127.87
Difference 64.95 lb

64.95x454 = 29,485 ml

$\frac{29,485}{22,400}$ = 1.31 moles

1.31 x (90) = 118 gm used
mole x (mole wt CO_2 + mole wt ethanol)

118 x $\frac{46}{90}$ = 60.5 gm alcohol

100 $\frac{60.5}{4.125x454}$ = 3.2% by weight alochol

100 $\frac{\text{wt alcohol}}{(\text{total weight beer})(\text{lb})}$

used 118
- 5 malt
-10 sugar
-10 distase
93

$\frac{93}{244}$ 100 = 38% used

38 $\frac{46}{90}$ = 19.4% conversion to alcohol

Total 7 bottles 45.375
7x11.625 = 81.375
Difference 36 lb

36x454 = 16,344 ml

$\frac{16,344}{22,400}$ = 0.73

0.73x90 = 65.7 gm used

65.7 x $\frac{46}{90}$ = 33.6 gm alcohol

100 $\frac{33.6}{4.06x454}$ = 1.8% alcohol

used 65.7
-10 sugar
55.7

$\frac{55.7}{244}$ 100 = 22.8% used

22.8x$\frac{46}{90}$ = 11.6% to conversion to alcohol

The above seems good, especially in light of the results achieved at the University of Minnesota. Some improvements or further definition would be helpful. Among the first steps would be:

1. Determine if the saccharification step in the malt test could be replaced with Diazamine, malt, or can one of the two materials being used be eliminated or reduced in amount.

2. Determine if the solids concentration in the wort can be increased.

Application of these results to your scale probably will require grinding, and probably screening. Without screening, the amount of non-productive solids, cellulose, in the wort will be so high that the ultimate alcohol concentrations will be even below the levels achieved here.