

Production of Crispy Veggies

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Abstract – The “CRISPY VEGGIES” is a new product that contains more than three vegetables as a mix, which is processed through osmotic dehydration with the use of sugar. Now a day’s kids and most of the adults are not interest in consuming vegetables. To overcome this problem, it is decided to create a new product with nutritious vegetables in an attractive way. Based on the market survey, the product was developed with a new production plant design.

I. INTRODUCTION

To Create our new product, we decide to have five vegetables as a mix. As a fusion, our market survey results clearly showing that most of the participants are wishing to have carrot, beet, and bitter gourd as a mix. 23.1% of people wish to have all five vegetable as a mix. In our point of view, making the “CRISPY VEGGIES” with all five vegetables will give a good final product as a mix. Here is small information about our raw materials.

RAW MATERIALS

There are mainly five types of vegetables are used to produced the Crispy veggie product. Fig. 1-5 are representing the different vegetables that used to produced the new product.

Bitter Gourd



Fig. 1. Bitter Gourd

Family - Cucurbitaceae

Botanical name- Momordicacharantia

Total production per year – 73492 ton

Bitter gourd is significant due to its medicinal properties. It is considered as an astonish supplier of several nutritious, iron,

calcium, phosphorus and vitamin B. When it is considered about In Sri Lankan consumable habit, Bitter gourd is eaten as a vegetable. It can be successfully grown on elevation from sea level to about 1200m. It can be cultivated in the low country and mid-country during both seasons. The identified districts for Bitter gourd production are Kurunegala, Hambantota, Ratnapura, Kandy, Matale, NuwaraEliya, Anuradhapura, Puttalam, and Ampara districts.

Advantages of bitter gourd

- Enriched with nutrition
- Reduce the black sugar
- Decrease the level of cholesterol
- Support to reduce the weight
- Versatile and delicious

Beetroot



Fig. 2. Beetroot

Family – Amaranthaceae

Botanical name- beta vulgaris

Total production – 55001 ton

Even though it is rich in several vitamins, does not contain a significant amount of any nutritional factors. Hence this is an ideal vegetable for health-conscious people.

Advantages of Beetroot

- Good source of potassium and other minerals
- Helps lower blood pressure
- Beetroot juice contains anti-inflammatory compounds which can reduce inflammation.

Carrot



Fig. 3. Carrot

Family name – Apiaceae

Botanical name- *Daucus carota* subsp. *sativus*

Total production – 57920 ton

Carrot is a root vegetable usually orange in color. Carrot can be grown in all agro-ecological regions.

Advantages of carrot

- Can help to reduce the risk of cancer and cardio vascular diseases
- The antioxidants and phytochemicals in carrots may help to regulate the blood sugar
- Helps to boost the immune system and prevent disease.

Ash plantain



Fig.4. Ash Plantain

Family name – Musaceae

Botanical name – *Musa* spp

Total production – 21107 ton

When comparing with dessert bananas, plantain contains more starch and less sugar than, therefore they are usually cooked or otherwise processed before eaten. Plantain must be cooked or fried when consuming it as green. The pulp is hard, and the peel is stiff. Therefore a knife has to be used to cut and remove.

Ash Gourd



Fig. 5. Ash Gourd

Family name- Cucurbitaceae

Botanical name – *Benincasahispida*

Total production – 8785 ton

It is grown widely in the plains of Sri Lanka up to an altitude of 1500 m. It is an important warm-season cucurbit vegetable, grown for its succulent hairy fruits, used in confectionery and Ayurvedic medicinal preparations. Immature fruit is cooked as a vegetable, but when ripe, it is used for making candies.

Advantages of Ash Gourd

- Brings an enormous amount of energy
- Keeps the nerves very calm
- Ash gourd extracts inhibited the development of ulcers

The nutritive values of the five vegetables are given in the Table 1.

TABLE 1: NUTRITIVE VALUES OF THE VEGETABLES (100g)

Parameter	Bitter Gourd [1]	Beetroot [2]	Carrot [3]	Ash Plantain	Ash Gourd
Energy	25 Cal	55Cal	52Cal	122Cal	13Cal
Moisture	92.4g				
Protein	1.6g	2g	1.19g	1.3g	0.4g
Fat	0.2g		0.31g	0.4g	0.2g
Carbohydrate	4.2g	12mg	12.26mg		
Calcium	20mg	24mg	42mg		
Phosphorus	70mg		45mg		
Iron	1.8mg	170mg			
Carotene	126mcg				
Thiamine	70mcg				
Riboflavin	90mcg				
Niacin	0.5mg				

Vitamin C	88mg		7.6g		
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OTHER INGREDIENTS

SUGAR

As a chemical term, “sugar” usually refers to all carbohydrates of the general formula $C_n(H_2O)_n$.

CALCIUM HYDROXIDE

$Ca(OH)_2$, also called slaked lime, $Ca(OH)_2$, is prepared by the process of water with calcium oxide.

NUTS

Nuts are usually high in fat, the fat they contain is a healthy type. They’re also good source of fiber and protein. Nuts are additional ingredients to our product.

II. RAW MATERIAL SELECTION

Raw material selection is one of the most important action in food processing.

- Should get raw materials from reliable industry
- Maturity levels are important in vegetable selection
- Freshness is important
- Any bruised, damaged vegetable are not acceptable
- If there are any insect holes, it’s not acceptable
- Have to know about the fertilizers which are used in field
- Organic vegetables are more preferable
- Sugar must be in good quality
- Brown sugar can change the product color as brown, white sugar is more acceptable
- Have to make sure that there is no any other foreign particle in sugar
- When buying nuts have to make sure that all the nuts a good in quality and rid of any extraneous matters
- When buying the calcium hydroxide have to be very careful with the dosage
- All the raw material should be rid of any contamination and foreign particle

III. CRISPY VEGGIES’ PROCESS FLOW

The crispy veggie is a product which contains different osmotic dehydrated vegetable cubes. Sugar is the main ingredient in this product. This product can survive six months in proper condition. Ingredients should be added in – Vegetable cubes: sugar = 1: 2. Other ingredients should be at the required level. The process flow diagram is given in Fig. 6.

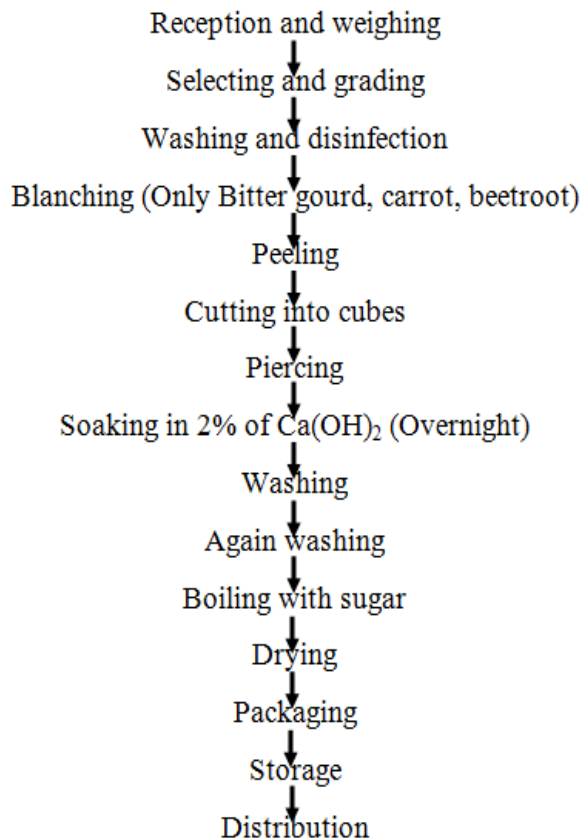


Fig. 6. Process flow diagram of Crispy Veggies

1. Reception and weighing

Raw vegetables will be arrived here and weight will be observed.

2. Selecting and grading

This is the point where the raw materials get selected and unwanted, damaged, and immature vegetables will be removed. Grading is the action where the required size of vegetables gets separated.

3. Washing and disinfection

Washing is an important activity. According to our product, carrots and beets are root crops so they may contain more soil and dirt. Those should be removed well. Here the using water may have chlorine and fungicide too. Have to make sure all the dirt gets removed.

4. Blanching

Blanching will tenderize the vegetable, and it remains the green color of vegetables. All three vegetables have to blanch separately; it can be the use of boiling water and hot steam. Carrot and beet are more rough vegetable so it may take some more time to blanch than a bitter gourd. Approximately bitter gourd needs 5 minutes, and carrot and beet need 10 to 15

minutes to blanch. After blanching vegetable have to be quickly washed with cold water to avoid the overcooking.

5. Peeling

Out of 6, 5 vegetables have peeled, and they have to be removed for further processing. Bitter gourd won't be peeled. Other five vegetables get the peel off by steam peelers or abrasive peelers. Removed peels will transfer for other uses.

6. Cutting in to cubes

All peeled vegetables will move to the cutter, and there it will cut into cubes in required size.

7. Piercing

In our product, this is the most important stage. This piercing action is essential for osmotic dehydration. Here the surface of vegetable cubes will be pierced with a needle type machine.

8. Soaking in 2% of Ca(OH)₂

This soaking action has to hold for overnight. Ca(OH)₂ is a lime solution so have to be very conscious with soaking tank material. The reason for this action is to get a rigid structure. Osmotic dehydration takes place here. While soaking vegetable cubes Absorbs the Ca²⁺, and it stuck in the middle lamella of the vegetable cell. So the above cube will be rigid.

9. Washing

Washing takes place in two times. The reason is to remove excess Ca(OH)₂.

10. Boiling with sugar

Osmotic dehydration takes place here. While boiling with sugar crystals, water inside the vegetables will come out, and sugar will penetrate into the vegetable cubes. Time is depending on the number of vegetable cubes. Using sugar amount will be; Vegetable: sugar, 1:2.

11. Drying

After boiling with sugar, drying takes place. Have to be very conscious of the drying method. If we use hot dryers here sugar crystals can be melted, so cold drying is preferable. Drying conveyer belt is essential.

12. Packaging

This is the stage where all the vegetable cubes meet each other. Above all, processing, stages have separate machines for each vegetable. The reason for not having all together is color. If beet mix with other vegetables, other vegetables also tend to get red color. To avoid this above all steps will be

processed separately. The packaging is one of the most important stages. Here preferable packaging method will be used, and all the required parameters have to be displayed on the packages. According to our survey, boxes are the most required packaging. Here all the vegetable cubes get mixed, and packaging will be done into required weight.

13. Storage

This is the place where processed and packed products will be placed. This place should be in proper temperature control, humidity, vent, and sanitation. If cold storage is preferable, then it will be placed.

14. Dispatching unit

From here onwards dispatching of products will be held.

PRESERVATION TECHNIQUE OF THE CRISPY VEGGIES

Preservation is considered as the process of treating and handling the vegetables to stop or greatly slow down spoilage. Preservation is extending the shelf-life of the product, with ensuring its safety and quality. In our new product selected vegetables are high water content. In microbial as well as chemical and is responsible for the consumer perception of many organoleptic attributes such as juiciness, elasticity, tenderness, and texture. So introducing this new product to increase the shelf-life of the product is our responsibility. Osmotic dehydration is considered as a preservation technique in this product. That is the best and most suitable method for this new product. The process is preferred over others due to their vitamin and minerals, color, aroma, flavor, and taste retention property. Osmotic is the process of water removal from vegetables. The cell membranes are semi-permeable and allow water to pass through them more rapidly than sugar. During the osmotic process, a small quantity of acid is removed along with water (our selected vegetables do not contain acids, but according to the process of a new product the cubic selected vegetables were dipped into the edible lime solution overnight). It is a dynamic process, in which solution water and acid are removed at first and then move slowly, while sugar penetration is very slightly at first but increase with time. Therefore the product concentration of sugar crystals, osmotic time, temperature, to make the osmotic concentration process faster (Fig. 7).

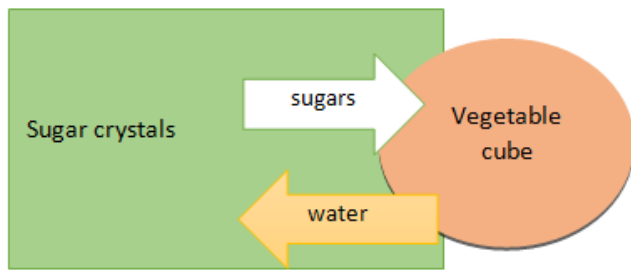


Fig.7. Osmotic dehydration while boiling with sugar and vegetable cubes

IV.FACTORS AFFECTING THE OSMOTIC DEHYDRATION

• Pre-treatment

Pre-treatment is an important process to avoid the cut vegetables turning from enzymatic browning. So before the osmotic process, the cut vegetables dipped into the edible lime solution, which is to prevent the vegetables from discoloration.

• Osmotic agents

Different osmotic agents can be used for the osmotic process, such as glucose, NaCl, Sucrose, etc. In this new product, sucrose is used as the osmotic agent.

• Quantity of the sugar crystals

The quantity of sugar can affect the osmotic dehydration process. Sufficient amount of sugar can increase the osmotic process. Quantity of the sugar is the key factor in the osmotic process.

• Duration time

The duration time is indicating the exchanges took place at the maximum rate within the first two hours of the osmotic treatment.

• Vegetables pieces

The vegetables are sliced, so the penetration range is higher than using full vegetable [4, 5].

V. PACKAGING

It is widely recognized that packaging has a main role in food protection after the process. The packaging is based on the “Three P’s.”

• **Protection** – Packaging should be designed to protect the product from the point of production through to the point of use, helping to maintain the product in its original condition. It makes handling easier too.

• **Preserve** – The packaging is used to help for the process of

the preservation of the product keeping fresh, and suitable for eating.

• **Promote** – Packaging help to the promotion of the product by helping to establish brand recognition and play its role in establishing brand loyalty.

PLANT LOCATION

The location of a food building is very important

- Plant have to be situated in the point where the easy access of the raw materials
- Ease of access for labors
- Adequate water available
- Ease of access for electricity
- Proper waste disposal environment
- Transportation
- Good road service
- Have to be rid of any nature disasters as flood, earthquake
- Have to be quite far from town, because plant noise can disturb the community

PROCESS PLANT DESIGNING

A hygienically designed and easy cleaning building is required for all fruit and vegetable process to prevent the products from becoming contaminated during processing. Insects and animals are attracted to food building if foods or wastes are left lying round after production has finished. Microorganisms can grow in food residues that are left on equipment, tables or floors which have not been properly cleaned. Contamination can occur in both wet and dry places. By considering following factors industry can produce a quality end product [6].

• The site

• Roof and ceilings

Fiber-cement tiles offer greater insulation against heat from the sun than galvanized iron sheets do. The vents in roofs the allow heat and steam to escape. The vent must be screened with mesh to prevent insect. Rafters or roof beams are unacceptable. Both can accumulate dust.

• Walls

It has to be arranged walls be rendered or plastered with good quality plaster to prevent dust forming in the processing room, and special attention should be paid to ensure that the area is easily cleaned. The good quality emulsion should be painted

in higher areas of walls. Tiling is a good idea for cleaning purpose.

• **Windows and doors**

Normally doors should be kept closed. But if they used regularly, thin metal chains or strips of material that are hung vertically from the door lintel may deter insects and some animal, while allowing easy access for staff. Alternatively, mesh door screens can be used. Have to make sure there is no gap between door and wall. Window sills should be made to the slope.

• **Floors**

Floors should be constructed with good quality concrete, smooth finished and without cracks. Attention should therefore be paid to cleaning up spillages as they occur and to regularly monitor the condition of the floor. Floor should therefore be curved up to meet the wall. The floor should slope at an angle of approximately 1 in 8 to a central drainage channel. Proper drainage prevents pools of stagnant water forming, which would in turn risk contamination of equipment and foods. Where the drain exists the building, there is a potential entry point for rodents so usage of mesh is most important.

• **Lighting and Power**

Natural daylight is both free and better-quality light. Additional lighting is needed, florescent tubes are cheaper to operate. If there are any fast-moving machinery parts, these should be lit with incandescent bulbs and not tubes. Waterproof sockets are a better choice. In order to avoid risk, all the power points should be placed at a sufficient high. It is important to use each power points to one socket. It prevents the circuit from overload. Appropriate equipment should be plugged to the relevant fuses. The main supply should have an earth leakage trip switch. Wiring has to be in a top safe level.

• **Water supply and sanitation**

Water is essential for processing and cleaning. Regular good quality water supply is a must. Using water have to be fully rid of any sediments and contamination. So, have to make sure that water is in good condition. Water treatment is important in this stage. If the water is going to be used in cleaning purpose than, the water should have chlorine or another fungicide, it will remove the dust, soil, dirt, and fungi in

vegetables. Water treatment can be done by filtration, by heating, by UV light, by chlorine, and by ozone treatment. Good sanitation is essential in food processing. Sanitation is an idea which has to hold throughout the processing. Waste management is another important topic in food processing.

• **Layout**

Different processing stages have to physically separate. It helps to get rid of cross-contamination. Raw materials have to be stored in a separate room, and that room should have the appropriate temperature, humidity, light, storage bins, vent, etc. The main office has to be separated; it should not cross the processing area. Toilets have to located separately and the adequate water supply, soap and separate towels a more important.

• **Equipment and facilities**

When selecting the equipment, there are several factors that have to consider such as raw material type, size of raw material, size of reducing part, grading, cleaning, ingredients used in processing, easy cleaning, easy handling, power usage, accuracy, weight, etc. Basic equipment is buckets, knife, transferring belt, cooking pan, packaging machines, weight balance, peelers, etc. When using acids equipment should be made with stainless steel or aluminum. Food grade plastics also a good choice to have vegetables. The wooden table is cheaper, but the proper cleaning is important because wood can absorb the water and it can contaminate the food.

EQUIPMENTS USED IN CRISPY VEGGIES PROCESS

- **Reception and weighing:** Food grade plastic buckets, conveyers, electrical balance
- **Ingredient storage:**Stainless steel storage bins, Refrigerators, Food grade plastic bins, rakes
- **Selecting and grading:** Stainless steel or aluminum grading machine, sorting machine, image processor, tungsten light, disc separator
- **Washing and disinfection:** Wet cleaners (soak/ floatation tank, spray washer, sterilizer, ultrasonic cleaners)
Dry cleaners (air classifier, screening separator)
- **Blanching:** Steam blancher, hot water blancher
- **Peeling:** Pressure vessel, stationary/ rotating blades, carborundum abrasive rollers
- **Cutting into cubes:** Stainless steel knife/ blade, slicing

machine

- **Piercing:** Piercing machine
- **Soaking in calcium hydroxide:** Soaking tank
- **Boiling:** Boiler, jacketed kettle
- **Drying:** Vacuum dryer
- **Packaging:** Net-weight fillers, sealing machine, printers, check weigher, packaging machine

ESTABLISHING QUALITY CONTROL SYSTEM

- Production planning
- Interaction of quality control and production staff during production
- Allocation of resource to quality control
- Monitoring the manufacturing process
- Monitoring the manufacturing environment
- End-product testing
- Incident of defective products
- Treatment of quality control data
- Staff/ management relations

QUALITY CONTROL SYSTEMS FOR VEGETABLE PROCESSING

- **Raw materials:**Vegetables, sugar, water, steam, containers, labels, detergents, sanitizers
- **Preparative treatments:** Sorting, grading, trimming, washing, removal of foreign particles
- Filling
- Closing and sealing operations
- Labeling, packaging, and warehousing
- Cleaning, sanitation and waste disposal

METHODS OF ANALYSIS AND PHYSICAL TESTING

- **Chemical analysis**
Ca(OH)₂ level, chlorine in water, moisture, pH,
- **Physical tests**

Calibration of thermometer for processing equipment, equilibrium relative humidity, vacuum

PACKAGING MATERIALS

There are several packaging methods as modified packaging and vacuum packaging etc. According to our survey, most of the participants like to have our product inboxes. Tins also likable. Tins are more suitable for large quantity, boxes and transparent packaging is more suitable for small quantity as 250g.

BOX

Cardboard can be considered as the most important packaging material. It is thicker, harder, and more resistant than paper. It has a good scope with recycling too.

TIN

The most suitable is tin-coated steel and aluminum cans. Aluminum is preferable due to lightness, low cost, and capacity to be recycled. It has the same barrier properties as steel but with the advantage of being resistant to corrosion.

GLASS BOTTLES

Glass is an inert material that is impermeable to gases and vapors. Glass containers can be bottles, and jars. It is attractive but breakable too.

TRANSPARENT PACKAGING

Plastics are organic polymeric material that can be molded into the desired shape. The lightness and versatility of these have been confirmed over decades in the processing and packaging of food. Due to low cost and easy handling it is very much suitable. PVC, PET, HDPE, LDPE are the preferable plastic types to pack the food products. But according to the survey results box is the most preferable one.

WASTE MANAGEMENT

In vegetable industry, it is natural that some wastes occur when selecting, sorting, boiling processes are done. Processing of vegetables produces two types of waste - a solid waste of Peel, seeds, stones etc. A liquid waste of juice and wash waters. Therefore, there is a serious waste disposal problem, which can lead to problems with flies and rats around the processing room, if not correctly deal with. Vegetable waste is a biodegradable material generated in large quantities, much of which is dumped on land to rot in the open, which not only emits a foul odor, but also creates a big nuisance by attracting birds, rats, and pigs' vectors of various diseases. Apart from post-harvest losses due to lack of storage capacity, processing and packaging of vegetables according to customers' specifications also plays a major role in waste generation. These wastes can be treated for bio fuel production through fermentation under controlled conditions or else used for composting. The natural decomposition of wastes by microbes generates products with high humus content. Research activities have confirmed that this carbohydrate-rich biomass

can be a potent substrate for renewable energy generation.

• Composting

Vegetables wastes are purely organic. Composting is the natural process of rotting or decomposition of organic matter by microorganisms under controlled conditions. This is most economic and environment friendly method of waste management.

• Peels are used for extracting natural colors

• Wastes are used to produce bio gas and bio ethylene

Biogas-generating technology is a favorable dual-purpose technology at present: the biogas generated can be used to meet energy requirements while the organic residue is a useful fertilizer. Biogas is a type of renewable energy that can be produced from the decomposition of animal and plant wastes and is composed of methane, carbon dioxide and trace impurities like hydrogen, hydrogensulfide and some nitrogen [7].

WATER TREATMENT

General purpose water includes all of the water used in washing and sanitizing raw materials, processing equipment, plant facility and ancillary equipment.

CONCLUSION

Now a day's vegetable consumption is very low within the age group of kids and adults. To overcome this issue, we decide to create a new food product from nutritive vegetables. We decide to use five vegetables, bitter gourd, carrot, ash plantain — Ash gourd and beetroot as a mix. The principal of our product is osmotic dehydration with the use of sugar. We had a survey, and according to that results, most of the participants like to our product as a snack with nuts, in cubic shape, most preferred quantity is 250g, artificial coloring and flavor are not likable from most of the participants and the most preferred packaging is box and tin. "CRISPY VEGGIES" have more than six months of shelf life. Osmotic dehydration is the best way of preserving food items. By fulfilling all the requirements as processing plan location, construction, equipment, process flow, waste management, sanitation, and energy requirements, our new product will come out as good quality and healthy snacks for people.

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