UNIVERSITY OF GHANA
LEGON

**'SUSTAINABLE INDUSTRIAL MARKETS FOR CASSAVA' PROJECT**

**FINAL REPORT 2 ON PROJECT YEAR 2 ACTIVITIES**

# REPORT ON ACTIVITIES AT KOKOFU AND ATEBUBU FOR THE PRODUCTION OF INDUSTRIAL ALCOHOL FROM CASSAVA

By

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**Summary**: Cassava is one of the richest sources of fermentable substances for the production of industrial alcohol. About 400 - 420 litres of ethanol/tonne of cassava flour can be produced. Cassava processing in Ghana is of utmost importance to the growth of the economy and livelihoods of the rural dwellers. Industrial processing of cassava has therefore been considered as one of the means of improving rural-livelihood. The purpose of this work is to produce industrial alcohol from cassava using appropriate technology in Atebubu district. Field trips were undertaken at Kokofu and Atebubu to produce the fermentables (intermediate products) and alcohol utilizing the processors and their equipment. 20 Kg of cassava flour was mixed with 100 L of water and then hydrolysed with 8 Kg of the rice malt. The hydrolysate obtained was 67 L having solid content of 24 %. This hydrolysate was fermented with 500 g of bakers yeast and then distilled at the artisanal level. About 14 L of the "potable alcohol" which is about 8 L of the industrial alcohol was obtained. It is therefore possible to produce industrial alcohol from cassava at the community level.

## 1.0 Introduction:

Cassava (*Manihot esculanta* Crantz) is one of the staple crops produced in the country. The current Ghana's production which leaves surpluses of about 2 to 3 million metric tonnes need to be processed. Kokofu and Atebubu (in Atebubu district) of the Brong - Ahafo region of the republic of Ghana have been considered for rural-livelihood improvement. Glucose syrup processors at Kokofu are mainly women who use cassava flour and rice malt (raw materials) in the production of glucose syrup. Their men have been organised to be involved in the production of high-quality cassava flour. About 10

litres of glucose syrups are produced a day by these processors. "Akpeteshie" distillers at Atebubu are men who are involved in production of alcohol using sucrose (table sugar) and bakers yeast. About 4 barrels of the fermented products are produced every eight (8) days. It would therefore be appropriate to use these two groups of processors and their equipment to do production trials and subsequent productions.

The purpose of these activities was to produce industrial alcohol from cassava utilizing the glucose syrup processors and "Akpeteshie" distillers at Kokofu and Atebubu respectively.

## 2.0 Methodology:

Visitations were made to glucose syrup processors three times and alcohol distillers ten times.

### 2.1 Materials

About 20 kg of cassava flour, 8 kg of rice malt and a container (500 g) of bakers yeast were used. These materials were obtained from Atebubu.

### 2.2 Methods

#### 2.2.1 Rice malt (at Kokofu)

A known quantity of paddy rice was cleaned, sorted, washed and soaked for 24 hours. The soaked paddy rice was then spread on trays and covered in the dark for 7 days. Water was sprinkled on the spread paddy rice during this period to allow maximum growth and enzyme production. The sprouted rice was then sun-dried to storable level and finally milled into powder/ flour. The milled rice malt was then stored at room temperature.

### 2.2.2 Cassava flour (at Kokofu)

The process used by the men at Kokofu to produce the high-quality cassava flour was used. The cassava flour was bought from these processors for the production of the intermediate products (fermentables).

### 2.2.3 Production of intermediate products (fermentables) (at Kokofu)

The process used for the production of the fermentables was a single - decoction method, as described below:

Two batches of 10 kg of cassava flour were each mixed with 20 litres of water heated to 60°C, to produce slurry. About 2 kg of milled rice malt was then added to each batch and mixed in. About 80 litres of boiling water was then mixed (with constant stirring) with one of the batches of slurry. The slurry became gelatinised, but as the enzymes in the rice thinned the paste very quickly, it became thin. Within a minute it was fluid-barely thicker than water. This mixture was then heated to boiling and similarly mixed with the second batch of slurry and rice malt. As with the first batch, the second batch quickly became thin. The drum containing the liquid was covered, to retain the heat. After sometime when the temperature had fallen to 62°C, another 4 kg of milled rice malt was added and stirred. Once again the drum was covered and conversion allowed to proceed. After 4 ½ hours almost all the starch was converted into maltose and the liquid clear and still quite hot.

The juice was then boiled briefly and filtered to remove the rice seedlings. The used seedlings was pressed to squeeze out excess juice, then washed to remove more of the sugars. The liquor was then poured into gallons for transport to distillers in Atebubu.

### 2.2.4 Industrial alcohol production (Atebubu)

The fermentables (intermediate products) produced at Kokofu was sent to "Akpeteshie" distillers at Atebubu for fermentation and distillation.

The fermentables was pitched with 500 g of bakers yeast, stirred and covered with transparent polythene bag and allow fermentation to take place for about a week. After the fermentation process was over, the fermented product was distilled using the traditional distillation equipment. The distilled alcohol was poured into gallons and sample taken to Accra for analysis.

## 3.0 Results/Outcome:

Table 3.1 below shows the yield of Hydrolysate, potable and industrial alcohol. The hydrolysate produced at Kokofu was about 67 L having solid content of 24 %. The process of producing the fermentables took about 8 hours, that is one working day. It will therefore be beneficial to increase the production of the fermentables. The saccharification/ starch conversion time was therefore 8 hours. Also, about 14 L of the "potable alcohol" which is about 8 L of the industrial alcohol was obtained. The 14 L of the potable produced was about 3 gallons. The figure 3.1 below shows the sequence of events in the production of industrial alcohol.

**Table 3.1: Yield of Hydrolysate, potable and industrial alcohol**

| Parameters | Quantity | Yield % |
|---|---|---|
| Hydrolysate/fermentables | 67 L/20Kg cassava flour | 24 % solids |
| Potable alcohol | 14 L | 47%v/v |
| Industrial alcohol | 8 L | 76%v/v |

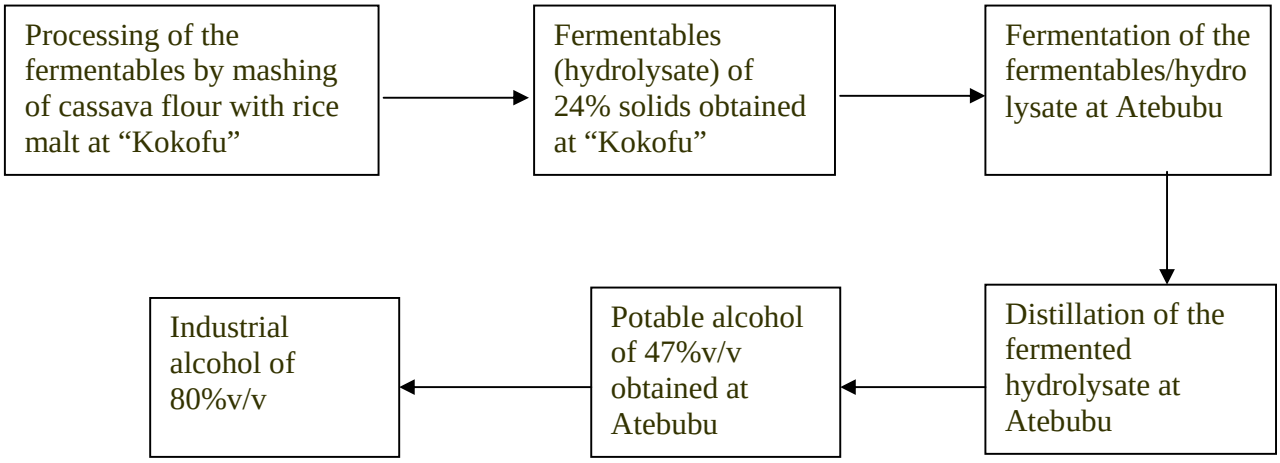


**Fig. 3.1: Sequence of events in the production of industrial alcohol**

### 3.1 Quality control

The pH of the mixture is very important since enzymes function at certain pH. So the pH of the mash was control using the pH paper or litmus paper of pH ranging from 4 - 7. The pH of the mash was maintained at 4.5 - 5.0. The temperatures in the process are quite important - if the liquids are too hot, the enzymes that convert the starch into maltose may be inactivated and if they are allowed to get cool, the activity of the enzymes will be reduced. Therefore temperature was controlled using thermometer within the range 50 -

70°C. After the 4 ½ hours, all the starch would have been converted into maltose. At this stage a saccharification/ degree of hydrolysis of starch test or the disappearance of starch test was made using iodine solution - a drop of this maltose "juice" in a dilute iodine solution showed no blueness. The sweetness of the hydrolysate was done using tasting test. Finally, the soluble solids/brix of the hydrolysate (fermentables) was determined using the hand refractometer. The strength of the distilled alcohol was tested using tasting with the tongue and specific gravity methods. The first distillate was found to be stronger and could be in the range of industrial alcohol. The second and third distillates were however potable alcohol.

### 3.2 Attitude and Impression of the artisanal processors

Both the glucose syrup processors and alcohol distillers were happy about the technology and are prepared to work with us establish these village industries at Kokofu and Atebubu. The acquisition of the raw materials will not be a problem since most of the people in these areas are cassava farmers. Another interesting thing was that, the distillers were also eager to know how the whole process is done.

### 3.3 Cost/benefit Analysis

This analysis was done based on only raw materials and the product obtained, cost of fuel, water and labour were not included. Table 3.2 shows the cost – benefit analysis for the production of industrial alcohol from cassava.

**Table 3.2: Cost – benefit analysis for production of industrial alcohol from cassava**

| **Parameters** | **Costs (¢)** | **Percentage** |
|---|---|---|
| **A. Inputs:**<br>1. Raw materials: | | |
| ➢ Cassava flour | 40,000.00 | 50 |
| ➢ Rice malt | 20,000.00 | 25 |
| ➢ Bakers yeast | 20,000.00 | 25 |
| **Total Input cost:** | **80,000.00** | **100** |
| **B. Output:**<br>1. Potable alcohol: | | |
| ➢ Three gallons | 135,000.00 | - |
| **Total Output cost:** | **135,000.00** | - |
| **Profit: Output - Input** | **55,000.00** | - |
| **% Profit gain ( gain/input)** | **-** | **68.75** |

### 3.4 Projections

Base on this observations, the following projections were made for the production of the fermentables. Table 3.3 shows the projections made for labour – shift system for the production of the fermentables.

**Table 3.3: Projections for labour shift – system for the production of the fermentables**

| Weight of flour | Drums of hydrolysate | Number of personnel | No. of Assistants |
|---|---|---|---|
| 60 Kg | 1 drum (201 L) | 2 | 1 |
| 240 Kg | 4 drum (804 L) | 8 | 4 |

## 4.0 Conclusion and recommendation:

In conclusion, it is therefore possible to produce industrial alcohol from cassava at the community level. It is recommended that future trials be done using malt to cassava flour ratio of 1:3. Thus using a malt base of 20 - 25 %.

## 5.0 Other activities undertaken by the group:

### 5.1 Process modification

Processes involved in the production of high yield fermentables and industrial alcohol were modified.

### 5.2 Market linkages

All blending industries for potable alcohol, scientific laboratories and hospitals were identified and the linkage is still in progress.

### 5.3 In-factory participation

No commercial industrial production is available in the country; however, there is a facility under Cocoa Research Institute of Ghana (CRIG). The institute at Tafo (E/R) was visited to inspect the industrial alcohol production plant, but we were referred to Assin - Fosu in the central region of Ghana. A visit was also made to Akuse industrial alcohol plant; however, the plant is not functioning.

### 5.4 Provision of Technical support

Hands - on practical training on equipment use and the use of quality control instruments were given to the processors.

### 5.5 Meetings

The team had four meetings every week to deliberate upon the activities and progress made within the week. Telephone communication was also made with other coalition partners, for example Mr. Krampa and his assistants at Kokofu and Atebubu about progress of work. A two - day conflict resolution workshop was also attended at Food Research Institute (F.R.I). The team also attended a coalition quarterly meeting on the 4th September, 2003 at F.R.I.

## 6.0 Appendix

**Equipment, materials and reagent used:**

**(A) Fermentables (intermediate products) production**

I. *Raw materials:*

(i) Cassava flour (Food-grade high-quality cassava flour as specified by Ghana Standards Board)

(ii) Rice malt (Industrial grade with the same specification as cereal flour by Ghana Standards Board)

(iii) Potable water

II. ***Processing equipment and fuel:***

(i) Aliminium pans (for mixing and heating)

(ii) Scale (for weighing)

(iii) Graduated cup (for measuring)

(iv) Stirring stick

(v) Coal pot

(vi) Charcoal

(vii) Net/Mesh and "Khaki" cloth (for sieving)

(viii) Bucket/bowl

(ix) Ladles

III. Quality control apparatus/reagent

(i) Refractometer (for determination of soluble solids/brix)

(ii) Iodine solution (for checking the degree of hydrolysis of starch/ disappearance of starch)

(iii) Litmus paper and (to check the pH of the mash)

(iv) Thermometer (to control the temperature of the mash within the range 70 – 50°C)

**(B) Alcoholic fermentation & distillation**

I. ***Raw material:***

(i) Hydrolysate / Fermentables (intermediate products) from cassava

(ii) Bakers yeast

II. ***Processing equipment and fuel:***

(i) Drums/barrels

(ii) Transparent polyethylene bag (for covering during fermentation process)

(iii) Buckets

(iv) Calabash

(v) Distillation equipment (A drum with a metal tube dipped into it and then tube coiled through cold water tank and finally to the receiving container).