Novel Approaches in the Value Addition of Tropical Root Crops for Food and Industrial Use

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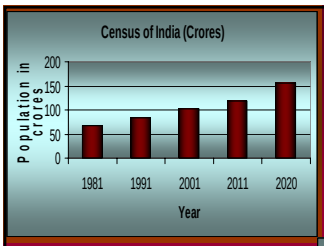
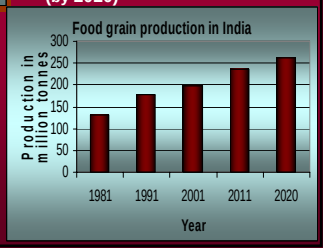


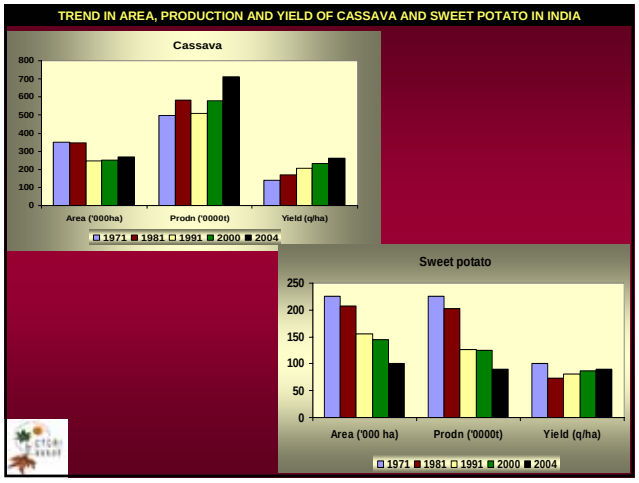
Inadequate supply of food:

A major threat for India(by 2020)?

Net shortage of food grains:
***ca* 26 million tonnes**
(by 2020)

Tropical tuber crops to bridge the gap in food production (by 2020)





Value Addition: Why is it necessary ?

- **Large deficit in foodgrains : a major crisis for India by 2020**
- **70 % of the population depend on agriculture as the main activity**
- **Energy requirement of India: to treble by 2030; necessity for alternative fuel sources**
- **Post harvest losses: accounting to > 30% in horticultural crops**
- **Demand for processed foods: visualized largely to cope with the changing lifestyle and rapid urbanization**

Value addition technologies for the food sector

Cassava Semolina

Nutrition facts (per 100 g) Energy: 508 Kcal; Protein: 5.0 g; Fat: 20.0g

Nutrition facts (per 100 g) Energy: 480 Kcal; Protein: 1.0 g; Fat: 24.3g

Fried snack foods from cassava flour

Sweet potato based instant gulab jamun mix

- **Gulab jamun- a sweet dessert of India**
- **Instant gulab jamun mixes from white fleshed, carotene rich as well as anthocyanin rich sweet potato tubers**
- **Sweet potato incorporation from 30-50%**
- **Other ingredients include milk powder, refined wheat flour and baking powder**

SNACK FOODS FROM CASSAVA

Nutrition facts (per 100 g) Energy: 504 Kcal; Protein: 11.5 g; Fat: 25.2g

Nutrition facts (per 100 g) Energy: 467 Kcal; Protein: 11.9 g; Fat: 22.2g

Nutrition facts (per 100 g) Energy: 436 Kcal; Protein: 1.0 g; Fat: 12.7g

Nutrition facts (per 100 g) Energy: 485 Kcal; Protein: 12.8 g; Fat: 24.6g

SNACK FOODS (SWEET POTATO)

Nutrition facts (per 100 g) Energy: 542 Kcal; Protein: 22 g; Fat: 29.8g

Nutrition facts (per 100 g) Energy: 492 Kcal; Protein: 11.3 g; Fat: 23.1g

Nutrition facts (per 100 g) Energy: 507Kcal; Protein: 8.6g; Fat: 22.9g

Nutrition facts (per 100 g) Energy: 554 Kcal; Protein: 11.2 g; Fat: 33.2g

SWEET POTATO JAM

40% sweet potato, 10% fruit pulp + 50% others

Nutrition facts (per 100 g) Energy: 247 Kcal; Protein: 1.3g; Fat: 0.05g

SWEET POTATO PICKLE

70% sweet potato, 25% sesame oil + 5% others

Nutrition facts (per 100 g)

Energy: 504 Kcal

Protein: 11.5 g

Fat: 25.2g

SWEET POTATO SOFT DRINKS

60% sweet potato, 40% others

Nutrition facts (per 150 ml)
Energy: 173 Kcal
Protein: 0.20 g
Fat: 0.07g

High fructose syrup for Confectionery industries

Root crop	Absolute starch content (%)	Conversion to glucose (%)	Conversion to fructose (%)
Cassava	94	96.86	42.34
Sweet potato	92	96.50	41.92
Greater yam	89	96.40	41.26
Arrowroot	89	95.16	42.58
Curcuma sp.	90	95.21	41.26
Tannia	91	93.42	39.10

- Conversion efficiency : Not influenced by the source
- Potential depends to a large extent on the raw material cost

Food Extruder

- ❑ The demand for quick cooking or instant food products is expanding at a phenomenal rate in developed and developing countries
- ❑ Most of the tuber crop powders can be used as feed ingredients in puffed snack food products

Extrusion Parameters for tuber crop powders

- Temperature: 70-230°C
- Feed rate: 5-30 rpm
- Screw speed: 70-130 rpm
- Die size: 1-5 mm

✳ Nutritionally fortified extruded products :presently under study

Extruded products from tuber crops

Cassava flour extrudates

Cassava starch extrudates

Greater yam extrudates

Sweet potato starch noodles

Low fat , energy-reduced extruded snacks from cassava

Amylase-rich cassava flour

Termamyl treated (18h,55ºC)

Germinated green gram treated (18h, 55ºC)

Mixed with wheat and chick pea flour (70:20:10)

Type of flour	Starch (%)	Fat (%)	Energy (Kcal/100g)
Termamyl-treated	69.5	1.0	334
Ter.+ Pre-gelatinised	58.3	1.6	313
Greengram	69.9	1.1	343
G.G+ pre-gelatinised	63.3	2.0	320

High protein, low fat geriatric health drinks from cassava

•Whey protein concentrate : an excellent substitute for milk powder in cassava starch based formulations

Ingredient (%)	Native starch	Pre-gelatinised starch
Starch	25	35
Maltodextrin	30	30
Milk powder/WPC	20	20
Chocolate powder	10	10
Sugar	15	5

WPC enhanced **Protein** to 13 % from 5% in milk powder added formulae. **Fat** reduced from 7% in milk powder formulae to 5 % in WPC added formulae.

Nutritionally fortified mini-papads (Wafers) from cassava

Fortification with cheese, defatted soy flour (DSF), prawn powder (PP) and Whey protein concentrate (WPC)

Ingredients	Incorporation (%)
Cassava flour	61.0
Rice flour	8.3
Cheese/WPC/DSF/PP	16.7
Chilli powder	2.8
Sugar	2.2
Condiments, spices and preservatives	9.0

*** Protein enrichment range: 8.3-16.8%**

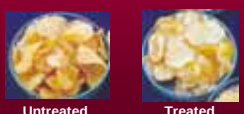
Pre-fermentation : A novel biotechnique for light coloured fried chips from cassava and sweet potato

Cassava	Pre-fermentation with yeast for 1 h at 30° C, blanching, surface drying and deep-frying
Sweet potato	Pre-fermentation for 2 h at 30° C, surface drying and deep-frying

Cassava chips

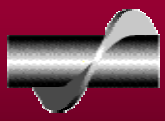
Untreated Treated

Sweet potato chips



Untreated Treated

Value addition technologies for the industrial sector



Alcohol from cassava

Starch → Glucose → Alcohol

- Patented technology (1980s)
- Comparative ethanol yield from various cassava sources

Cassava source	Yield (l/tonne)
Cassava starch (dry)	470
Cassava flour (dry)	300
Wet root slurry (fresh)	120
Rotten roots (wet)	90
Starch factory waste (byproduct) (dry)	200
Cassava peel (fresh)	56

Recent upsurge in interest due to potential as biofuel

Major bottleneck in adoption: high production cost

← Cassava gum for office use

Cassava starch for textile use →

COLD WATER MISCIBLE STARCH 'Texcool' FROM CASSAVA

- Textile application
- Good and stable viscosity
- Completely soluble in cold water

BIODEGRADABLE PLASTICS FROM CASSAVA STARCH

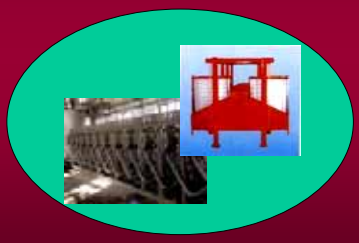
Patented in India and abroad

* Commercially proven technology
* Can be easily adopted by the existing plastic manufacturers
* The film possesses adequate mechanical strength and flexibility
* Biodegradation time: 6 months to 5 years
* Technology transferred to four companies in India
* Major drawback: Cost 40% higher than conventional material

Tuber starches for tablets

- Corn starch used as inert filler in tablets
- Tuber starches in native form and modified form can serve as replacers to corn starch in tablets
- Potential of starches from cassava, sweet potato, yam, arrowroot and elephant foot yam as disintegrant in tablets was studied: Arrowroot was the best.
- Octenyl succinate cassava starch and alpha amylase modified cassava starch were studied for use as binder in tablets. Latter has better binding properties.

Processing Machinery for tuber crops



Machinery for Tuber Crops

Cassava harvester

Cassava peeling knife

CASSAVA CHIPPING MACHINES

HAND OPERATED

Output : 38-117 kg/h

PEDAL OPERATED

Output: 83-768 kg/h

MOTORISED

Output: 300-1100 kg/h

MULTIPURPOSE MOBILE STARCH EXTRACTION PLANT FOR TUBER CROPS

CAPACITY

Cassava: 200 kg/h
Sweet potato:135 kg/h

Rasper and Granulator

CASSAVA RASPER

Capacity : 400 kg/h
Motor : 0.5 hp

FEED GRANULATOR

Capacity : 20 kg/h
Application : for making granulated (spherical) feed

PILOT PLANT FOR LIQUID ADHESIVE FROM CASSAVA STARCH

Capacity : 100 litres

Applications :

Carton sealing, laminated board, metal foil-to-paper laminating, corrugated board, bottle and container labeling, bill posting, cigarette seaming, bag making etc.

Advantages :

- **Good flow characteristics**
- **'Ready-for-use' by the consumer**
- **Ideal for small scale entrepreneurs**

Commercially important enzymes (using tuber starches as source for microbial growth)

Type of enzyme	Use
Alpha – amylase	Liquefaction of starch in alcohol, liquid glucose and HFS production
Gluco amylase	Saccharification of starch
Glucose isomerase	Conversion of glucose to fructose in HFS production
Cellulase	Production of alcohol and commodity chemicals from lignocellulosic wastes
Pectinase	Clarification of fruit juices during production of wine, beer and soft drinks
Lipase	Cheese maturation, eco-friendly detergents etc.
Alkaline proteinases	Eco-friendly detergents as stain removers

* Proposed under the World Bank-aided National Agricultural Innovation Project

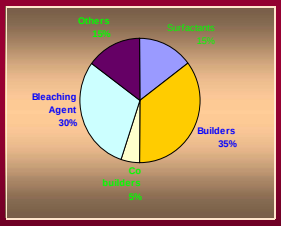
Natural microbial biocolours

Synthetic colours	:	Decreasing use due to increasing awareness about toxicity
Natural biocolours	:	Produced by microorganisms especially by the mold, *Monascus purpureus*
Type of pigments	:	Red : Rubropunctatin Monascorubin Purple : Rubropunctamine Monascorubramine Yellow : Monascin
Production	:	From starch / starch factory waste as carbohydrate source for microbes

* Proposed under the World Bank-aided National Agricultural Innovation Project

Eco-friendly Detergents based on Starch

Composition of Detergents



- Cassava starch based surfactants, builders/co-builders and bleaching activators to be produced
- Help enhance the spectrum of utilization of starch

In situ **and Outreach training programmes as a tool for transfer of technology**

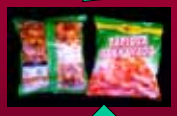
Training on food production technologies for Self Help Groups

Demonstration of processing equipment

AGRO-PROCESSING CENTRES

- Opportunities for *Income* and *employment* generation
- Provide *good quality processed foods* to local/rural population at relatively lower prices
- Supply *primary processed raw materials* to large industries in cities
- *Value addition* to agricultural and horticultural produces

CTCRI – Bank of India – NIDS Collaboration



Reaching to Empower

As the world moves on and on

CTCRI also marches ahead

To serve the cause of the farmers and industrialists


THANK YOU