

**TRAINING MANUAL**  
**FOR THE**  
**PRODUCTION OF GLUCOSE SYRUP**

R 8268-00

**Edited By**

**Nanam Tay Dziedzoave**  
**Andrew Graffham(Dr.)**  
**E. O. Boateng**

**Contributors**

**Nanam Tay Dziedzoave**  
**Cletus Gyato**  
**Wilhemina Quaye (Mrs)**  
**Godwin Ameleke**

**Collated, Organised And Prepared For Printing By**

20268/20

# TRAINING MANUAL

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## PRODUCTION OF GLUCOSE SYRUP

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Nanam Tay Dziedzoave, Food Research Institute, Accra.  
Andrew Graffham, Natural Resources Institute, U.K.  
E. O. Boateng, National Board for Small Scale Industries, Accra.

### Contributors

Nanam Tay Dziedzoave, Food Research Institute, Accra.  
Cletus Gyato, Food Research Institute, Accra.  
Wilhemina Quaye (Mrs), Food Research Institute, Accra  
Godwin Ameleke, Animal Research Institute, Accra.



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Institute



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DFID

Collated, Organised And Prepared For Printing By  
E. O. Boateng

National Board For Small Scale Industries (NBSSI), Accra, Ghana.

## ACKNOWLEDGEMENT

This publication is an output from a research project funded by the United Kingdom Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID. The research project is "Development of New Market Opportunities, to Increase the Contribution that Cassava makes to Sustainable Rural Livelihoods" ( R.7418 - Crop Post-Harvest Research Programme).

The collaborating institutions on the project are:

Food Research Institute, Accra, Ghana

Forest Research Institute of Ghana

National Board for Small Scale Industries (NBSSI), Accra, Ghana

Natural Resources Institute (UK)

University of Ghana – Department of Nutrition and Food Science and

Ministry of Food and Agriculture, Brong Ahafo Directorate, Ghana

The inputs of the research officers of the collaborating institutions in writing the manual are greatly acknowledged, especially those from Dr. Andrew Graffham of NRI of UK. Our special thanks to Miss Hilda Ansah, Stenographer Secretary at the Policy Planning, Monitoring and Evaluation Department of NBSSI, Head Office for typing the script.

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## 1.0 INTRODUCTION

Glucose syrup is a concentrated aqueous solution of glucose, maltose and other nutritive saccharides obtained from edible starch. Depending on the proportion of the different sugars in the syrup, the syrup may be specifically called a maltodextrin, high maltose syrup, or high dextrose glucose syrup. The type of glucose syrup this training manual addresses is the high maltose syrup. This type of glucose syrup has peculiar characteristics like, low hygroscopicity, low viscosity, high resistance to crystallization, low sweetness, reduced browning capacity and good heat stability. These properties make it useful in many applications in the food and pharmaceutical industries. In breakfast cereals it is used to improve shelf life, enhance colour, reduce breakage and maintain crispness. It is also used to control crystallisation and sweetness in ice creams and lollies whilst at the same time providing body and strength to these products. When used in confectionery products it helps to lower the hygroscopicity of the product, controls crystallization, prevents drying and lowers viscosity. Glucose syrup is also very useful in the manufacture of frozen fruits, liquors, and crystallized fruits and in brewing.

Several industries in Ghana use Glucose syrup in their manufacturing operations. The bulk of the syrup used is however imported. In an attempt to expand existing markets for cassava, an existing Vietnamese technology for glucose syrup production was adapted and modified to enable the production of glucose syrup from cassava flour and rice malts. The aim is to provide a local supply source for glucose syrup to substitute for the imported product. The adoption of the technology by both producers and end-users would yield a lot of economic and social benefits to entrepreneurs who produce the syrup, the end-users as well as the farmers who produce the cassava. Some of these benefits would include, foreign exchange savings, improvement in income levels, employment creation, efficient use of our natural resources, and easy access to an industrial raw material amongst others.

This production manual seeks to provide an easy-to-follow step-by-step process for the production of Glucose Syrup. The manual also highlights quality control issues, machinery and equipment requirements and the potential markets for the product.

It is hoped that prospective entrepreneurs will find the manual handy and useful as they explore this new viable industrial activity, which promises to be a novel avenue for utilizing the vast resources of cassava and local rice in Ghana.

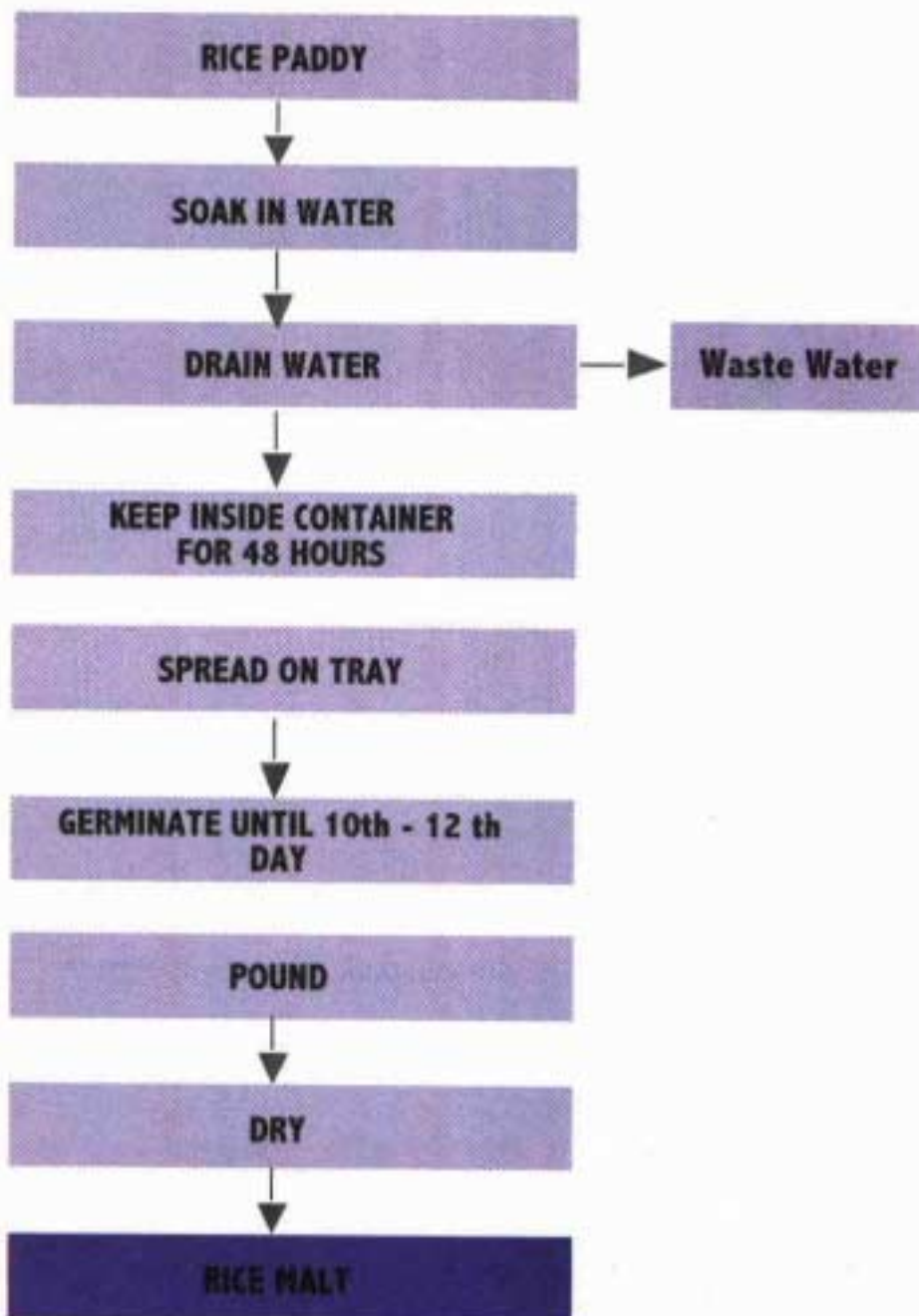
## 2.0 PRODUCTION OF GLUCOSE SYRUP

The production of glucose syrup involves:

- Preparation of Malted Cereal.
- Conversion of cassava flour into glucose syrup.

### 2.1 Preparation of Malted Cereal

Rice is the recommended cereal for malt preparation. In the absence of rice, maize or sorghum may be used. The flow chart below summarizes the process.



Soak recommended rice variety in clean tap water for 24 hours. (change water every 8 hours approximately).

- Drain water and leave soaked grains in container for 48 hours. (Water grains two times each day).
- Spread grains to a thickness of about 2-3 cm in malting tray with a perforated bottom and place on a slope.



**PICTURE OF GERMINATING RICE GRAINS**

- Cover germinating seeds with dark sheet to avoid excessive light during germination.
- Water grains two times a day up till the 7-9th day after soaking, and once a day thereafter until the 10th-12th day of soaking.
- Pound seedlings in mortar with pestle or with other mechanical pulper
- Dry seedlings and use

## 2.2 Conversion of HQCF into Glucose Syrup



**PICTURE SHOWING OVEN-DRYING OF RICE MALT**

- Add 80g of rice malt to 1kg of HQCF (Batch A)
- Prepare another batch of 80 g rice malt and 1kg HQCF (Batch B)
- Add a little over 1 litre of water to each batch of malt/flour mix and mix thoroughly.
- Add about 4.8 litres of boiling water to Batch A
- Stir mixture until no sign of whiteness is seen (5-10 min)
- Boil the mixture.
- Add the boiling mixture to Batch B
- Stir until no sign of whiteness is seen
- Cover mixture and leave to cool to about 60-65°C



- Add 160g of rice malt, stir and leave for 4-8 hours
- Boil mixture briefly and filter
- Evaporate filtrate to about half the original volume
- Add 20g of sodium metabisulphite and mix thoroughly

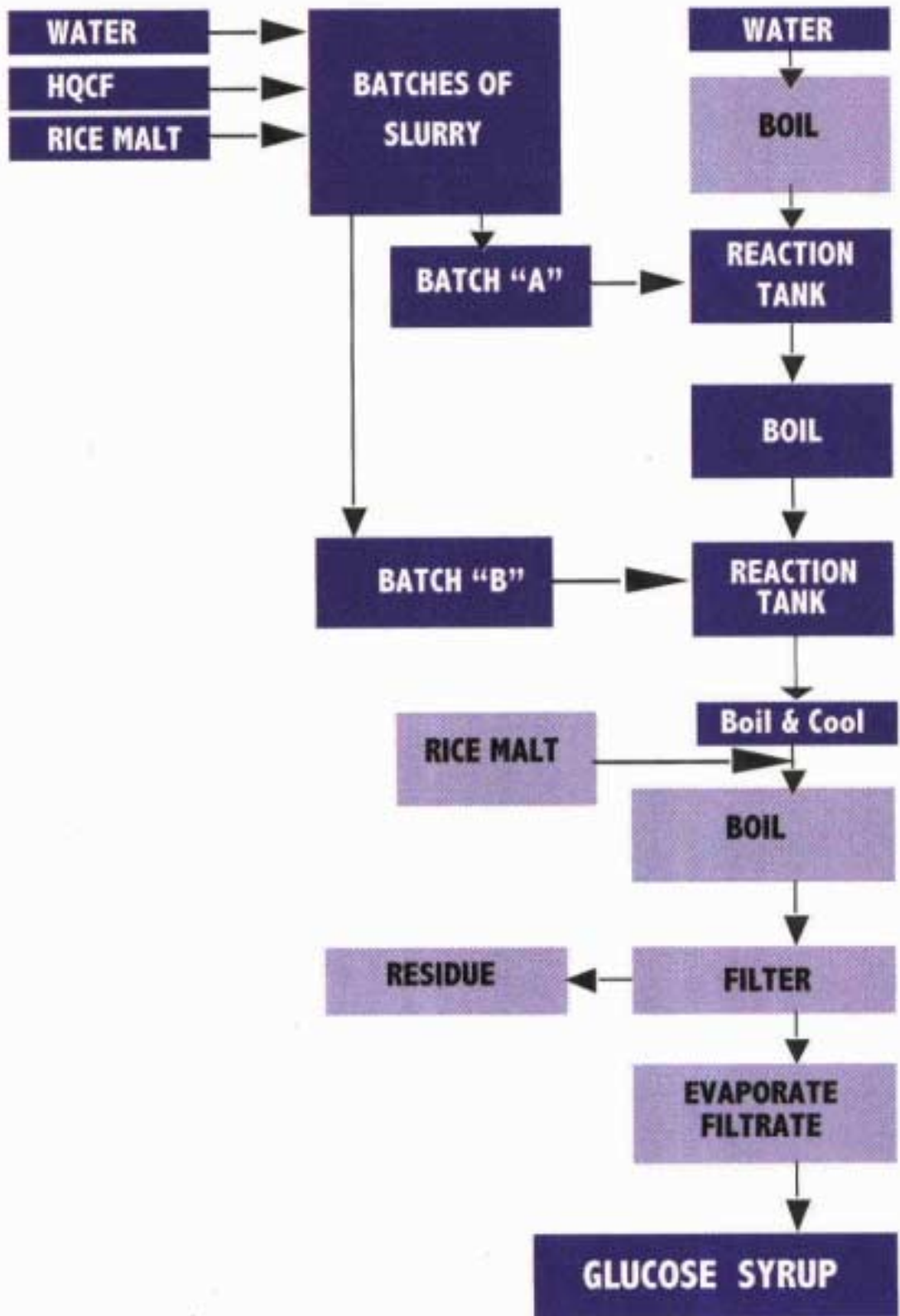


**PICTURE OF BOTTLED GLUCOSE SYRUP**

- Continue evaporation until liquid becomes thick and syrupy
- Remove from heat and pour into a dry drum to cool.
- Package into suitable plastic or glass containers.

*The flow chart below summarises the process.*

*Flow Chart For The Production Of Glucose Syrup*



### 3.0 QUALITY REQUIREMENTS OF GLUCOSE SYRUP AND FACTORS IMPACTING ON SUCH REQUIREMENTS

Parameter	Specification	Unit Process and other factors impacting on Quality
Moisture (%0)	15-20%	Evaporation Process.
pH	5.5-6.5	Flour quality.
DE	45	Malt quality and quantity, Time/Temperature controls.
Colour	Colourless	Metabisulphite addition, flour quality, Filtration Process.
Odour	Odourless	Flour and malt quality
Taste	Very sweet	Malt quality and quantity, Time/Temperature controls.
Clarity	Very clear	Metabisulphite addition, Flour quality, Filtration process
Bacterial Count (max)	100 cfu/g	Water quality, malt quality
Fungal Count (max)	100 cfu/g	Water quality, malt quality
Pathogens	nil	Water quality, malt quality

The production process described above would yield a product that currently meets the specifications on Moisture, pH, DE, Taste, Fungal Count, Bacterial Count and Pathogens. The product would however require further processing to completely meet the specifications on colour, odour and clarity. In spite of this limitation the product is still a good industrial material.

**4.1 Major Equipments**

Stove/Furnace and accessories

Heating Vessel

Foam Chimney (A basket with diameter as the heating vessel may be used).

Filter Unit

Evaporation Unit

Robust Screw Press

Opened top drums/Aluminium Pans

Water holding containers

**4.2 Minor Equipments**

Galvanised Steel Buckets

Circular Basket work Covers: to cover drums containing liquids

Weighing Scale (Small)

Weighing Scale (Medium)

Long Handle Ladle

Paddles: for stirring

Metal Bowls

Lifters

Small Shovel

Sample Sticks

Glass tumblers

Graduated Cylinder

Thermometer

Brix Hydrometer (Refractometer)

Natural Fibre (jute or hessian) Cloth Sacks: for filtering juice

Fine Screen: for removing scum from boiling liquid

Coarse Screen

Pestle

Mortar

Pokers (steel rods)

## 5.0 **POTENTIAL MARKETS, ECONOMICS AND PROFITABILITY OF GLUCOSE SYRUP PRODUCTION**

### 5.1 *Product Market*

The potential markets for glucose syrups are the confectionaries, pharmaceuticals and beverage and biscuit industries in Ghana. It is estimated that about 116,000kg of sugar syrup was imported into Ghana in 1999, and at least some four industries are known to be using about 90% of what is imported. Some specific industries that could be potential buyers of glucose syrups include:

- Longlife Confectionary Ltd. Accra.
- Fanmilk Ltd., Accra.
- Korama Ice Cream, Accra.
- Dannex Ltd., Accra and Kumasi.
- Gihoc Pharmeceuticals Div., Accra.
- Kinapharma Ltd., Accra and Kumasi.
- Pro-Bio Laboratories Ltd., Accra.

### 5.2 *Economics and Profitability*

The financial analysis of glucose syrup production quantified the cost of investments and returns in terms of market prices and presents estimates of the enterprise's financial profitability based on assumed cost of capital. The economic value of the enterprise was then estimated by adjusting the financial prices to reflect the real value of the enterprise (with regards to both inputs and outputs) to the nation. Three measures of project worth were used in the economic analysis analysis namely, Net Present Value (NPV), Internal Rate of Returns (IRR) and Benefit-Cost ratio (B-C). In addition, Sensitivity analysis was incorporated to reflect the extent of effect on profitability by variations in the level of costs and revenues. The assumptions below were made in the analysis:

#### *Assumptions*

- Costs estimates are based on current prices in Ghana in March 2002
- Current Foreign Exchange conversion used is US\$1.00 : 47600
- The analysis is restricted to first five years of the project implementation
- No residual values are assumed after 5 years for Equipment
- Exchange rates and market prices are assumed to be efficiently determined.
- No price distortions in traded items.
- There are no subsidies and tax exemptions are assumed. Therefore financial and economic analysis are similar

- Rice seedlings (enzyme) preparation is integrated into sugar syrup production since there is no active market for seedlings immediately.
- Cassava flour and cassava starch give the same quality of sugar syrup
- No byproduct sales are assumed
- Costs and benefits estimations are based on constant prices. Thus general inflation will exert the same relative effect on both costs and benefits
- 30% lending rate/ cost of capital is used (April, 2002)
- Cash flows in future years are assumed to occur in one lump sum at the end of the year.

### *Cost estimates*

<b>Item</b>	<b>Year1 Village-based</b>	<b>Year1 Commercial Scale</b>
Land and Building	6,000,000	20,000,000
Major Equipment	5,650,000	11,850,000
Minor Equipment	360,000	1,400,000
Indirect Labour	2,125,000	2,125,000
<b>Total</b>	<b>14,135,000</b>	<b>35,375,000</b>

### *Revenue*

Revenue Projection for Small-Scale /Village based Sugar Syrup Production

<b>Year</b>	<b>Capacity (Kg/year)</b>	<b>Projected Revenue (¢'000)</b>
1	12000	51600
2	12000	51600
3	18000	77400
4	24000	103200
5	24000	103200
<b>Total</b>	<b>-</b>	<b>387000</b>

Source: Quaye et al., 2002

Revenue Projection for Large-Scale Sugar Syrup Production

<b>Year</b>	<b>Capacity (Kg/year)</b>	<b>Projected Revenue (¢'000)</b>
1	72000	416,232
2	84000	485,604
3	96000	554,976
4	96000	554,976
5	96000	554,976
<b>Total</b>	<b>-</b>	<b>2,566,764</b>

Source: Quaye et al., 2002

## *Financial and Economic Feasibility*

Cash flow analysis of the various options showed that small-scale and large scale glucose syrup production using cassava flour are financially and economically viable with estimated NPV of 43,023,264 and 485,755,097 at 30% discount rate; and IRR of 44% and 137% respectively. Thus, large-scale sugar syrup production yields financial returns that far exceed the current market interest rate or opportunity cost of capital. However, glucose syrup production from starch is not financially viable, because of the high cost of locally produced starch. It was also realized that glucose syrup is more expensive than ordinary sugar and cannot be substituted for sugar as a sweetener. Sensitivity tests done by changing some sensitive parameters; 10% total cost overrun and 10% decrease in selling price levels show that at 10% total cost overrun, NPV of 11,532,165 at 30% discount rate and IRR of 42% are obtained while 10% reduction in selling price showed NPV of 46,864,623 at 30% discount rate and IRR of 20% for large scale glucose syrup production. However, changes in both parameters gave negative NPV for small-scale glucose production. As already mentioned, different selling prices reflect the differences in cost of production. Selling prices are sticky downwards.

## **6.0 CONCLUSION**

This Training Manual for the Production of Glucose Syrup demonstrates another business opportunity for existing and prospective business people to create wealth in our rural areas by using the available local resources of cassava and rice. There is an existing market for glucose syrup in food processing and pharmaceutical industries based in the urban centres.

The production and use of glucose syrup by local industries will help conserve foreign exchange presently used for its importation and also create job opportunities for producers of raw materials and the users of the product.

It is hoped that the business community will combine their entrepreneurial and managerial knowledge to exploit the business opportunity offered by this manual for the benefit of all.

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## CONTACTS FOR FURTHER INFORMATION

For further information on Glucose Syrup contact the following addresses:

### **NAME OF ORGANISATION**

Food Research Institute Box M.20, Accra.

Nutrition And Food Science Department – University Of Ghana – Legon

Ministry Of Food And Agriculture, Crop Post Harvest Division, Sunyani

Natural Resources Institute, United Kingdom



