RESEARCH ACHIEVEMENTS

DEPARTMENT OF PROCESSING AND ENGINEERING

And

AICRP on POST HARVEST ENGINEERING & TECHNOLOGY

Department of Processing and Food Engineering
College of Agricultural Engineering& Technology
Junagadh Agricultural University
Junagadh-362001

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INTRODUCTION

The Department of Processing and Food Engineering is one of the departments of the College of Agricultural Engineering and Technology established in June, 1984. The Department of Processing and Food Engineering has undertaken various research projects in addition to its teaching activities at Under Graduate and Post Graduate levels. The department is offering 37 credit hours course work at B. Tech. level and also offering post graduate course leading to M. Tech. degree with the specialization in Processing and Food Engineering. The total numbers of B. Tech., M. Tech. and Ph.D. dissertation / thesis submitted since 1988 to 2015 on different aspects of Agricultural Process and Food Engineering are 112, 63 and 7 respectively, with the goal to train required technical man power in the field of Agricultural Process and Food Engineering suitable for research and education and also to assist farmers, processors & entrepreneurs in reduction of post harvest losses and value addition through processing. The important areas of research work are (i) engineering properties of biological materials (ii) drying and dehydration of fruits and vegetables (iii) processing of oilseeds (iv) development of process technology (v) storage of food products and (vi) development of processing machineries.

An All India Coordinated Research Project on Post Harvest Engineering & Technology, a full fledged ICAR sponsored scheme, started in 1980 with the aims of research in developing, upgrading and disseminating various post harvest practices leading to value addition. This scheme has multidisciplinary approach having Biochemist, Microbiologist

and Entomologist working along with the Agricultural Engineers on different aspects of post harvest technologies. In the span of 35 years, various technologies have been developed, upgraded and tested for the crops like, cereals, pulses, oilseeds, fruits, vegetables, medicinal and spices. The scheme is also having the facilities for fabrication of equipments, drying, primary processing, biochemical laboratory for nutritional and biochemical analysis for various food products.

The important research finding based on the research work carried out by the faculty members of the department and scientists of the scheme have been incorporated in this document.

Feed Block Making Machine

A feed block-making machine for preparing 4 –5 blocks per hour was developed by the Post Harvest Technology, Junagadh center for wafering of groundnut haulms/vines (1.75 kg) and wheat straw (1.75 kg) by mixing of molasses (0.7 kg), common salt (0.15 kg), defatted groundnut cake (0.5 kg) and urea (0.15 kg) for animal feed.

The bulk density of the feed block was increased 33 per cent, which indicated large reduction in the requirement of space for transportation and storage. On dry basis, the feed block contains 19.4 % crude protein, 76.2 crude fiber, 36.3 % nitrogen free extract and having 8 % moisture content and other trace elements. The feed blocks were found acceptable by the cattle.

Solar Dryer cum Green House

Groundnut, a major crop in Gujarat, after harvesting is left in the field for 7-14 days for drying. The crop during field drying is subjected to losses due to change in weather, animals, birds and insects. Looking to the need, a farm level dryer having a batch capacity of 200 kg or 2.475 m^3 with 600 mm bed thickness was developed by the Post Harvest Technology, Junagadh Center to prevent fungal contamination, uniform and timely drying of crops to safe moisture level.

Solar Dryer cum Green House

This dryer reduces moisture content from 65 to 17 % within four days instead of 6-8 days as required in traditional method. It also gives 95 % germination of seeds as compared to traditional method (84 %).

Development of Model Agro-Processing Centre

The Agro - Processing Centre at Village - Fareni (District Rajkot, Gujarat) was established in 1996 with the objective to promote the improved processing equipments and technologies among the farmers to reduce post harvest losses and to provide processing facilities at rural threshold to generate employment and strengthen rural based economy.

Mini Oil mill

Filling & Sealing of oil tin

The location based processing facilities are created by the funding from ICAR. These APCs also provide effective platform for the popularization of new technologies to farmers by conducting various extension programmes. Presently, four such centers i.e Tadka Pipaliya (Ta. Bhesan Dist. Junagadh), Virol (Ta. Mangrol, Dist. Junagadh), Loej (Ta. Mangrol, Dist. Junagadh) and Vadala (Ta. Talala, Dist. Gir Somnath) are running successfully.

The Honourable Vice-Chancellor, Director of Campus, Director of Research, Deputy Director of Extension and Members of Board of Management, Dean, College of Agricultural Engineering & Technology and many other has visited the various Agro-Processing Centres. They all have appreciated the working of Agro-Processing Centres.

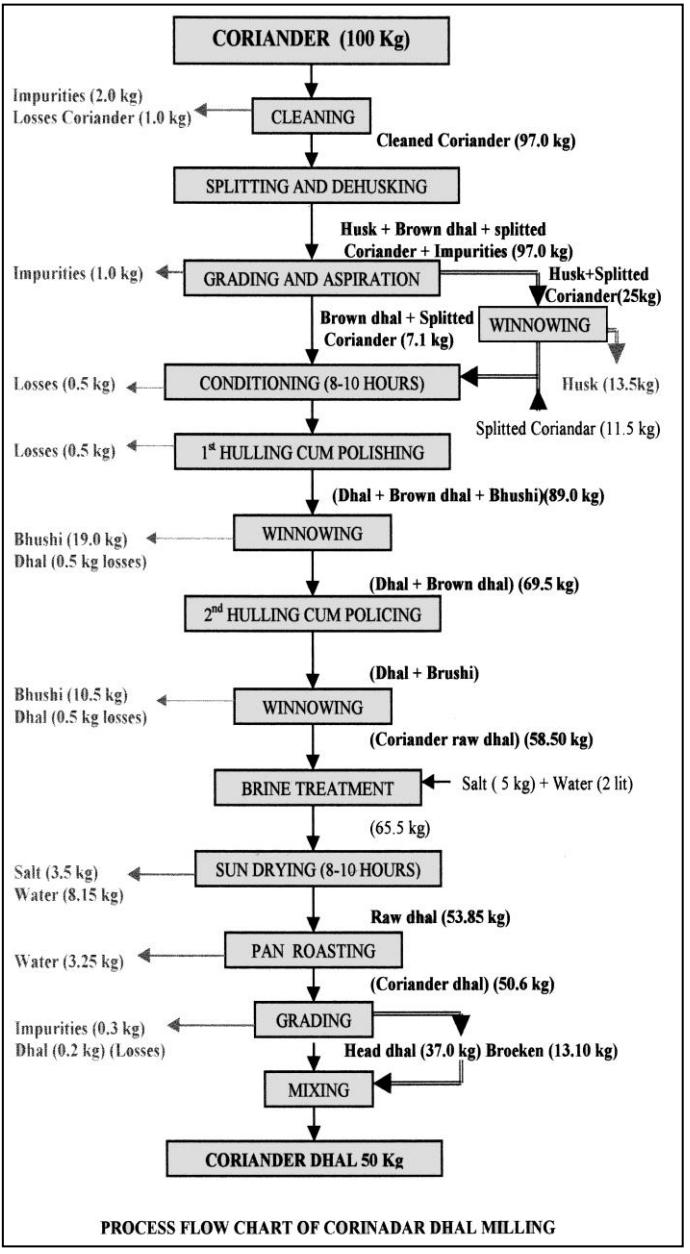
Post Harvest Technology of Coriander Dhal Milling

Gujarat state is one of the largest producers of spices in the country accounting for over 50 % of all India production. Coriander is one of the foreign exchange earning crops of minor spices. Thus it plays a vital role in the economy of the farmers of Gujarat. Coriander dhal is widely used in Gujarat as carminative. The dhal mills located in Gujarat state produces about 25000 tonnes coriander dhal annually. So, the research work was carried out and the following recommendations for the users / millers were suggested.

1. Dry coriander dhal in sun by taking 100 mm bed thickness for lower moisture content i.e. 31 % and 50 mm for higher moisture content i.e., 50 % to get better quality product.

2. Use cylindrical or concave de-husker rather than hammer type to get better quality product.

3. To get better shelling efficiency and Minimum broken % and low power consumption the coriander should be treated in hot water at 40 ^{o}C followed by cold water at room temperature for 8 hours of soaking.



PROCESS FLOW CHART OF CORINADAR DHAL MILLING

Shelf Life of Kesar Mango

Kesar mango is mainly grown in Junagadh district. It has very good export potential if its shelf life could be increased up to 30 days after maturity and followed by good ripening. The mature and healthy mango was vacuum packed in 100-gauge polyethylene bag and 700 mm Hg. The fruits were stored at 13 ºC and 90 to 95 % RH. The results revealed that the weight loss, TSS, reducing sugar and total sugar increases with storage period, while firmness, ascorbic acid and titrable acidity decreases. Even in organoleptic evaluation the better performance was observed for the vacuum packed mangoes. The cost of packaging for 1 kg of mango comes to be Rs. 2.86.

Vacuum packed

Vacuum packed mango after 32 days storage

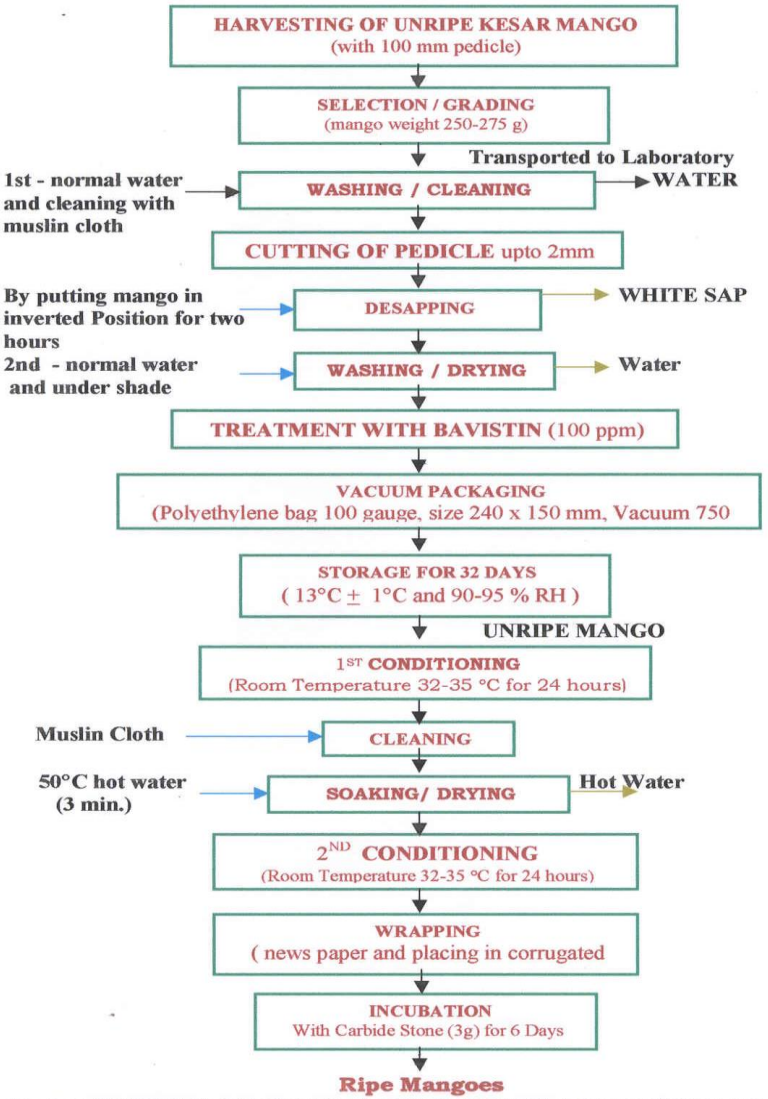


Fig. 1 : PROCESS FLOW DIAGRAM FOR STORAGE AND RIPENING OF KESAR MANGO

It may be concluded that in 100-gauge polyethylene bag and 700 mm Hg vacuum level with 13 ºC and 90 to 95 % RH storage condition, mango can retain its maturity up to 32 days.

Groundnut Storage

Studies on relative susceptibility and extent of losses in different improved varieties of groundnut against rice moth (*Corcyra cephalonica)* during storage were carried out by taking six different improved varieties of groundnut Viz., GG-2, GG-5, GG-11, GG-13, GG-20 and TG-26. The results revealed that on the basis of apparent and real weight loss and population build up in 6 groundnut varieties, the variety GG-20 was found highly susceptible to the *Corcyra cephalonica* and GG-5 was less susceptible as compared to other varieties.

Studies were also carried out to assess the extent of damage caused by *corcyra cephalonica* at different mechanical injury levels of groundnut i.e., injured pods and injured pods of 2, 4, 6, 8, 10, 12 and 14 percent levels for GG-2 variety of groundnut. The results revealed that with the increase of mechanical injury levels from o to 14 % there is an increase in weight loss, percent pod damage, and population built up of the insect.

Insect Removal Bin for Groundnut Bruchid

The wandering behaviour of insects, their tendency to move towards well aerated region and also to enter cracks and crevices are being exploited in the bin developed by TNAU. The bin consists of outer container, inner perforated container with five perforated rods, pit fall portion, insect collection device and grain outlet. The whole bin is mounted on a stand.

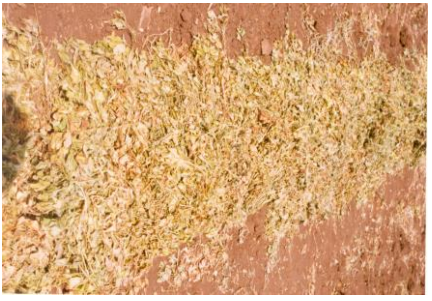
The insect's viz., Bruchid (*Caryedon serratus Fab*.), Rust red flour beetle (*Tribolium castaneum Hb.*) and Corcyra (*Corcyra cephalonic stainton*) were removed from the improved bin during the experimental period. The improved bin was found effective for removing the insects. However, the percent pod damage of groundnut was observed more in improved bin and galvanized bin over gunny bag during 5 months storage period. The percent pod damage by rust red flour beetle and Corcyra were recorded higher in galvanized bin and improved bin as compared to gunny bag. Thus, the improved bin was found useful in removing the insect.

Insect removal storage bin

Drying Methods for Quality Groundnut Seed

After harvesting the groundnut pods of GG-20 variety (summer) was brought from the college farm. The pods from 42 to 43 percent (w.b.) moisture content were dried to 6 to 7 percent moisture content by different methods such as shade drying, unheated air and heated air-drying. The dried pods were packed in 5 kg capacity jute bag. The bags were stored in the ventilated room under ambient condition. The heated air, unheated air and shade drying were taking five, six and ten days respectively to dry the groundnut pods to reach equilibrium moisture content.

DOR method



Windrow shade method

In all the treatments the pods weight was increasing with the storage. The highest germination was observed in unheated drying (89.60 %) followed by shade (87.67 %) and heated (83.66 %). The germination count during the entire storage period of seven months was observed promising under the treatment unheated and shade drying. During same period of storage, vigour index in case of unheated drying (545.58) was observed maximum followed by shade (517.30) and heated air-drying (437.66). The percent infestation varies from 5 to 10 %. Considering both quality and drying characteristics unheated air-Considering both quality and drying characteristics, the unheated drying followed by shade drying was observed best amongst all the three treatments.

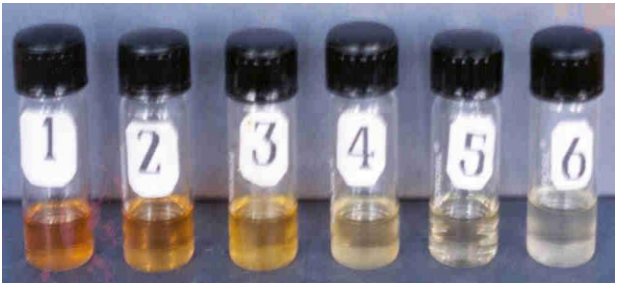
Cleaner-cum-Grader for Cumin

Cleaner-cum-grader for cumin

For cleaning and grading of the cumin seeds, vibrating double screens type machine was designed and fabricated. The main components of the machine are: feed hopper, sieve box, blower, power transmission unit and frame. The project is continued. The maximum cleaning efficiencies was found at 50 kg/hr feed rate, 150 rpm and 7-degree screen slope. The cost of the grader is Rs. 15000/- and cleaning cost is Rs. 0.31/kg.

Essential Oil from Cumin Seeds

The spices are primarily used in food industry for improving the quality of products, mostly after grinding into a powder. The disadvantage of the use of spice powders is quality variation from batch to batch. This problem can, however, be greatly minimized by using the extractives like essential oils which are obtained directly from the raw material by water distillation as the solvents create problem of removal of solvent. During 1995-96, India exported oil from cumin to the tune of 0.6 tones worth Rs. 12 lakh.



Essential oil of Cumin

The extraction of essential oil from cumin by the method of distillation should be carried out with ground cumin having particle size of -35+48 mesh and 2.31 h of distillation time so as to get higher recovery and good quality of oil from cumin.

Utilization of Agricultural Wastes for Drying of Red Chillies

The drying of red chilies is one of the major processing operations, which prevent it from the attack of insects, pests, and promotes longer storage life. The disadvantages of traditional chilly drying method, i.e., sun drying, can be eliminated by using the developed agricultural waste fired dryer having drying capacity of 100 kg fresh red chillies.

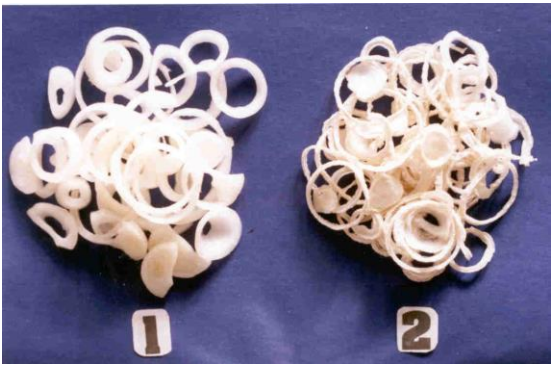
The performance of the dryer was evaluated by taking different bed thicknesses and different airflow rates. The temperature of drying was 53 ± 2 °C for the purpose of drying all the trays at a time. The total drying time was 20 to 22 hours as compared to sun drying method, which takes about 15 days to complete drying of the red chillies. To get optimum colour of chillies 10 cm bed thickness may be recommended while using a waste fired dryer. The use of agricultural waste fired dryer was found highly economical.

Waste fired dryer

Dried red chilli

Onion Dehydration

As onion is a perishable crop, it cannot be stored in normal condition for a long time. Presently, about 40 % of the total onion production is estimated lost as the part of post harvest losses during various operations. Dehydration plants are facing problems regarding quality and rehydration characteristics of final product and takes about 5-6 hours time for a batch of 100 kg.



Fresh and Dehydrated onion flakes

It is recommended that the dehydration of Talaja local white cultivars of onion should be carried at 76 °C drying temperature and 27 m/min velocity of air, keeping 3 mm thickness of slice to get the good quality of dehydrated flakes with minimum drying time i.e., 58 min and the bacterial counts of the final product falling in the range of acceptable limit of international standard.

Dehydration and storage of vegetables

The processors, exporters are advised to store dehydrated onion, garlic and unripe mango powder in polyethylene (HDPE) bags of 50 micron in vacuum packaging (740 mm Hg) to retain the quality up to 120 days of storage period.


Plate No. 3.6 Onion powder


Plate No. 3.7 Garlic powder

Drying of vegetables using crop residue dryer

The agro processor interested in using the crop residue based dryer developed by Junagadh Agricultural University for drying serrated carrot, carrot slices, cabbage leaves, cauliflower pieces, tomato slices and whole green chillies are recommended to use following operating parameters :

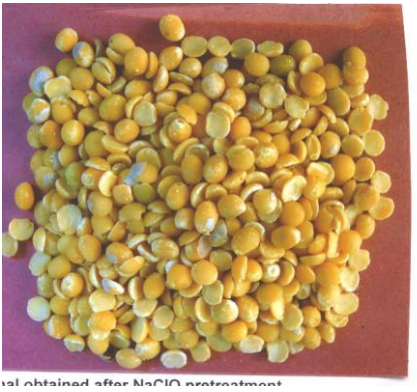
1. Air temperature : 51 to 55 0C
2. Air velocity : 1.5 m/s
3 Bed thickness : 8.0 cm
4. Average fuel required: 5.5 kg/h

Technology for Pigeon Pea Milling

Out of all pulses, pigeon pea is the most difficult pulses to dehusk and split. Only about 40-50 % pigeon pea grains are dehusked and split in first pass of pre-conditioning and milling. Also, it takes 3-5 days for complete processing and milling losses are also high. No BIS has been prepared for pigeon pea milling technology as well as its machinery. Looking to this, enzyme used technology has been developed, which resulted in good quality of pulses with minimum time.

The biotechnology based enzyme solution soaking treatment having 1000 ml soaking volume, 0.05 g enzyme concentration for 2 kg pigeon pea with 7 h soaking time was found the most effective considering the shape of dhal (quality of finished product). The amount of husk removed was to the tune of 76.24 %. Hence, the enzyme solution soaking treatment having above parameters recommended as an effective pre-treatment for loosening of the seed coat of pigeon pea grains. When increase the soaking volume, the recovery of husk increases more than 98 %.

Laboratory scale-dehusking machine



Dehusked dhal

Storage of coriander seeds

Farmers of south Saurashtra region are advised to store the Well dried coriander seed in plastic coated jute bag (ICBR1:11.57) or High Density Polyethylene (HDPE) bag 35 micron (ICBR1:7.23) to protect from the infestation of cigarette beetle (Lasiodermaserricorne Fab.) up to 10 months of storage after harvesting.

On Farm Fruit Grader

A manually operated on-farm fruit grader based on flapper conveying system was designed and developed to satisfy the need of marginal and big farmers, cooperatives societies dealing with fruit marketing and fruit traders.

Fruit Grader

The grader was capable to grade the fruits according to size in three categories as (i) up to 40 mm (ii) 40 to 60 mm and (iii) above 60 mm. The total grading space available was varying from 2 to 8 cm. The grader could be operated by two labours and it cost about Rs 12,000/- at the prevailing rate. The overall grading efficiency found maximum at 14 rpm, which was about 90 % without any damage to fruits. The grading capacity at maximum overall efficiency was 873.10 kg/h.

The grading cost for grading 100 kg of sapota fruits by the developed grader was about Rs. 3.60 as compared to Rs. 8.30 by manual grading giving net savings of about Rs 4.70 or 56.63 %.

Peanut Blended Extruded Products

Extrusion technology is used world wide for the production and modification/improvement of quality of various products. It has been used to produce a wide variety food including snacks, ready-to-eat (RTE) cereals, confectioneries, texturized, extruded crisp breads, and pet food products. Snacks account for 15 % of the total caloric intake of children and adolescents, according to a USDA survey. Overall, the consumption of snacks continues to increase. Thus, enhancing the nutritional value of snack foods may have a positive impact on the overall nutritional quality of the diet of the general public. Partially defatted peanut flour (PDPF) is a good source of supplementary protein for the human diet.

The PDPF was mixed with wheat, maida, rice and chickpea in different proportion and extruded products was developed by hand operated extruder machine.

Based on the results of all the properties studied and sensory evaluation of extruded products, the maida-extruded products were best-extruded products followed by rice, chickpea and wheat. The optimum extrusion condition for the preparation of extruded products from wheat, maida, rice and chickpea should be 25 % PDPF and 120^{o} C steam temperature for steaming the prepared dough.

Gel Extraction from Aloe Vera Leaves

Aloe vera gel is the commercial name given to the fiber free mucilaginous exudate extracted from the hydroparenchyma of the succulent leaves of Aloe vera (Aloe barbadensis Miller). The exudate of Aloe vera is used for numerous medical nutritional and cosmetic applications. Gels, concentrates and powders are suitable for cosmetic, hair care, personal care, pharmaceutical, beverage, food, functional food, nutraceutical and dietary supplement formulations.

The cultivation of Aloe vera has acquired great commercial importance for medicinal products and cosmetics processing but information is scarce about processing of this crop. Looking to the importance of the Aloe products such as creams, ointments, juices, and shampoo containing the Aloe gel, it is very much essential to study the post harvest technology of the Aloe vera plant. The flow diagram for the preparation of Aloe vera gel is shown in figure.

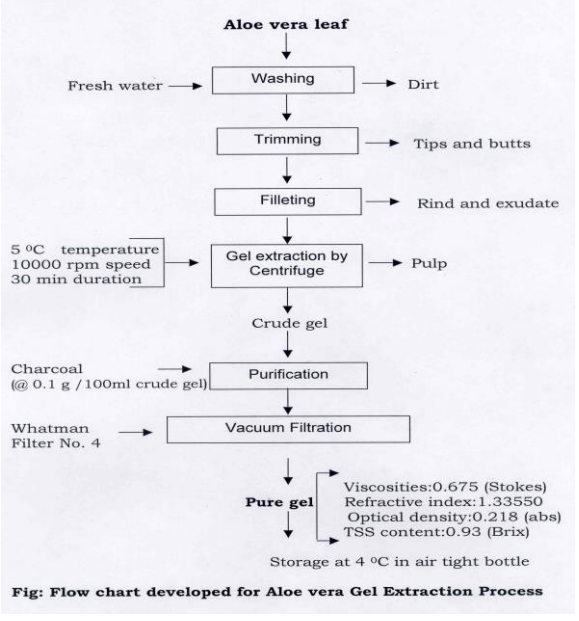
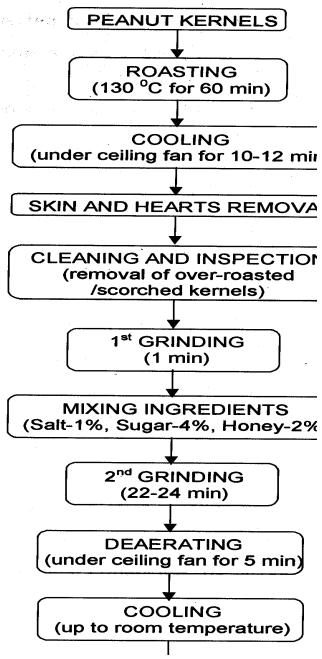


Fig: Flow chart developed for Aloe vera Gel Extraction Process

With the growing awareness among people about the importance of balanced diet as well as figure consciousness, the demand of low calorie-high protein foods is increasing, as people tend to avoid consumption of high-fat foods that cause obesity and associated health problems. Peanut butter is the food prepared by grinding shelled and roasted peanuts to which salt and sweetening agents are added. In India, however, this product is available commercially only in the metropolitan cities. In times to come the demand of peanut butter in India is likely to grow owing to its nutritional virtues. Therefore, it was of interest to optimise the important process parameters and develop the appropriate process technology for production of peanut butter from Saurashtra cultivars of peanut. The flow diagram for the preparation of peanut butter is shown in figure.



Process flow diagram for the preparation of peanut butter

Forced Air Ventilated Storage for Onion

Onion (Allium Cepa L.) is the important spice vegetable crop, grown almost all over the country, which is seasonal in production, but required round the year. Onion bulbs, throughout the country, are stored by conventional methods. There are different types of storage structures used in different parts of the country. They lack proper ventilation system and therefore, the need to keep the onions dry and cool during storage is not achieved. This necessitated a forced ventilated storage of onion for reducing the losses during storage along with keeping its quality.

The forced air ventilation system for the existing storage structure was designed considering the quantity of onion to be stored, requirement of air and its distribution system. Storage life of Talaja Red onion could be increased by more than three month under forced ventilated storage. The weight loss could be reduced from 23.74 under natural ventilated storage to 10.24 per cent under forced ventilated storage. The stored onion could get higher prices thereby giving 25-30 % more profit when stored in forced ventilated storage system.

Extraction of enzymes from potato peels

To get more benefit, Potato processors are advised to adopt a procedure of use Bacillus subtilis bacteria for the production of Alpha-amylase and Protease enzymes through microbial and biochemical method from potato peels (byproduct) developed by Junagadh Agricultural University. It is beneficial (CBR 1:7.54) as compared to readymade available enzymes in market.

Waste Potato peels Crude Enzyme Extract

Sapota Cleaner

The farmers are recommended to use hand-operated sapota cleaner developed by Junagadh Agricultural University for cleaning and shining sapota surface after harvesting.

Packaging of fresh & processed guava fruits

The farmers, processors and exporters are recommended to adopt packaging technique developed by Junagadh Agricultural University for increasing the shelf life of guava fruit up to 18 days at room temperature by packing in 50 µ polyethylene bag with a vacuum level of 700 mm Hg.

The farmers, processors and exporters are recommended to adopt hot air drying technique developed by Junagadh Agricultural University for preparing of Guava powder by drying of fresh guava slices (3 mm thick) pretreated with 1 % $CaCl_2$ + 2 % KMS solution for 10 minutes at 600 ^{0}C drying air temperature and 1.25 m/s air velocity in drying period of 17 hours. The powder prepared by this method can be stored up-to 80 days at room temperature by packing in 50 µ polyethylene bag with a vacuum level of 700 mm Hg.

PRETREATED GUAVA SLICES LOADED IN TRAYS BEFORE DRYING

LOADING OF DRYING TRAYS IN THE DRYING CHAMBER.

VACUUM PACKED GUAVA POWDER AFTER 80 DAYS OF STORAGE PERIOD.

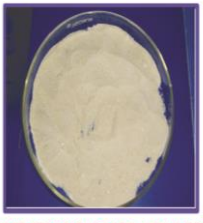
Custard apple powder

The farmers, processors and exporters are recommended to adopt freeze drying technique and storage techniques for custard apple developed by JAU.

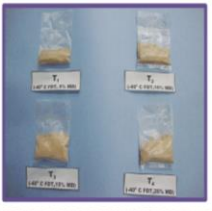
For making of custard apple powder by freeze drying of fresh custard apple pulp pretreated with 5 % maltodextrine at -40 ^{0}C temperature using freeze dryer in drying period of 41 hours. The custard apple powder obtained by this method gets better retention vitamins and carbohydrates.

For increasing the shelf life of custard apple powder up to 90 days at room temperature by packing in 50 µ polyethylene bag with a vacuum level of 700 mm Hg.

The farmers, processors and exporters are recommended to adopt freeze drying technique developed by Junagadh Agricultural University for preparing of Custard Apple guava powder by freeze drying of fresh Custard Apple pulp (1.5 kg) pretreated with 5 % Maltodextrine at 60 ^{0}C air temperature with a drying period of 41 hours. The Custard Apple powder obtained by this method has better product quality and could be stored up-to 90 days at room temperature when packed in 50 µ polyethylene bag at a vacuum level of 700 mm Hg.



3.4 FREEZE DRIED CUSTARD APPLE POWDER



6.3 CUSTARD APPLE POWDER WITH VACUUM ON 90TH DAY OF STORAGE (PREPARED AT - 40° C TEMPERATURE)

Storage study of mechanically damage wheat harvested by combine harvester

The farmers storing wheat are advised that the mechanically damaged wheat harvested by combine harvester to be stored with the treatment of castor oil (15ml/1.0Kg grain) and can be kept in metal bin container to keep safe against lesser grain borer up to eight month of storage as it reduces pest population, grain damage, and weight loss as compared to untreated wheat kept in jute bags.

Extraction of pectin from Kesar mango peel by resins

Mango processors are recommended to adopt a process technology developed by Junagadh Agricultural University for the production/extraction of pectin from mango peel using cation exchange resin as an extraction medium with peel to extraction medium ratio of 1:4, extraction pH of 2.56, extraction temperature of 80 °C, extraction time of 60 min and two times extractions. This method can give better yield and quality of pectin with benefit cost ratio (BCR) of 1.17.

Mango peel

Extracted pectin