M. Tech and Ph. D theses
of
Processing & Food Engineering
(2005-2012)

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June 24, 2013

MESSAGE

The overall economy of farming could be improved if we are in a position to develop machinery and new techniques and provide simple and dependable technology for post harvest handling, storage, processing, transportation and marketing of different commodities. The reduction in post harvest losses to any amount is going to increase the availability of food grains to that extent which will be beneficial to our country. Also simple value adding activities such as processing at or near the farm help to increase farmers profit and rural employment. In view of above, the teachers & scientist of Department of Processing & Food Engineering and the AICRP on Post Harvest Technology at our University carried out the research work through Post Graduate students in the area of Processing & Food Engineering.

The abstracts of Theses of Ph. D and M. Tech Agricultural Engineering with specialization in Processing & Food Engineering have been compiled and published in the document. The research efforts concern on the crops of Saurashtra region. The field of research related to drying & dehydration of food products, processing & value addition, development of processing machinery, storage of agricultural products etc.

I hope the information given in this abstracts will be useful to researches, manufactures, processors and planers engaged in the field of post harvest technology.

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F O R E W O R D

The post harvest technology has three dimensions i. e. primary processing, secondary processing and utilization of agricultural wastes, residues & byproducts obtained during processing. The harvested crop is subjected to various operations like drying, threshing, cleaning, milling, curing, storage and marketing. These operations performed scientifically, have a potential of saving the post harvest losses.

The abstracts of Theses of Ph. D and M. Tech Agricultural Engineering with specialization in Processing & Food Engineering highlighted the research work carried out on the topics related to machine development, processing of fruits and vegetables, process development, during and dehydration and extraction of essential oil etc.

I congratulate the team of teachers and scientists of the Department of Processing & Food Engineering and AICRP on Post Harvest Technology for their efforts in bringing out this valuable document.

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PREFACE

It gives me a great pleasure that the second issue of abstracts of M. Tech and Ph. D theses with specialization in Processing & Food Engineering is being published by the Department of Processing & Food Engineering & AICRP on Post Harvest Technology.

The abstracts of M. Tech and Ph. D theses have been published in the areas of drying & dehydration of food products, processing & value addition, development of processing machinery, storage of agricultural products etc. I hope that this publication shall be useful as reference for the teachers, students and others.

I would like to express my since gratitude to Dr. N. C Patel, Vice Chancellor, Junagadh Agricultural University, Junagadh, Dr. C. J, Dangaria, Director of Research & Dean P. G. Studies, Junagadh Agricultural University, Junagadh and Dr. N. K Gontia, Dean & Principal, College of Agricultural Engineering & Technology, Junagadh Agricultural University, Junagadh for their inspiration, and timely encouragement besides providing necessary facilities to bring out this publication.

I also express my since gratitude to them, who have helped to bring out this publication directly or indirectly.

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Ph. D. (Processing & Food Engineering)		
Sr.No	**Title**	**Page No**
1.	Packaging and Storage Studies on Fresh Guava Fruit and Osmotic-Air Dehydrated Powder of Guava (Psidium Guajava L.) (2010)	
2.	Standardization of Drying and Extraction Techniques for Production of Lycopene from Tomato Processing Waste (pomace) (2011)	
3.	Development and Storage Of Whey Based Banana Beverage (2012)	
4.	Design and Development of Gel Expulsion Machine for Aloe Vera Leaves (2012)	
5.	Studies on Osmo-Freeze Drying of Sapota (achras sapota l.) (2012)	
6.	Design and Development of Onion Grader (2012)	
7.	Enzymatic Pre-Treatments on Pigeon Pea for Better Recovery and Quality of Dhal (2012)	
M. Tech (Processing & Food Engineering)		
1.	Development of Gel Extraction Process for Aloe Vera Leaves (2005)	
2.	Studies on Forced Air Ventilated Storage of Onion (2005)	
3.	Studies on Post Harvest Practices for Banana Followed In Gujarat (2005)	
4.	Development of Technology for Production of Peanut Butter from Saurashtra Cultivars (2005)	
5.	Studies on Physico -chemical and Rheological changes during Ripening of Custard Apple. (2005)	
6.	Studies on Process Development for Banana Flour (2006)	
7.	Studies on the process development for quality Papain (2006)	
8.	Studies on Osmotic -Air Drying Characteristics of Sapota Slices (2006)	
9.	Studies on Storage of Dehydrated Onion and Garlic Powder (2007)	
10.	Preservation of Rose and Gerbera Flowers by Different Drying Methods (2007)	
11.	Studies on Effect of Blend Ratio on Physical, Textural and Sensory Properties of Pasta (2007)	
12.	Studies on Convective and Microwave Drying of Grapes (2008)	

13.	Studies on High Vacuum Freeze Drying of Aloe Vera Filets and Its Storage (2010)	
14.	Study on Hydraulic Pressing of Groundnut Kernel for Maximum Oil Recovery (2010)	
15.	Effect of Ethylene Absorbent in Combination with Stage of Maturity and Storage Temperature on Shelf Life of Banana for Export (2010)	
16.	Development of Process for Extraction of Pectin from Mango Peels (2010)	
17.	Effect of Blanching on Quality and Shelf - Life Of Peanut Kernel (2010)	
18.	Processing and Storage of Sugarcane Juice (2011)	
19.	Thin layer Drying Study on Foamed Aonla Pulp (2011)	
20.	Studies on Extraction of Essential Oil from Mandarin Orange Peel (2011)	
21.	Extraction of Oil from Mango Kernel By Hydraulic Pressing (2011)	
22.	Studies on Osmotic -Air Drying Characteristics of Prickly Pear Fruit Slices(2011)	
23.	Process Technology for Preparation of Peanut Milk (2011)	
24.	Studies on Osmo-Air Drying of Ber Candy (2012)	
25.	Studies on Ambient Storage of Lime Juice Concentrate Packed in Sachet (2012)	
26.	Studies on Effect of Variety, Maturity and Concentration of Tamato Crush During Storage (2012)	
27.	Extraction of Oleoresin from Rotten Onion by Supercritical Co2 Extraction Method. (2012)	

Abstracts of the Ph. D. Thesis

Packaging and Storage Studies on Fresh Guava Fruit and Osmotic-Air Dehydrated Powder of Guava (Psidium Guajava L.) (2010)

Student: Dineshkumar K. Antala

Advisor: Dr. A. K. Varshney

Abstract

India is one of the largest producers of the guava fruit (Psidium guajava L.) in the world. Guava is an important fruit crop of India and called the "Apple of the Tropics". Improved packaging technology and storage reduces post harvest losses and increases the shelf life of fresh guava fruit and processed products of the fruit. It also reduces the glut in the market and farmers fetch remunerative price during harvesting season in the domestic market.

Freshly harvested and fully matured guava fruit (Lucknow-49) were procured from a farm of Vanthli Taluka, Junagadh District. The guava fruit were immediately pre-cooled at 10 ^{0}C for 1 h to remove field heat and graded on the basis of weight and damaged fruit were sorted out. After washing, the fruit were pretreated with 500 ppm benomyl for 5 minutes and dried under shade. Two fruit were placed in a 150 x 225 mm size of LDPE bag with 80-100 mm headspace for packaging. The fruit were treated with active MAP with three levels of gas concentrations i.e., 3 % O_2 + 5 % CO_2, 6 % O_2 + 5 % CO_2 and 9 % O_2 + 5 % CO_2 and packed in two levels of thickness of LDPE bags i.e., 25 µ and 50 µ. The samples were stored at two levels of temperature of 5 ± 1 ^{0}C with 90-95 % Rh and 10 ± 1 ^{0}C with 85-90 % Rh.

The physical, biochemical, sensory characteristics of the guava fruit and gas concentration in head space within package were recorded at an interval of 7 days during storage. It was concluded that the shelf life of guava fruit can be increased up to 42 days by packaging in 50 µ LDPE bags at 9 % O_2 + 5 % CO_2 gas concentration and stored at 10 ^{0}C without much change in physical, biochemical and sensory characteristics. The cost of packaging of guava fruit and net profit per kg were estimated to be 5.11 and 10.89, respectively.

The uniformly ripened with reasonably hard guava fruit of 60 to 65 mm diameter was selected for osmotic dehydration. The selected fruit were washed with clean water, peeled, cut into two halves, cored and sliced in 10 mm thickness. The slices were pretreated with 0.1 % KMS and 0.1 % citric acid solution for about 5 minutes and immersed in three different sucrose solution concentrations i.e., 50, 60 and 70 ^{0}Brix with sample to solution ratio 1:5 (w/w). The samples were kept at room temperature

(25 ± 7 ^{0}C) and 50 ^{0}C for 6 h and 12 h immersion time without any agitation. After completion of immersion time, the guava slices were removed from the solution, drained and rinsed with clean water to remove the syrup adhered to the surface. The osmotic-dehydrated guava slices were dried in a single layer in a tray dryer at 60 ± 2 ^{0}C drying temperature and 2.5 m/s air velocity. Dried guava slices were ground and sieved by 300 mesh sieve to obtain powder.

The observations of various characteristics viz., solid gain, water loss, water loss to solid gain ratio, weight loss and moisture content of guava slices were recorded during osmotic dehydration. The drying characteristics of guava slices were observed during tray drying. The observations of various physical, biochemical and sensory characteristics of guava powder were evaluated after osmotic-air dehydration. The initial moisture content of guava slices reduced from 455.86 % (d.b.) to 41.08 %-195.25 % (d.b.) after osmotic dehydration and after osmotic-air dehydration, it reduced from 41.08 %-195.25 % (d.b.) to 4.25 %-4.94 % (d.b.). The highest water loss to solid gain ratio and rehydration ratio of guava slices was found to be 5.28 and 2.93 for 60 ^{0}Brix sucrose solution, 6 h immersion time and 50 ^{0}C process temperatures during osmosis and tray drying, respectively. The maximum water solubility index, water absorption index and ascorbic acid of guava powder was observed to be 86.68 %, 516.63 % and 146.17 mg/100 g for 60 ^{0}Brix sugar solution, 6 h immersion time and 50 ^{0}C process temperature.

It may be concluded that 60 ^{0}Brix sucrose solution, 6 h immersion time and 50 ^{0}C process temperature showed best quality in terms of drying, physico-chemical and sensory characteristics of guava powder.

The best quality powder was packed in 50 µ flexible packages viz., LDPE, HDPE, PP, aluminium laminated polyethylene (ALPE) pouch of 105 x 140 mm size with nitrogen gas keeping 40-50 mm headspace and also in glass bottle. The powder in 50 µ LDPE bag without sealing was considered as control. The dehydrated powder was stored for a period of 8 months at room temperature (14.3-37.4 ^{0}C and 16.3-86.4 % Rh). The physical, biochemical, microbial and sensory characteristics of guava powder were determined at an interval of 2 months up to 8 months during storage.

The highest water solubility index, water absorption index, ascorbic acid, total sugar and sensory score was found to be 85.28 %, 508.69 %, 114.99 mg/100 g, 53.60 % and 7.90, respectively in ALPE pouch with nitrogen gas followed by HDPE bag with nitrogen gas at the end of 8 months of storage. The minimum moisture content, reducing sugar, titratable acidity, non- enzymatic browning and total plate count of guava powder was found to be 4.80 %, 33.78 %, 0.96 %, 0.095 OD and 365 cfu/g

respectively in ALPE pouch with nitrogen gas followed by HDPE bag with nitrogen gas at the end of 8 months of storage period. Yeast and mould, E. coli and salmonella were found absent in all packaging materials except control.

The osmotic-air dehydrated guava powder can be stored up to 8 months in nitrogen gas filled ALPE pouch without much change in physical, biochemical, microbial and sensory characteristics. The cost of preparation as well as packaging of guava powder and net profit per kg of guava powder was estimated to be 292.30 and 216.70, respectively.

Standardization of Drying and Extraction Techniques for Production of Lycopene from Tomato Processing Waste (Pomace) (2011)

Name of Student: Sanjay H. Akbari

Advisor: Dr. A. K. Varshney & Dr. D. C. Joshi

Abstract

Tomato (Lycopersicon esculentum) is a fruit used mainly as a vegetable both in fresh as well as in processed forms. Lycopene is an important carotenoid in tomatoes is responsible for the red colour in tomatoes. The antioxidant capability of lycopene has led to promising results in decreasing the risk of some illnesses and cancers.

Tomato peels can be a viable source of lycopene, as the per unit mass of tomato peels contain about five times more lycopene than the whole tomato pulp. As the primary component of tomato pomace, the tomato peel has the potential for higher amounts of lycopene than tomatoes themselves. Based on the interesting chemical composition of tomato by-products and fractions, propose their use in human nutrition as functional food. Tomato processing waste (pomace) having peel, pulp and some amount of seed has a high moisture content that makes it susceptible to microbial proliferation and spoilage. Therefore, skin can be preserved by drying and then used for lycopene extraction.

Supercritical fluid extraction (SFE) has emerged as a highly promising environmentally benign technology for selectively recovering thermally labile bioactive ingredients from natural sources. The nutraceutical produced by SFE using carbon dioxide (CO_2) at near-ambient temperatures are preferred by consumers due to their superior quality and higher bioactivity without the problems of residual solvent and microbial contamination. It yields tailor-made extracts of superior organoleptic profile and shelf life, with high potency of active ingredients. Further, due to the

relatively low temperature of operation, the extracts are very close to those found in nature both in smell and taste.

In this study, the effects of different dryer (tray, vacuum and fluidized bed) and temperature (50, 60, 70, 80 and 90 °C) on lycopene retention in dried pomace were evaluated. The dried pomace developed by standardized drying techniques was used for optimization of processing parameter (temperature, pressure, dynamic time) of SFE and particle size on the basis of lycopene extract yield and purity of lycopene. Purity of lycopene was determined using HPLC. The optimized extract was studied for its shelf life for two months at different storage conditions.

The highest lycopene content in whole tomato as well as pulp was found in cv. Heem Shikhar (3.09 and 3.05 mg/100 g). Also, the highest lycopene content in peel was found in cv. Heem Shikhar (8.67 mg/100 g). Pulp: peel: seed ratio found in Heem Shikhar variety was 90.96: 6.68: 2.35. The moisture content of tomato pomace produced from Heem Shikhar variety was found 84.71 %, protein 7.13 %, fat 0.31, fiber 2.65 %, ash 0.7 % and carbohydrates by difference was found to be 4.51 %. The seed to pulp and peel ratio in dry pomace was found to be 34:66.

The pomace dried at 50 ºC temperature in fluidized bed dryer had significantly maximum lycopene content (24.34 mg/100 g) retention which was followed by tray and vacuum dryer.

Optimum value of lycopene extract (4.93 g/100 g) and purity of lycopene (81.319 %) was found at 60 °C temperature, 375 bar pressure, 120 min dynamic time of SFE conditions and keeping particle size of dried pomace of 0.6 mm. Lycopene extract stored at a temperature of 30 °C showed gradual decrease in purity of lycopene content after 7 days to till 60 days. Changes in purity of lycopene stored at -4 °C were less prominent till 60 days.

Development and Storage Of Whey Based Banana Beverage (2012)

Student: Navnitkumar K. Dhamsaniya

Advisor: Dr. A. K. Varshney

Abstract

Banana is the second largest produced fruit after citrus contributing about 16 per cent of the world's total fruit production. India is one of the largest producers of banana in the world, contributing more than 27 per cent of the global banana production. In India, the major banana producing states are Maharashtra, Tamil Nadu

and Gujarat. The productivity of banana in Gujarat (61.5 t/ha) is remarkably higher than the national standard (34.4 t/ha). Also, the area under banana crop is increased by 25.76 per cent while the production increased by 51.27 per cent during the last five years in Gujarat. Rising area, production and productivity of banana in Gujarat as well as in India is becoming a matter of concern for the development of new value added products from the ripe banana to avoid its losses after ripening.

Whey is one of the highly nutritious byproduct from dairy industry containing valuable nutrients. A huge quantity of whey is being drained out annually from the dairy industries poses a serious threat to environmental safety. Hence, the conversion of whey into beverages is one of the most attractive avenues for its utilization for human consumption. The beverages prepared using whey has off-flavour. Mentha arvensis (M. arvensis) extract is commonly used as a natural flavouring agent in most of the whey-based fruit beverages. It is, therefore, felt appropriate to use the M. arvensis instead of other flavouring agents like vanilla, chocolates, etc. in the development of natural beverage for fetching the higher market demand.

The banana (cv. 'Grand Naine') fruits of good quality and well matured, ready for ripening were procured from the local market. The physical and biochemical properties of the selected fruits were determined using the standard analytical methods.

The process of heating the ripe banana slices is an important process parameter in the production of banana juice. Hence, the heating temperature and time duration was standardized for obtaining optimum juice yield having higher total soluble solids with the characteristic banana odour and taste in the prepared banana juice. Three levels of temperature (40, 70 and 100ºC) and three levels of time duration (30, 45 and 60 minutes) were selected for heating the banana slices to obtain the banana juice of desired quality. The physicochemical properties and organoleptic qualities of the prepared banana juice were determined using the standard equipments and methods. From the combined evaluation of physicochemical properties and organoleptic characteristics of the banana juice prepared during the various treatment combinations, it may be concluded that the ripe banana slices should be heated at 100ºC temperature for 45 minutes in hot water bath to obtain the banana juice having higher yield, TSS content and superior organoleptic quality. After standardizing the heating parameters, the banana juice was produced at optimum processing conditions for utilizing in the beverage preparation.

Similarly, the milk whey was prepared from the standardized Taaza brand milk having 3.1% fat & 7.9% SNF and marketed by Mother Dairy, Junagadh, Gujarat. The

procedure adopted for the production of whey was followed as described by De (1991). The physicochemical characteristics of prepared milk whey viz., protein, fat, total solids, pH and acidity were measured using digital milk analyzer.

The M. arvensis extract was prepared from its plant material obtained from the local vegetable market following the standard procedures. The different proportions of banana juice i.e. 5, 10 and 15 ml, M. arvensis extract i.e. 1, 3 and 5 ml and the ground sugar powder was added at equal rate of 8 g in each sample. The rest of the amount of milk whey was added to the mixture for making 100 ml beverage for optimizing their proportions to develop an acceptable whey banana beverage. On the basis of the physicochemical properties and sensory attributes of the banana beverage prepared using various proportions of banana juice and M. arvensis extract, it was established that the beverage prepared with 15 ml banana juice and 3 ml M. arvensis extract indicated better physicochemical properties and superior organoleptic quality.

An acceptable whey banana beverage, obtained at the optimized proportions of banana juice, M. arvensis extract and milk whey, were packed in airtight transparent and amber coloured glass bottles and stored under the refrigerated conditions (7+1°C) to evaluate its shelf life. The physicochemical and organoleptic characteristics of the stored beverages were evaluated at 7 days interval for 42 days of storage period. From the physicochemical properties and microbial analysis, it was concluded that the prepared beverage packed in transparent glass bottle can be stored safely up to 35 days at the refrigerated condition. However, it was felt advisable to consider the safe storage period of 28 days for its safely consumption.

Hence, from the study conducted, it may be concluded that the prepared whey banana beverage should be packed in transparent glass bottle and store at refrigerated conditions (7 + 1 ºC) safely up to 28 days. Further, it may also be concluded that, looking to the nutritious virtues, cost of production and cost-benefit ratio, the developed whey banana beverage could be recommended for the large scale production at industrial level.

Design and Development of Gel Expulsion Machine for Aloe Vera Leaves (2012)

Student : Vallabh K. Chandegara

Advisor : Dr. A. K. Varshney

Abstract

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). Aloe vera gel is used in medicine, cosmetics and nutrition purposes. The hand filleting and whole leaf processing are the methods, generally used for the extraction of Aloe vera gel. The expanding Aloe industry urgently needs to develop appropriate machine to maintain its biological activity and hygienic conditions. An effort has been made to design and develop the Aloe vera gel expulsion machine.

An Aloe vera gel expulsion machine based on the principle of splitting leaf to reduce crushing force and expulse the inner gel by passing split leaf between two rotating roller. The whole gel expulsion machine is divided into following two components: (a) Splitting unit and (b) Gel expulsion unit. The performance of the developed gel expulsion machine was evaluated at seven speeds of the machine i.e. 45, 60, 75, 90, 105, 120 and 135 rpm of expulsion roller and three leaf thicknesses i.e. less than 25 mm, 25 – 30 mm and greater than 30 mm in terms of gel recovery, expulsion efficiency, output capacity and percentage of residual gel in leaf. The expulsed gel through the developed machine was evaluated for quality parameters like viscosity, optical density and refractive index.

The average length width and thickness of Aloe vera leaf are 495.20, 86.38 and 28.32 mm respectively with apparent volume 323.90 cc, whereas the average leaf weight, crude gel weight and pulp recovery was found to be 0.409 kg, 0.213 kg and 51.92 % respectively. The maximum gel recovery 39.14 % was found of at the speed of 75 rpm and 30 mm leaf thickness. The minimum residual gel percentage i.e. 4.41 % was found at speed of 75 rpm and less than 25 mm leaf thickness. The highest gel expulsion efficiency 84.05 % was found at speed 90 rpm and 25 –30 mm leaf thickness. The maximum output capacity was found 116.19 kg/h at speed 135 rpm and leaf thickness ranging from 25 to 30 mm.

It was concluded that for getting maximum gel recovery, minimum residual gel percentage, highest expulsion efficiency and output capacity, the expulsion of Aloe vera leaves should be carried out at 75 rpm roller speed and 25 – 30 mm thickness of leaves. The average values of viscosity, refractive index and optical density of the expulsed gel were found to be 0.621 Stokes, 1.3364 and 0.239 respectively. The mean values of pH, TSS, fiber content, total sugar and reducing sugar were found to be 6.298, 1.174 0Brix, 1.1158 (Pulp) and 0.194 (gel), 1.9528 %, and 0.0258 % for mechanical gel expulsion. The cost of gel expulsion for Aloe vera leaves by the developed machine was estimated to be 667.5/tonne as compared to 2000 per tonne by the manual method.

Studies on Osmo-Freeze Drying of Sapota (achras sapota l.) (2012)

Student: Sanjay P. Cholera

Advisor: Dr. N. C. Patel

Abstract

Sapota (Achras sapota L.), which is commonly known as "Chikoo" in India, is a highly perishable fruit found in almost all the tropical parts of the country. Once sapota fruit ripens, it needs to be consumed within a couple of days due to its perishable nature. A possible alternative solution to this problem is to prepare best quality sapota powder by modern advance technique of osmo-freeze drying to get the combined benefits of these two valuable processes. Osmotic dehydration prior to freeze drying will retains the colour, flavour, aroma, texture and taste in the final product. Subsequent freeze drying will give the dried product of excellent quality, stability and reconstitution characteristics when placed in water. The packaging of sapota powder by best comprehensive method is to permit long term storage without any quality or microbial deterioration.

The uniformly matured and reasonably hard sapota fruits (cv. Kallipati) were cleaned, peeled and sliced manually at 4 mm thickness. Osmotic dehydration of 4 mm sapota slices was carried out at different osmotic variables, viz., osmotic solution concentration was kept 60 and 70^0 Brix, immersion time was 5 and 10 h, process temperature was 30, 40 and 50^0 C and sample to solution ratio was 1:5. The observations of different osmotic characteristics viz., solid gain (SG), water loss (WL), water loss to solid gain ratio (WL/SG), weight loss and moisture content of sapota slices during osmotic dehydration were recorded. Also, the biochemical characteristics viz., titratable acidity, total sugar and ascorbic acid of osmotically dehydrated sapota slices were also determined.

The initial moisture content of 73.54 to 74.80 % (wb) of the fresh sapota slices was reduced to 48.80 to 61.13 % (wb) after osmotic dehydration. The highest values of water loss to solid gain ratio (6.02 %), titratable acidity (0.15) % and ascorbic acid content (22.52 mg/100 g) as well as reasonably lower gain of sugar (22.40 %) during osmotic dehydration of sapota slices were obtained in treatment having 60 ^{0}Brix osmotic solution + 5 h immersion time + 50 ^{0}C temperature. It could be concluded that the treatment having 60 ^{0}Brix osmotic solution + 5 h immersion time + 50 ^{0}C temperature was found to be the best on the basis of osmotic and biochemical characteristics of osmosed sapota slices among all the treatments.

Osmotically dehydrated sapota slices were freeze dried at -20 and -40 ^{0}C

temperature at a constant vacuum pressure of 1 torr using freeze dryer. Also, the tray drying of sapota slices was carried out at 60 ^{0}C air temperature and 1.25 m/s air velocity as a control treatment.

The highest freeze drying time of 42 h was required to reduce the initial moisture content of 152.65 % (db) to 3 to 4 % (db) in treatment having 60 ^{0}Brix osmotic solution + 5 h immersion time + 50 ^{0}C process temperature - 40 ^{0}C freeze drying temperature, whereas lowest of 26 h was required to reduce initial moisture content of 104.62 % (db) and 96.85% (db) to 3 to 4 % (db) in treatments having 70 ^{0}Brix osmotic solution + 10 h immersion time + 40 ^{0}C process temperature - 40 ^{0}C freeze drying temperature and 70 ^{0}Brix osmotic solution + 10 h immersion time + 50 ^{0}C process temperature - 40 ^{0}C freeze drying temperature, respectively. The treatments with -20 ^{0}C freeze drying temperature required more freeze drying time (4 to 6 hour) as compared to treatments with -40 ^{0}C freeze drying temperature to reduce the almost similar initial moisture content of osmotically dehydrated sapota slices to 3 to 4 % (db).

Overall quality evaluation of osmo-freeze dried sapota powder revealed that the highest values of rehydration ratio (4.56), water solubility index (89.15 %), water absorption index (701.82 %), titratable acidity (0.26 %), ascorbic acid content (54.66 mg/100 g), overall acceptability (8.33) as well as lowest non-enzymatic browning (0.040 OD) were obtained in treatment having 60 ^{0}Brix osmotic solution + 5 h immersion time + 50 ^{0}C process temperature - 40 0C freeze drying temperature. However, the recovery of powder (24.86 %) and total sugar content (61.15 %) were comparatively lower in the said treatment that might be attributed to lower solid gain during osmotic dehydration.

It could be concluded that treatment having 60 0Brix osmotic solution + 5 h immersion time + 50 ^{0}C process temperature – 40 ^{0}C freeze drying temperature, was found to be the best among all the treatments on the basis of physical, biochemical and sensory characteristics of osmo-freeze dried sapota powder.

The packaging of the best quality osmo-freeze dried sapota powder obtained by treatment D6 (S1I1T3F2) was carried out in different packaging materials viz., low density polyethylene (LDPE), high density polyethylene (HDPE), poly propylene (PP) and laminated aluminium foil (LAF) pouches at 300 and 700 mm Hg vacuum pressure and stored at room temperature (15.4 - 38.2 0C and 16.3 - 82.4 % Rh). The quality evaluation of osmo-freeze dried sapota powder was carried out during 10 months storage period on the basis of its physical, biochemical, microbial and sensory evaluation.

The highest retention of physical characteristics viz., moisture content (5.05 %

(wb)), water solubility index (86.13 %) and water absorption index (687.39 %), as well as biochemical characteristics viz., titratable acidity (0.32 %), total sugar (55.33 %), ascorbic acid (53.54 mg/100 g) and non-enzymatic browning (0.225 OD) was obtained in treatment having laminated aluminium foil pouches with 700 mm Hg vacuum level, at the end of 10 months of storage period among all the treatments. While, the lowest total plate counts of 7.68 cfu/g as well as absence of E. coli, yeast and mould, salmonella as well as highest sensory score of 7.27 in terms of colour, flavour, taste, odour and overall acceptability was obtained in the said treatment.

Based on the storage studies of osmo-freeze dried sapota powder, it may be concluded that treatment having laminated aluminium foil pouches with 700 mm Hg vacuum level, was found to be the best among all the treatments on the basis of physical, biochemical, microbial and sensory characteristics of osmo-freeze dried sapota powder due its impervious nature as compared to other packaging materials.

Finally, optimizing the process of all the three different experiments of this investigation, it may be concluded that the best quality osmo-freeze dried sapota powder was obtained by osmotic dehydration of 4 mm thick sapota slices at 60 ^{0} Brix osmotic solution concentration, 5 h immersion time, 50 ^{0}C process temperature and 1:5 sample to solution ratio followed by freeze drying at –400 ^{0}C freeze drying temperature and 1 torr constant vacuum pressure. The best quality powder obtained by these optimized variables could be efficiently stored in laminated aluminium foil pouches (LAFP) with 700 mm Hg vacuum level for more than 10 months without much change in physical, biochemical, microbial and sensory characteristics.

Design and Development of Onion Grader (2012)

Student: Mukesh N. Dabhi

Advisor: Dr. N. C. Patel

Abstract

India is the second largest producer of onion in the world after China, with over 15 million tonnes produced in 2010-11. Onion in India is grown across the country and also consumed in all parts of the country. As a culinary ingredient it adds to the taste and flavour in a wide range of food preparations, besides its use in salads. The key onion producing states are Maharashtra, Karnataka and Gujarat contributing over 50 per cent of all India production. India leads the list of exporters of onion followed by Netherlands, Bangladesh, Malaysia and Sri Lanka form the largest block for Indian onion exporters, followed by Arabian Gulf countries.

Onion bulbs, throughout the country, are graded manually at farm and trader level. Manual grading of onion is a labour consuming and tedious operation coming with many losses. Therefore, the modern technologies, like automatic grading systems, are of utmost need. Grading is one of the most important operations affecting onion export. It determines the size of standard sale package, thereby increasing marketing attractiveness, and simplifies the mechanization of different handling systems, such as cutting and peeling.

There are different types of onion graders available in the Indian market. These are of higher throughput (10 to 12 t/h) and highly expensive (costing ` 10 lakh or more). Hence, they are not being used at the farm level as it is beyond the reach of ordinary farmers having small land holding who are growing onion crop. This necessitated developing an efficient low cost grading machine for onion.

Physical properties such as the equatorial diameter, polar diameter, shape index, geometric mean diameter, arithmetic mean diameter, cross sectional area, unit mass, bulk density and frictional properties like coefficient of friction of the onion bulbs and mechanical damage to onion bulbs during the grading were determined at 85.23 per cent moisture content. The mean equatorial diameter of onion bulb was 55.80 mm while polar diameter and shape index were 44.72 mm and 5.60, respectively. The mean value of geometrical mean diameter, arithmetic mean diameter, cross sectional area and unit mass of onion were 51.12 mm, 51.45 mm, 2137.80 mm2 and 63.20 g. The mean value of bulk density for small (up to 40 mm), medium (40-60 mm) and large (above 60 mm) size of onion was found to be 552, 548 and 545 kg/m^3, respectively. The coefficient of friction for galvanized iron, mild steel, aluminum and plywood was found to be 0.42, 0.39, 0.45 and 0.32, respectively. Also, the angle of repose for galvanized iron, mild steel, aluminum and plywood was found to be 23, 21, 24 and 17o, respectively.

Considering physical characteristics of onion bulbs and grading principle, rotation and translation of the product, a divergent roller type power operated grading machine was developed. The grading machine consisted of hopper, rollers, power transmission and driving assembly, and collection unit. Machine was developed using the locally available material. The effects of different machine parameters viz., roller speed and roller inclination, and their interaction on grading efficiency and capacity were studied. Grader performance was evaluated for onion bulbs at 5, 7, 9, 11, 13 and 15 rpm roller speeds; and 4, 8 and 12º roller inclinations. The cost economics for grading of onion using the developed machine was also worked out by considering the standard assumptions. It could be recommended that the onion (Talaja Red) should be

graded in the developed divergent rollers type onion grader at 15 rpm roller speed having 8o roller inclination to obtain the optimum grading efficiency, i.e., 82.98 per cent on weight basis and 85.25 per cent on number basis. At the optimized conditions, the capacity of the developed grader was found to be 601.38 kg/h and the cost of grading could be lower by 12.32 per cent as compared to traditional manual grading practices, in addition to saving time and eliminating drudgery.

Enzymatic Pre-Treatments on Pigeon Pea for Better Recovery and Quality of Dhal (2012)

Student: Velji P. Sangani

Advisor: Dr. N. C. Patel

Abstract

Pigeon pea (Cajanus cajan L.) is one of the important pulse crops of India contributing 20.87 % to the total production of all pulses. India accounts for 90 % of the total world production of pigeon pea. Pigeon pea is significantly contributing to meet the dietary requirement of crude fiber, ash, fat, magnesium, manganese and copper. Pigeon pea contains high amount of vitamin B, Carotene and ascorbic acid. Pigeon pea is mainly consumed as dhal because it takes less time to cook and has acceptable appearance, texture, palatability, digestibility, and overall nutritional quality.

The pigeon pea grain is considered as most difficult for de-hulling as compared to other pulses owing to its seed coat which is more firmly attached with the cotyledons through a layer of gum and mucilage. The primary objective of dehulling is to remove seed coat from the cotyledons, during which four different fractions, i.e., dhal, broken, powder and husk are obtained. Pre milling treatments are generally employed to loosen the seed coat to remove husk without losing any edible portion.

The experiments mainly consisted of physicochemical properties of pigeon pea grains, scanning electron microscopy of enzyme treated grains, enzymatic pre-treatments on milling quality, protein content and cooking time. Different properties of pigeon pea grains, namely size in terms of length, breath and thickness, sphericity, bulk density, porosity, true density, angle of repose and coefficient of static friction against different surfaces were determined at 10, 15, 20, 25 and 30 % (d.b.) moisture content. The proximate compositions of pigeon pea grains, viz., carbohydrate, protein, fat, crude fiber and ash were determined at 10.46 %, (w.b.) moisture content.

The effect of four enzymatic hydrolysis parameters viz., enzyme concentration

(20, 30, 40, 50 and 60 mg/ 100 g dry matter), incubation time (3, 6, 9, 12 and 15 h), incubation temperature (40, 45, 50, 55 and 60 0C) and tempering water pH (4.0, 4.5, 5.0, 5.5 and 6.0) on hulling efficiency, protein content and cooking time were optimized using response surface methodology. For the comparison of enzymatic pre-treatment, the dry milling method was considered as control.

Microstructure of all the enzymatically hydrolyzed as well as oil treated (control) samples were examined using a Scanning Electron Microscope. Sensory evaluation of the cooked samples of enzyme treated and control samples was carried out immediately after cooking in terms of colour, appearance, flavour, texture, taste and overall acceptability.

The average length, width, thickness, size and thousand grain mass of pigeon pea grains increased from 6.05 to 6.32 mm, 5.43 to 5.63 mm, 4.64 to 4.71 mm, 5.337 to 5.510 mm and 97.90 to 116.83 g with the increase in moisture content from 10 to 30 % (d.b.). The sphericity, bulk density and true density decreased logarithmically from 0.883 to 0.871, 872 to 814 kg/m^3 and 1353 to 1307 kg/m^3 with the increase in moisture content from 10 to 30 % (d.b.), respectively. The porosity and angle of repose of pigeon pea grains increased logarithmically from 35.47 to 37.96 % and 28.17° to 34.08° with increasing moisture content from 10 to 30 % (d.b.), respectively. At all the moisture contents, the static coefficient of friction was highest against plywood surface which ranged from 0.41 to 0.62, for galvanized sheet from 0.34 to 0.52 and lowest for glass surface that is from 0.336 to 0.456. The moisture content of pigeon pea grains was found to be 10.46 % (w.b.), protein 18.73 %, carbohydrate 58.15 %, fat 1.62 %, crude fiber 7.45 %, total ash 3.70 %.

The cavity thickness observed through sectional images of enzyme treated pigeon pea samples using scanning electron microscope varied from 3.80 to 48.84 µm. It was observed that the cavity thickness of enzymatic treated samples increased which resulted in to the increase in the percentage husk removed.

From the above study, it could be recommended that the better recovery and quality of pigeon pea dhal could be obtained by enzymatic pre-treatment of enzyme concentration of 37.80 mg/100 g dry matter, 8.69 h incubation time, 48.5 ^{0}C incubation temperature and 5.49 tempering water pH for obtaining a hulling efficiency 88.12 % with 21.81 % protein content and 21.5 min cooking time for dhal. This could increase hulling efficiency by 13.47 %, protein content by 12.33 % and decrease in cooking time by 19.77 % as compared to the control. The sensory evaluation indicated that the dhal obtained through enzymatic pre-treatment had higher value of overall acceptability as compared to control sample.

Abstracts of the M. Tech. Thesis

Development of Gel Extraction Process for Aloe Vera Leaves (2005)

Student: Vallabh K. Chandegara

Advisor: Dr. A. K. Varshney

Abstract

Aloe vera is a succulent that belongs to the liliaceae family. Aloe a native, chiefly to the warm dry areas of South Africa, but cannot survive freezing temperatures. The cultivation of Aloe vera has acquired great commercial importance for medicinal products and cosmetic processing but information is scarce about processing of this crop. This investigation was aimed at standardizing important process parameters with the specific objective of developing an appropriate process technology for extraction of gel from Aloe vera Barbadensis. For the extraction of gel from Aloe vera leaves, principle of centrifugation was employed.

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).

Different physical properties of Aloe vera leaf like length; width, thickness, weight and pulp weight were measured. The average value of length, width, leaf weight, pulp weight, apparent volume, pulp weight and pulp recovery was ranged from 48.0 to 65.5 cm, 5.5 to 11.5 cm, 0.326 to 0.658 kg, 127.32 – 485.73 cc, 0.156 – 0.331 kg and 42.82 – 57.14 % respectively for Aloe vera leaf. The moisture content, fiber content, pH and sugar content was found 99.8 % 0.2 %, 6.389, 1.9125 (Total sugar) and 0.0259 (Reducing sugar) from Aloe vera gel respectively.

The experiment were planned using a 4 factor completely randomized design. The treatments consisted of two levels of Acetone i.e. without addition of Acetone and 10 % addition of Acetone, three level of Centrifuge temperature i. e. 5, 10 and 32 ^{0} C (Ambient), three level of Centrifuge speed i.e. 2000, 5000 and 10000 rpm and three level of Centrifuge duration i. e. 10, 20 and 30 min with 3 replications. The optimum proportion of Acetone, CF temperature, CF speed and CF duration was decided on the basis of quality parameters of gel. The results obtained are analyzed statistically.

The effect of Acetone, CF temperature, CF speed and CF duration on quality parameters like Gel recovery (%), Viscosity of gel, (Stokes), Refractive index of gel, Optical density of gel, and TSS content of gel, (Brix) were studied. The combined effect of the different extraction parameters such as Proportion of Acetone addition to pulp, CF temperature, CF speed and CF duration, a four factor Completely Randomized Design of experiment was employed.

It was recommended that the extraction of gel from Aloe vera by the method of Centrifuge should be carried out at 5 0C CF temperatures, 10000 rpm CF speed and 30 min CF duration without addition of Acetone to pulp so as to get higher gel recovery (50.17 %) and good quality of gel i.e. Viscosities: 0.675 (Stokes), Refractive index: 1.33550, Optical density: 0.218 (abs) and TSS content: 0.93 (Brix).

Studies on Forced Air Ventilated Storage of Onion (2005)

Student: Mukesh N. Dabhi

Advisor: Dr. N. C. Patel

Abstract

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. India occupies second position in production and third in export of onion in the world. Major onion producing states are Karnataka, Maharashatra, Orissa, Gujarat, Uttar Pradesh and Madhya Pradesh. Onion production in Gujarat state was 7174 metric tonne in 2002-03.

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. In some parts of the country like Karnataka, onions are stored in hessian cloth bags, which results in more than 60 per cent storage loss in 4 months. Controlled aeration is an established technique by which the temperature and humidity are modified within the store. This necessitated a forced ventilated storage of onion for reducing the losses during storage along with keeping its quality.

The existing traditional storage structures of trader at Mahuva were used in the study. 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. 15 tonnes onion bulbs were stored under the forced ventilated storage and control, i.e., natural ventilated storage. The effects of storage period and storage ventilation at top, middle and bottom layer were determined by analyzing the losses and quality of the stored onion. The quality of the stored onion was evaluated by determining TSS, reducing sugar, total sugar and pungency at the initial storage of onion and after the end of storage. The storage diseases as per cent intensity of black mould and soft rot were recorded during storage.

The average values of size and spericity of onion bulbs (Talaja Red variety) were found to be 54.3 mm and 1.07, respectively at 86.69 percent moisture content (w.b.). The average value of bulk density of onion was found to be 562 kg/m^3.

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. Pungency was higher in onion kept under forced ventilated storage. The total sugar content was higher and the reducing sugar content was less under forced ventilated storage. This revealed that the dry matter degradation was lower under forced ventilated storage. The storage disease at top was higher due to direct effect of atmosphere on the onion. The extent of storage disease was less at bottom and middle layers under forced ventilated storage.

It could be recommended that the onion (Talaja Red) should be stored under the forced air ventilated storage to increase the shelf life of onion, reduce the weight loss as well as infection of black mould and soft rot thereby keeping good quality of onion in terms of pungency and TSS. Moreover, the stored onion could get higher prices thereby giving more profit.

Studies on Post Harvest Practices for Banana Followed In Gujarat (2005)

Student: Paresh R. Davara

Advisor: Dr. N. C. Patel

Abstract

The losses in banana occurred due to the poor post harvest practices followed by the farmers and traders. Great potentialities exist for reducing the post harvest losses and value addition through processing of banana. In view of above, the present investigation was undertaken to assess the post harvest losses and value addition to banana through processing, etc. The farmers and traders of banana growing districts like Anand, Surat, Vadodara, Narmada, Bharuch and Junagadh were selected for the field survey in order to obtain the above details.

The post harvest losses at different stages, i.e., at the field level, at traders level and processors level were estimated. The actual loss at every stage was determined after excluding the weight of peduncle. The effects of various ripening methods followed in Gujarat on the losses were also studied.

The physical properties of banana viz., fruit diameter, effective fruit length,

effective fruit width, fruit curvature, total fruit weight, pulp weight, peel weight, pulp content, peel content, pulp to peel ratio, peel thickness, pulp volume and specific gravity of pulp were determined for unripe and ripe bananas. Also, the biochemical properties viz., moisture content, ash content, TSS content, ascorbic acid content, total sugars content and starch content were determined for unripe banana and ripe bananas of the five varieties grown in Gujarat, i.e., Robusta, Grande Naine, Sona, Mahalaxmi, Shreemanthi.

The study revealed that the overall post harvest loss in banana after harvesting till ripening was found to be 15.43 % which included harvesting, transportation and handling as well as the ripening losses. Most of the ripeners were following ethephon + ice treatment considering its convenience and good appearance of banana after ripening. The processors in Gujarat were engaged in processing of banana only for banana figs and banana chips. Only negligible losses were reported and observed during the processing of banana.

Development of Technology for Production of Peanut Butter from Saurashtra Cultivars (2005)

Student: Navnitkumar K. Dhamsaniya

Advisor: Dr. N. C. Patel

Abstract

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 optimize the important process parameters and develop the appropriate process technology for production of peanut butter from Saurashtra cultivars of peanut.

The production of peanut butter consisted mainly of roasting and grinding with addition of salt and other sweeteners. The roasting was standardized as well as other important parameters involved in the process were critically examined to develop the appropriate process technology for production of peanut butter from Saurashtra

cultivars of peanut. The roasting of peanut kernel at 130 ^{0}C for 60 min yielded the butter of quite superior sensory quality. The skin and hearts of the roasted kernels were removed to obtain the butter of consistent high quality and uniform in colour. Salt was added to incorporate the optimum flavour. The other ingredients added were the sugar and honey for sweetening the butter and stabilizing the fat. The optimum proportion of salt, sugar and honey was found at the rate of 1, 4 and 2 per cent of the final weight of roasted split kernels, respectively.

The sensory and textural measurement as well as the proximate analysis was carried out for the peanut butter prepared, from selected five peanut cultivars of Saurashtra region viz., GG-2, GG-7, GG-20, GG-11 and GG-13, at the optimized conditions following the developed process technology. The peanut butter prepared using the kernels of GG-20 cultivar exhibited better overall acceptability as well as better firmness and spreadability during the textural measurement. Considering all the parameters, GG20 cultivar could be recommended for the production of good quality peanut butter as per the developed process technology. The Spanish bunch type cultivars viz., GG-2 and GG-7 gave the lower ratio of oleic to linoleic acid content i.e. stability index, suggesting their non-suitability for the production of peanut butter.

Studies on Physico-chemical and Rheological changes during Ripening of Custard Apple. (2005)

Student: J. N. Nandasana

Advisor : Prof. D. M. Vyas

Abstract

Custard apple is considered as one of the delicious fruits, contains protein, fiber, minerals, vitamins, energy and little fat. The shelf life of custard is very short and should be consumed within 4-5 days after harvesting maturity. It becomes soft at maturity and sometimes burst at even slightly high maturity. To keep pace with increasing demand, fresh fruit must be handled, graded, stored and processed efficiently with minimum damage. A study was undertaken to find out changes, occurring in various physical, biochemical, and rheological properties along with texture profile analysis during ripening of custard apple.

It was found that all the dimensions were proportionately reduced with days of ripening, where as sphericity was unchanged. The weight loss, fruit density, bulk density and coefficient of friction was decreased during ripening. The lowest

coefficient of friction was observed for cardboard surface. On the day of harvesting the eatable pulp, peel and seed content was 44.64, 47.33 and 8.03 %, respectively. The percent peel content was decreased, whereas per cent pulp and seed content was increased during the period of ripening. The moisture content of pulp was found increasing, while peel's moisture content was decreasing with ripening. The linear equations for all the three dimensions, percent cumulative weight loss, fruit density and bulk density with days of ripening were developed.

The changes in rheological properties of custard apple such as rupture force, deformation, rupture energy, firmness and compliance under compression, puncture and cutting with ripening were determined using Universal Testing Machine and Texture Analyser. The effect of ripening on rupture force, deformation, firmness, rupture energy and compliance under compression was found significant and was decreasing with ripening except compliance. The results obtained under puncture and cutting were more or less in line with those under compression. No specific trend was obtained for firmness and compliance under puncture. The exponential mathematical models were developed to predict the behavior of force, deformation, energy required, firmness and compliance under compression, puncture and cutting with ripening.

Texture profile analysis was performed to find out the changes in different textural parameters, viz; gumminess, springiness, resilience and cohesiveness was during ripening. The gumminess and cohesiveness was found decreasing, where as no specific trend was observed in case of springiness and resilience during the period of ripening.

The starch content was found decreasing, where as TSS, reducing sugar and total sugar was increasing with the days of ripening. The different mathematical models were developed to predict the behavior of these biochemical parameters with ripening.

Studies on Process Development for Banana Flour (2006)

Student: Jigneshkumar B Karkar

Advisor: Dr. A. K. Varshney

Abstract

Banana (Dwarf Cavendish) is as old as mankind and it is one of the most popular fruits. Considering the nutritive value and fruit value of bananas, it could be considered as poor man's apple, and it is the cheapest among all other fruits in the country.

The commercial products prepared from bananas are canned or frozen puree, dried figs, banana powder, banana flour, banana flakes and banana chips (crisp). Among all the products prepared from banana the most widespread and important product is flour preparation from unripe banana. Banana flour is said to be highly digestible and is used in baby and invalid food and can also be used in the preparation of bread and beverages.

Banana flour is prepared from mature green high starch content bananas. The fruit are peeled, sulfite, dehydrated and powdered to free flowing flour.

The experiments were planned by using 3 factor completely randomized design. The 3 and 5 mm slice of unripe banana was treated with three different treatments i.e. control, steaming & blanching, steaming & chemical, and dried at 50 and 60 0C temperatures by supplying hot air at with 1.5 m/s. The physical and bio-chemical analysis was carried out for unripe fruit and prepared unripe banana flour. Drying characteristics and re-hydration ratio was also determined.

The physical properties of unripe banana flour such as diameter, specific gravity and volume were determined and found to be 38.28 mm, 1.02, 133.42 cm^3 respectively. The bio-chemical properties such as soluble solid, total ash content was 5.78 % and 4.88 %, whereas total soluble sugar and starch content in unripe banana fruit was found to be 5.85 % and 31.24 % respectively. The average value of ascorbic acid and free amino acid contain in unripe banana fruit was found to be 86.3 mg/100g, 0.18 % respectively whereas the total phenol was 0.75 %.

Studies on the process development for quality Papain (2006)

Student: Jayeshkumar B. Sojitra

Advisor : Prof. D. M. Vyas

Abstract

Papaya is a very wholesome fruit and is ranked second to mango as a source of the precursor of vitamin A. The importance of this fruit crop lies for the latex present in its young fruits and other parts that contains two proteolytic enzymes, papain and chymopapain. The crystalline form of the proteolytic enzymes that are derived on purification and isolation from the latex is designated as papain. A study was undertaken to find out changes, occurring during storage of raw and pre treated latex at different temperature and packaging material, drying of latex by different drying methods and its storage under different temperatures and packaging materials.

The freshly extracted latex was treated with salt and sulphur and stored at 5 and 15 °C besides room temperature after packing it in aluminum foil, glass container and plastic bag (35 micron) along with untreated latex. It was found that the KMS treatment was more effective as there was 0.18% less reduction in papain activity as compared to salt treated samples. The reduction in papain activity was lowest for the aluminum foil packed samples treated with salt and sulphur and stored at 5 oC temperature.

The freshly extracted latex was dried using hot air oven, fluidized bed dryer, vacuum oven and solar dryer at different drying temperatures. The fluidized bed drying was found to be most effective in reducing the moisture content of latex for first two hours of drying whereas dehydration of papaya latex by vacuum oven drying method preserved the texture of the material and retained its whitish yellow colour. In all drying methods the variation in moisture content and drying rate with time was observed to be curvilinear and the drying was under falling rate. The page model was found to be best fitted for all methods of drying.

The vacuum oven drying at 60 °C drying temperature and 300 mm Hg pressure was found to be best in respect of colour, texture of and papain activity (494.88 TU/mg) followed by fluidized bed drying at 60 °C (482.32 TU/mg) and hot air oven drying at 50 °C (466.69 TU/mg). The papain activity of the samples dried by solar drying method was 399.94 TU/mg, which was about 19% lower than the activity of the sample dried at 60 °C in vacuum oven.

The storage temperature had a negative effect on papain activity during storage. The lowest reduction in papain activity was found in the samples packed in aluminum foils followed by the samples packed in glass containers when the comparison was made among the samples packed in different packaging materials but dried by same drying method with the same drying temperature.

Studies on Osmotic-Air Drying Characteristics of Sapota Slices (2006)

Student: Vikram A. Kshirasagar

Advisor : Prof. D. M. Vyas

Abstract

Sapota is a major fruit crop of our country after mango, but large amount of sapota fruits are lost due to their highly perishable nature and lack of processing techniques. Sapota contains approximately 73.7% moisture content (wb). Removal of

water from product, to make it unavailable for microbial growth is one the important principles used in food processing. Tough and woody texture, loss of juicyness, shrinkage and poor nutritional quality are few common problems of hot air drying. Osmotic dehydration followed by other means of drying removes the water to a safe storage without much deterioration in quality.

The uniformly proper matured sapota fruits were washed, cleaned, peeled and sliced to 4 mm thickness. The slices were pre treated by dipping them in 1% calcium chloride solution for 10 minutes to maintain the firmness. The pre treated slices were then dipped in sugar syrup of 50, 60 and 70° Brix added with 0.1% potassium meta bisulphate and 0.1% citric acid, as preservatives in beakers having syrup to fruit ratio as 1:4, 1:6 and 1:8. The beakers were then placed in temperature controlled water bath at 40, 50, 60 °C and at room temperature for 5 hours. The weight reduction, water loss and sugar gain during the osmotic dehydration were studied. The osmotically dehydrated sapota slices were then dried in a tray dryer at 60 °C drying temperature with 3 m/s air velocity.

It was found that the weight reduction, water loss and sugar gain increased with temperature and concentration of sugar syrup. The weight reductions of sapota slices after 5 hours of osmosis were found to vary in the range of 42.45 to 71.54%. While, the water loss and sugar gain were varying from 45.74 to 77.33 and 3.29 to 5.79%, respectively. The weight reduction, water loss and sugar gain data were statistically analysed and regression equation of third order polynomial was found to best fit for all the experimental data. The subsequent air drying experiments showed that the complete drying of osmotically dehydrated sapota slices was took place in the falling rate period. In general, 6-8 hours of air drying at 60 °C temperature and 3 m/s velocity was required to reduce the moisture to the safe storage limit (5% wb). The diffusion coefficient during the air drying was estimated and found to vary from 8.98 X 10-10 to 1.03 x 10-9 m2/s. The dehydrated sapota slices were apparently found to be in satisfactory condition even after the four months storage. The rehydration ratio and coefficient of restoration on weight after the four months storage was found to vary from 1.96 to 2.14 and 0.17 to 0.21, respectively.

Studies on Storage of Dehydrated Onion and Garlic Powder (2007)

Student: Ajit Shivaji Otari

Advisor: Dr. A. K. Varshney

Abstract

India is the second largest producer of vegetables in the world. Onion (Alluim cepa L.) and garlic (Alluim sativum L.) mainly grown in India. Onion and garlic content several sulphur compounds such as allicin, allistaline, garlicine diallyl disulphide, diallyl trisulphide and allyl propyl disulphide which are effective in reducing harmful blood cholesterol, thus preventing coronary thrombosis, heart attack and stroke. They are also effective against some bacteria. Dehydration is one of the commonly used methods of preserving vegetables. The raw vegetables or freshly harvested vegetables are not having much shelf life because of high moisture content. Therefore dehydration is the process to store the vegetables for longer time. The different packaging materials also affect on the shelf life of dehydrated vegetables. There are chances of moisture migration during storage, which may result in fungal growth and ultimately affect the shelf life of final products. Packaging provides a barrier between the food and the environment. It controls light transmission, the transfer of heat, moisture and gases, and movement of microorganisms or insects.

The experiment was carried out to study the shelf life of dehydrated onion and garlic powder during storage when stored in different packaging materials. Freshly harvested onion and garlic was sorted, graded, washed, sliced and dehydrated at 60 ^{0}C and at 1.4 m / s air velocity in mechanical tray dryer. Dehydrated onion and garlic slices were grind and powder was prepared. Onion and garlic powder were packed in different packaging material viz., Polyethylene bags 50 micron, Vacuum-packed polyethylene bags 50 micron, Aluminum foil laminated bag 20 micron, Plastic jar and Glass bottle for storage study. These packed onion and garlic were stored at room temperature for six month. After every month stored onion and garlic powder was analysed for Biochemical and microbial changes during storage. Organoleptic tests were also carried out.

After six-month storage of onion and garlic powder in different packaging materials, the vacuum-packed materials showed the best results for storage of powder materials.

Preservation of Rose and Gerbera Flowers by Different Drying Methods (2007)

Student: Mahendrasinh T. Kumpavat

Advisor: Prof. D. M. Vyas

Abstract

India with nearly 88,607 hectare of land under flowers is one of the leading floricultural countries in terms of area, followed by China and Japan. Through, Gujarat

contributes almost 10% of area; its share in production of flowers is merely 1.5% of total floriculture production of the country. Fresh flowers, through exquisite in their beauty, but have short life due to their highly perishable nature. The charm of flowers can be maintained and preserve for several years by employing the technology of drying. Dried flowers can be put to many beautiful and varied uses.

The principle behind preservation of flowers by drying is based on quickly reducing moisture content of flowers to a point at which biochemical changes can be minimized or brought to a standstill while maintaining cell structure, petal pigment level and shape of flower. The different flowers required suitable drying method with appropriate drying parameters according to their foliage characteristics. Moreover, the dried flowers should retained their colour, shape, texture and dry matter.

Gerbera (Gerbera jamesonii Bolus ex Hook.F) belongs to the family of Asteraceae, is most commonly used worldwide as a cut flower and occupies fourth position among the top ten cut flowers. While rose (Rosa Sp.) is largely harvested flower in India and are used in various way. Therefore, a study was conducted to determine suitable method for drying for rose and gerbera flowers.

The full boom rose and gerbera flowers, were dried by employing different drying methods such as hot air drying at 40, 50 and 60 ^{0}C, microwave oven drying with silica gel at 50 ^{0}C, vacuum drying at 40 ^{0}C and 760 mm Hg pressure besides solar and shade drying to find out the most suitable method and drying parameters for drying, with a view to change in weight, size, colour and drying characteristics. The experiment was mainly involving the measurement of initial moisture content, size and weight of rose and gerbera flowers and drying of flowers by different drying methods. During and after drying weight loss, reduction in size, bio-chemical analysis for chlorophyll, carotene and xanthophylls content and sensory evaluation was carried out.

The Exponential and Page's model were tested for their validity to rose and gerbera flowers drying. The results were drawn from biochemical analysis, drying behavior, sensory evaluation and statistical analysis.

The maximum and minimum drying time for rose flowers was observed as 5 days and 13 minutes during shade and microwave oven drying respectively. While in case of gerbera flowers the maximum and minimum drying time was found as 5 days and 25 minutes during shade and microwave oven drying respectively. The drying of both the flowers under all the treatments completely took place in the falling rate period. The drying behaviour of both the flowers was predicated reasonably by Exponential and Page's model. Though, from the value of coefficient of variations the Page's model was found to be best fitted.

The maximum over all drying rate for rose and gerbera flowers was found during microwave oven drying with silica gel at 50 ^{0C} which was of the order of 5.8685 and 3.2164 %/min respectively followed by vacuum drying at 40 0C, while minimum overall drying rate for both the flowers was observed during shade drying.

From the reduction in size point of view, microwave oven drying of rose and gerbera flowers at 50 ^{0}C with silica gel was found best amongst all drying methods as it resulted the least percent reduction in size which was of the order of 11.85 and 17.77 % respectively. The sensory analysis revealed that none of the drying treatment was significant in terms of maintaining colour and petal structure of both the flowers.

The overall sensory evaluation of dried rose and gerbera flowers for colour, shape, petal structure and mechanical damage indicated that the microwave oven drying at 50 ^{0}C with silica gel followed by vacuum drying at 40 ^{0}C and 760 mm Hg vacuum performed well as compared to other treatments.

The minimum decrement in all the three colour pigments was observed in the flowers dried in microwave oven at 50 ^{0}C with silica gel followed by vacuum drying at 40 $^{\circ}$C and shade drying.

From the drying characteristics, change in size, sensory analysis and the decrement in colour pigments, microwave oven drying with silica gel at 50 ^{0}C followed by vacuum drying at 40 ^{0C} was found reasonably good method for quality dried produce of rose and gerbera flowers.

Studies on Effect of Blend Ratio on Physical, Textural and Sensory Properties of Pasta (2007)

Student: Kundan Ghanshyam Sarode

Advisor : Prof. D. M. Vyas

Abstract

Extrusion technology has played an increasingly important role in many industries such as food, feed and polymer over the last few decades. It has become an important technique in an increasing variety of food process and has distinct advantage over many of the existing processing system such as versatility in operation, variety of size and shape, high product quality and consistency, high productivity, significant reduction in cost of production and less manual operations.

Pasta products are the most ancient source of food consumed from wheat.

Pasta's versatility, long shelf life, availability in numerous shapes and sizes, high digestibility, good nutrition, and relatively low cost are attractive to the consumer. Defatted groundnut flour (DGF) is a good source of protein. It was utilized to improve the nutritional quality of developed pasta products. The semolina and defatted groundnut flour (DGF) was mixed together in five different ratios and pasta products was developed by using the pasta machine. The products were analyzed for proximate composition, physical properties and functional properties. The sensory evaluation of extruded products was also carried out. Response surface methodology was used to optimize the parameters involved.

The results showed that the nutritional quality such as moisture content, protein content, fat content and crude fiber content were increased with increase in the percentage defatted groundnut flour, whereas the ash content and carbohydrates were decreased as the percentage of defatted groundnut flour decrease.

The physical properties such as specific density, bulk density, porosity and sectional expansion index decreased with the increase in percentage of the DGF and increased as the frying oil temperature increased. The functional properties such as water absorption index, water holding capacity, water solubility index and ph decreased with the percentage of the DGF increased and increased with the frying oil temperature increased. The textural properties such as cutting force and hardness increased with the percentage of the DGF increased and decreased with the frying oil temperature increased.

All the sensory parameters were significantly influenced both by blend ratio and frying oil temperature. The maximum value of overall acceptability was found as 7.06 for blend ratio of 60 % semolina and 40 % DGF at 185 ^{0}C frying oil temperature.

Studies on Convective and Microwave Drying of Grapes (2008)

Student: Ms. Bhavini R. Mandavia

Advisor: Dr. N. C. Patel

Abstract

Grapes are available only 3 -4 months during the year and have limited self life. So, it is necessary to process freshly harvested grapes into value added products. Raisins (dried grapes) are highly acceptable product witnin the country and also have demand at international level. The preservation of grapes by drying is a major industry in many parts of the world, where grapes are grown. During the grapes, either by open

sun drying, shade drying or mechanical drying produces raisins.

Present technique of raisin processing (sun drying and mechanical drying) is time consuming and labour intensive. Also, the operations are done in unhygienic condition. The final product so obtained is of poor quality and do not match with internal standards. It is therefore, necessary to dry the grapes properly to reduce the time and to improve roduct quality, which required a study of different drying methods and pre-treatments for grapes.

Thompson Seedless variety was selected for conducting the experiments during this investigation. The drying experiments were done using the developed laboratory scale thin layer convective dryer and microwave oven to suggest the optimum drying method for getting good quality of raisins. The effect of independent variables namely, pre-treatments like control NaOH & KCO_3 + olive oil and drying methods viz., convective drying, microwave drying and convective + microwave drying were studied on the dependent variables namely drying time (t) , final moisture content (%db), energy consumption and quality of raisins. The parameters like total soluble sugars, reducing sugars, and total soluble solids and sensory attributes viz., colour, texture, taste and overall acceptability were also studied for the quality evaluation.

Drying ime required for treatment of convective drying under control, NaOH & KCO_3 + olive oil pretreatments were 46.5, 8.5, and 20.5 hours respectively, and that for the treatment of microwave drying under control NaOH and KCO_3 + olive oil were .334, 1.67 and 1.5 hours respectively, Further the treatment of convective + microwave drying required were 23.67, 2 and 9.83 hours for control, NaOH and KCO_3 + olive oil respectively,

Based on the analysis, the recommended process technology for raisins included convective + microwave method of drying with NaOH pre-treatment. The suggested process technology required drying time of 2 hours, specific energy consumption of 1.57 kWh/100 g. The raisins obtained had the total soluble sugars, reducing sugars, and total soluble solids wre found higest to the tune of 72.92 %, 70.53 % and 85.25 % respectively. It has also recwived the higest mean score for organolaptic properties i.s. colour (8.08), texture (7.26), taste (8.18) and overall acceptability (808).

Studies on High Vacuum Freeze Drying of Aloe Vera Filets and Its Storage (2010)

Student: Ms Svatiben V. Anadani

Advisor: Prof. D. M. Vyas

Abstract

Aloe vera (Aloe Barbadensis Miller) is a perennial, drought resisting, succulent plant, which has been used for a variety of purposes like, medicinal, preparation of health food drinks and other beverages and cosmetic and toiletry industries for the preparation of creams, lotions, soaps, shampoos and facial cleaners.

The inner gel, a most important part is obtained by cutting away the outer covering and "rind" of the leaf. The phenolic compounds are found to be present in Aloe vera gel, which is responsible for the anti-oxidant effects.

The raw Aloe vera fillets are dried using simple vegetable tray dryer or the liquid maltodextrin treated Aloe juice is converted into powder using spray drying process. But the high heat exposure during these processes changes somewhat some of the potentially beneficial constitutes and makes the product of lower quality.

Freeze drying or lyophilization is the process whereby water is removed from a material under freezing temperature and a high vacuum. The process requires a large amount of energy to obtain the very cold temperatures and high vacuum needed but heat induced changes to other useful constitutes are avoided. Moreover, after rehydration, freeze dried products may have a better taste, texture and appearance, compared with some other drying techniques. Considering this fact a project was undertaken to optimize high vacuum freeze drying temperature for obtaining best quality dried Aloe vera fillets and to study storage behaviour of freeze dried fillets under different packaging materials at room temperature.

The Aloe vera fillets of size 10×10×10 and 10×10×05 mm were freeze dried in Lyophilizer at -25, -35, -45 and -55 °C under vacuum. During freeze drying, the observations on weight loss of the samples were recorded at certain interval and drying behaviuor was determined in terms of moisture removal, drying rate and drying constants.

The structural (Shrinkage Volume, Particle Density), functional (Moisture Content, Rehydration Ratio and Water Holding Capacity) and biochemical (Total Phenol Content) properties of the dried samples were determined after each drying run.

The dried fillets were stored at room temperature in four different packages as HDPE bag (without vacuum), HDPE bag (with vacuum), transparent glass bottle and plastic coated aluminum foil bag. During storage, observations on variation in total

phenol content, weight gain and moisture content were recorded at every 15 days interval for six months.

The experimental observations of drying were fitted to Exponential and Page model. From the coefficient of variations, the Page model was found to be best fitted for all the drying runs. The drying constant 'k' was in the range of about 1.5×10-5 to 3.5×10-5 h-1.

The maximum value of rehydration ratio and water holding capacity found in the samples of 5 mm thickness, processed at -25°C was 24.94 and 23.93 %, respectively. The minimum shrinkage volume and maximum particle density was observed in the fillets dried at -45°C of 5 mm thickness and -45°C of 10 mm thickness which was 1042 cm^3 and 0.0851 mg/cm3 respectively. The values of same properties of the samples prepared by drying at – 25°C of 5 mm thickness was of the order of 1250 cm^3 and 0.0637 mg/cm^3 respectively and were nearly similar to 1042 cm3 and 0.0851 mg/cm^3.

The maximum value of Phenol content (3.53 mg/g) in the dried samples of a Aloe vera was found in the samples of 5 mm thick fillets dried at -25 °C. From the observations on functional, structural and biochemical properties of dried Aloe vera fillets at -25 °C freeze drying temperature with 5 mm thickness found to be the most feasible treatment.

For all the temperatures of drying and thicknesses, the minimum increment in moisture content and reduction in phenol content during storage was found in the fillets packed in HDPE (with vacuum) followed by glass bottle. While the fillets packed in HDPE (without vacuum) were showing maximum increment in moisture content during storage.

From the analysis of observations it was concluded that for effecting drying and quality retention point of view, the Aloe vera fillets should be dried at – 25 °C. Moreover, packing the dried fillets in HDPE (with vacuum) followed by transparent glass bottle was giving minimum variation in Phenol content and moisture gain during six months storage at room temperature.

Study on Hydraulic Pressing of Groundnut Kernel for Maximum Oil Recovery (2010)

Student: Ms. Devayani V. Jadhav

Advisor: Dr. N. C. Patel

Abstract

Groundnut is one of the important oilseeds in India in terms of production and use. Larger percentage of harvested groundnut is used for production of vegetable oil. In India, groundnut oil is mostly used for cooking purpose. Among the different methods of oil expression/extraction from groundnut, the hydraulic press is one of the ways of mechanical expression. The hydraulic press is more useful for small scale processors due to relatively lower initial and operating cost. Moreover, it gives relatively uncontaminated oil and pure cake residue as compared to screw press or solvent extraction method. The present research work was undertaken to study the different process parameters responsible in obtaining better quality groundnut oil efficiently as well as better quality cake through hydraulic pressing. Hydraulic pressing of groundnut kernel was done using UTM and specially designed test cell. Shelled, cleaned groundnut kernels of GG-20 variety were used for the study.

Before final experiments could be taken up, number of preliminary trials were conducted to standardize process of hydraulic pressing in context to the levels of pressing load and sample size of groundnut kernels. Based on preliminary trials and some earlier studies, efforts were made to study the effects of pretreatments viz., roasting and steaming of groundnut kernels on oil recovery and quality of oil. Raw groundnut kernels were considered as control. Control treatment involved two levels of particle size, whole and crushed and two levels of pressing load, 35-45 kN and 45-55 kN. Roasting of groundnut kernels involved two levels of roasting temperature, 110 0C and 130 0C, each with two levels of roasting time, 20 minutes and 25 minutes. Steaming of groundnut kernels involved two levels of steam pressure, 1.0 kg/cm^2 and 1.25 kg/cm^2, each with two levels of time of steaming, 5 minutes and 10 minutes. However, levels of particle size and pressing load were kept same for control, roasted, and steam treated groundnut kernel samples. For hydraulic pressing, sample size of 250 g of pretreated groundnut kernels was used. After placing each 50 g kernels in test cell, a GI plate was placed on it. Each pretreated sample was subjected to two passes of hydraulic pressing. Groundnut oil and cake thus obtained were analyzed for their quality parameters. Entire experimentation was carried out with two replications.

Data obtained from roasted as well as steam treated groundnut kernel samples were analyzed statistically using completely randomized design with four factors. However, the pretreatments to groundnut kernels viz., roasting, steaming and control were compared by 'two independent samples t-test'.

It was found that among control (raw groundnut kernel samples), raw whole sample subjected to pressing load of 45-55 kN yielded maximum oil recovery (76.43 %). Among roasted samples, roasted crushed sample, which was roasted at 110 0C, for 25

minutes, subjected to pressing load of 45-55 kN gave oil recovery of 74.92 percent. However, in case of steaming, whole groundnut kernel sample treated at 1.0 kg/cm^2 pressure, for 5 minutes, subjected to pressing load of 45-55 kN gave the maximum oil recovery to the tune of 53.44 percent.

Considering viscosity of groundnut oil, among control, whole sample subjected to pressing load of 35-45 kN resulted in minimum viscosity (94.0 cP) oil. However, among roasted groundnut kernel samples, whole sample roasted at 130 ^{0}C for 25 minutes, subjected to pressing load of 35-45 kN gave oil with minimum viscosity (92.15 cP). Whereas, among steam treated groundnut kernel samples, steam treated crushed sample which was subjected to 1.0 kg/cm^2 steam for 5 minutes, hydraulically pressed under load 45-55 kN gave oil with minimum viscosity (91.35 cP).

Among raw samples, whole sample subjected to pressing load of 35-45 kN resulted in oil with minimum acid value (1.01 mg/g). However, among roasted groundnut kernel samples, roasted crushed sample, subjected to pressing load of 45-55 kN which was roasted at 130 0C for 25 minutes gave oil with minimum acid value (1.01 mg/g). Among steam treated groundnut kernel samples, steam treated crushed sample, subjected to 1.0 kg/cm^2 steam for 5 minutes, hydraulically pressed under load 35-45 kN gave oil with minimum acid value (0.94 mg/g).

Regarding saponification value of groundnut oil, among control, crushed groundnut kernel sample pressed under load 45-55 kN yielded groundnut oil having minimum saponification value (173.04). However, among roasted groundnut kernel samples, whole sample roasted at 110 ^{0}C for 25 minutes, subjected to pressing load of 35-45 kN resulted in oil with minimum saponification value (176.78). While, among steam treated groundnut kernel samples, crushed sample, subjected to steam pressure of 1.0 kg/cm^2 for 10 minutes, pressed under load 35-45 kN after hydraulic pressing, gave oil having saponification value 165.55.

It was found that groundnut oil obtained from all pretreated groundnut kernel samples contained no traces of moisture content. Moreover, all the pretreatments i.e. control, roasting and steaming produced non-significant effect on refractive index of oil obtained; refractive index ranged from 1.4588 to 1.4612.

Considering cake properties, among control, whole raw groundnut kernel sample, subjected to pressing load of 45-55 kN gave cake with minimum oil content (15.27 %) and maximum protein content (40.70 %). However, among roasted groundnut kernel samples, roasted crushed sample, which was roasted for 130 0C for 20 minutes, subjected to 45-55 kN pressing load gave cake having minimum oil content

(16.83 %). However, roasted crushed sample, roasting temperature being 110 ^{0}C and roasting time 25 minutes, subjected to pressing load of 45-55 kN resulted in cake with minimum protein content (39.39 %).

However, among steam treated groundnut kernel samples, steam treated crushed sample, subjected to pressing load of 45-55 kN and steam treated whole sample, subjected to pressing load of 35-45 kN, both treated by 1.0 kg/cm^2 steam, for 5 minutes gave cake having minimum oil content (31.32%) and maximum protein content (29.97%), respectively after hydraulic pressing.

Based upon the above results, considering the highest oil yield and comparatively good quality of oil obtained, it could be recommended that hydraulic pressing of groundnut kernel should be carried out using raw, whole groundnut kernel subjected to pressing load of 45-55 kN. This could give per cent oil yield of 38.21 percent (76.43 % oil recovery) with acid value 1.21 mg/g and saponification value of 178.65.

Effect of Ethylene Absorbent in Combination with Stage of Maturity and Storage Temperature on Shelf Life of Banana for Export (2010)

Student: Ms. Sonali C. Khanbarad

Advisor: Dr. N. C. Patel & Dr. D. N. Kulkarni

Abstract

Banana is the most important fruit crop in terms of nutritive value, which has large scale demand for table purpose and is available in large quantity throughout the year. India's share in world production of banana is 31.6%. Despite being the world's largest producer, India's export of banana is abysmally low due to non-ideal post harvest practices and transport, lack of storage facilities, out dated banana handling practices, etc. The post harvest period begins from the harvesting of the fruit upto consumption of the fruit. Ethylene gas causes fruits to ripen & decay. Controlling ethylene gas after picking will extend the life cycle of commodity allowing them to be held for a much a longer period of time. For a much lower capital investment, ethylene removal systems based on chemical adsorbent using natural clays coated with potassium permanganate and other materials can be used.

Hence, it is essential to select the appropriate ethylene absorbent and to study its effects on shelf life as well as on physical, biochemical and organoleptic parameters of banana during storage at different stage of maturity and storage temperature.

Therefore, the present study was undertaken at Post Harvest Division, Farm Fresh, Jain Irrigation Systems Ltd, Jalgaon.

Bunches of mature green (Grand Naine) banana fruits (75% and 90% maturity) were harvested from the farms of the Takarkheda and Dhanora of the Jain Irrigation Systems Ltd., Jalgaon. The selected fruits were washed with clean alum water and dried under shade and transported to cold storage. The combine effect of polythene bag with and without ethylene absorbents was tested on shelf life of banana (75% and 90% maturity) stored at T_1 (13 ± 1^0C), T_2 (15 ± 1^0C) and T_3 (17 ± 1^0C) temperature. Banana stored at room temperature with all ethylene absorbent treatments served as control.

It was observed that combinations S_1T_2 (polythene bag + paper strips soaked in $KMnO_4$ stored at 15 ± 1^0C) for parameters weight loss, pulp to peel ratio and phenol content; S_2T_2 (polythene bag + aluminium silicate soaked in $KMnO_4$ stored at 15 ± 1^0C) for parameters respiration rate, total sugar, acidity, starch and sugar acid ratio were found to be best whereas, S_0T_3 (polythene bag without ethylene absorbent stored at 17 ± 1^0C), S_1T_3 (polythene bag + paper strips soaked in $KMnO_4$ stored at 17 ± 1^0C) and S_2T_3 (polythene bag + aluminium silicate soaked in $KMnO_4$ stored at 17 ± 1^0C) were found to be best for parameters total soluble solid, reducing sugar and ascorbic acid respectively, in case of 75% stage of maturity. Also, It was also observed that combinations S_2T_3 (polythene bag + aluminium silicate soaked in $KMnO_4$ stored at 17 ± 1^0C) for parameters weight loss, reducing sugar, acidity, ascorbic acid and sugar acid ratio; S_0T_2 (polythene bag without ethylene absorbent stored at 15 ± 1^0C) for parameters total soluble solid, total sugar and phenol content were found to be best whereas, S_1T_2 (polythene bag + paper strips soaked in KMn_{O4} stored at 15 ± 1^0C) and S_2T_2 (polythene bag + aluminium silicate soaked in $KMnO_4$ stored at 15 ± 1^0C) were found to be best for parameters pulp to peel ratio and respiration rate respectively, in case of 90% stage of maturity.

Colour, taste and overall acceptability were found best for the treatment combination S_2T_2 (polythene bag + aluminium silicate soaked in $KMnO_4$ stored at 15 ± 1^0C) for all days in both the stages of maturity. Texture was found best for the treatment combination S_2T_2 in 75% maturity of banana and S_2T_3 (polythene bag + aluminium silicate soaked in $KMnO_4$ stored at 17 ± 1^0C) in 90% maturity of banana.

From the present investigation, it could be recommended that 'Grand Naine' banana harvested at 75% stage of maturity packed in polythene bag + aluminium silicate soaked in $KMnO_4$ and stored at 15 ± 1^0C and 90 ± 5 RH could extend the shelf life of banana up-to 30 days.

Development of Process for Extraction of Pectin from Mango Peels (2010)

Student: Nilesh D. Chavan

Advisor: Dr. A. K. Varshney & Dr (Mrs) Karuna d. Kulkarni

Abstract

India is the second largest producer of fruits in the world. Mango (Mangifera indica L.) is the most important fruit crop of India and most preferred fruit to be processed into a variety of products. The waste generated from mango industry is in the form of peel, stones and pulper waste. Mango peel which contributes 12-15 percent of total weight of fruit is a very good source of some nutrients such as sugars, pectin, proteins and fibers. The free and plentiful availability of mango peels from\ mango processing units and the ease in their handling could make it a valuable source of raw material for pectin production. Pectin plays a significant and indispensable role in the fruit processing industry. The pectin industry requires standard and best method for extraction of pectin from mango peels.

Experiments were carried out to develop the method for extraction of pectin from mango peels. Mango peels of Totapuri variety were collected from Jain Fruit Processing Plant, Jalgaon, Maharashtra. Water washed mango peels and alcohol insoluble residues of mango peels were prepared and used as a raw material for pectin extraction. Two extractions were carried by 0.25 percent ammonium oxalate, 0.05N HCl and cation exchange resin as an extracting medium. Extraction ratio 1 : 2 was kept constant for extraction by 0.25 percent ammonium oxalate and 0.05N HCl, whereas in case of cation exchange resin it was varied from 1 : 2, 1 : 3 and 1 : 4. The extraction pH 4.6, 1.75 and 2.56 was kept constant for extraction by 0.25 percent ammonium oxalate, 0.05N HCl and cation exchange resin respectively. Extraction was carried out at 80 0C and 100 ^{0}C for 60 min. After each extraction, pectin was precipitated and washed by ethanol, dried and grinded in to 85 mesh size powder. The percent yield of pectin in first extraction, second extraction and total yield in first two extractions was recorded. The prepared pectin powder was used for further biochemical analysis. Cation exchange resin and ethanol used for pectin preparation was recovered. Effect of extracting medium, raw material, extraction temperature and extraction ratio on yield and quality of pectin was analyzed statistically by Completely Randomized Design (CRD) at 0.05 percent level of significance.

The yield, equivalent weight, methoxyl content, molecular weight, relative viscosity, viscosity and jelly grade were found maximum and ash content, alkalinity of ash, anhydrouronic acid and acetyl value were found minimum for pectin extracted

from alcohol insoluble residues of mango peels as compared to water washed mango peels.

The yield of pectin, equivalent weight, methoxyl content, molecular weight, relative viscosity, viscosity and jelly grade shows increasing trend and ash content, alkalinity of ash, anhydrouronic acid and acetyl value shows decreasing trend with increase in extraction temperature and extraction ratio. The CV % was found within the range for all quality parameters.

Centrifugation of extracted solution at 7000 rpm, recovered 82 to 93.50 % of cation exchange resin used in pectin extraction process. On an average 89.27 % of pure ethanol was recovered by simple distillation process.

Standard extraction condition and improved steps for pectin extraction by 0.25 percent ammonium oxalate, 0.05N HCl and cation exchange resin were suggested and cost economy of large scale pectin production by all the three suggested improved method were calculated.

Pectin extraction by cation exchange resin process was found most favorable process as it gives more percent profit on sale and on capital investment i.e. 0.80% and 4.15% respectively than that of pectin extracted by 0.25 percent ammonium oxalate and 0.05N HCl process. Looking to the above profit on scale and profit on capital investment, pectin extraction by cation exchange resin process is recommended for large scale pectin production on industrial level.

Effect of Blanching on Quality and Shelf- Life Of Peanut Kernel (2010)

Student: Sudhir S. Shinde

Advisor: Dr. A. K. Varshney

Abstract

India is one of the leading producers of peanut in the world. Peanut (Arachis hypogaea L.) is an annual legume crop and a major source of oilseed. It is commercially popular due to its superior edible oil quality and protein in the meal. In production of processed peanut products, the blanching of peanut has great importance. But the information on industrial blanching protocols is proprietarily limited. Blanching plays a significant and indispensable role in the peanut processing industry. Experiments were carried out to study the effect of blanching on quality and shelf life of peanut kernels. To achieve these objectives, the raw peanut kernels of GAUG-10 cultivar used for export purpose, were procured from M/s Rachana Seeds Industries, Rajkot Road,

Dolatpara, Junagadh. From the study, it was observed that the blanch-ability is higher for soaking peanut kernels in the water and freeze dried at –50 °C. It was also found that the moisture content is directly proportional to the relative humidity and inversally proportional to the temperature of storage room. The oil content and hardness decreases with increase in moisture content and vice versa. The protein content also increases with decrease in oil content and vice versa. The blanching of peanut kernels by soaking in 0.075 % H_2O_2 for 1 min reduces the aflatoxin content by 91.59 %. The malonaldehyde content was found maximum in the water soaked peanut kernels whereas the aluminum foil with vacuum packaging found stable packaging material for storage of blanched peanut kernels.

It may be conclude that peanut blanched by soaking with 0.075 % H_2O_2 for 1 min at -50 °C temperature and stored in aluminum foil with vacuum packaging was found favorable to maintain the quality and shelf-life of peanut kernel up-to 3 months of storage period.

Processing and Storage of Sugarcane Juice (2011)

Sudent: Mr. Harsh R. Thakar

Advisor: Dr. A. K. Varshney

Abstract

Sugarcane is one of the most important agro-industrial crops as well as one of the most important cash crops in our country. Sugarcane is the primary raw material for all major sweeteners produced in the country and sugarcane juice is a high-energy drink that is natural, sweet and is a healthy alternative to refined sugar added drinks. It quickly replaces lost energy in the most arduous circumstances. The present research work was undertaken for processing and storage of pasteurized sugarcane juice by using different packaging materials and storage temperatures in obtaining better quality sugarcane juice. Sugarcane variety co6304 were selected for preparing sugarcane juice beverage on the basis of yield and sensory attributes for the storage and processing in this study.

In the experiment, juice was pasteurized at 80ºC for 15 min by heating the juice in the steam jacketed SS kettle then after sodium benzoate at the rate of 180 ppm was added as an preservative and lemon juice 0.5 % and ginger 0.1 per cent was also added for better taste. In each 200 ml of juice was filled in taking four different types of packaging materials i. e. glass bottles, PET bottles, HDPE pouch and LDPE pouch and

three different storage temperatures i.e. room temperature 35 ± 2º C, 15± 2º C and refrigerated temperature 5 ± 2ºC. In this experiment biochemical and quality parameters of pasteurized sugarcane juice were analyzed in a Factorial Completely Randomized Design (FCRD) at every 15 days interval for 90 days.

The titrable acidity of pasteurized sugarcane juice in increased significantly at 5 % of significance with the increasing in storage period for packaging materials as well as storage temperatures. The increasing titrable acidity observed lower in the treatment M1T3 i.e. Glass bottle stored at room temperature 5± 2º C and the higher rate of increasing in titrable acidity was observed in the treatment M4T1 i.e. LDPE pouch stored at room temperature 35± 2º C. The lower rate of increasing in colony forming units were detected in the treatment M1T3 i.e. glass bottle stored at refrigerated temperature 5± 2º C up to 30 days of storage period.

The results revealed that total soluble solids, pH and total sugar were decreased significantly at 5% of significance when the increase the storage period initial to 90 days. The rate of decreasing in these biochemical parameters were slower in the treatment M1T3 i.e. glass bottle stored at refrigerated temperature 5± 2º C and higher in the other different packaging materials and storage temperatures up to 90 days of storage period. viscosity of sugarcane juice gives non-significant results, that means the viscosity of sugarcane juice was not changed during the storage study of 90 days. The overall acceptability rating was significantly higher in the treatment M1T3 i.e. glass bottle stored at refrigerated temperature 5± 2º C then other packaging materials and storage temperatures.

From the above biochemical parameters and sensory evaluation results, it may be concluded that the prepared pasteurized sugarcane juice can be stored safely up to 45 days in glass bottle (M1) at refrigerated temperature i.e. 5 ± 2ºC (T3) then other packaging materials and storage temperatures, and practically it can be stored very safely for a period of 30 days with a grace period of 15 days and use as a nutritious packaged pasteurized sugarcane juice drink alternative to other sugar added drinks.

Thin layer Drying Study on Foamed Aonla Pulp (2011)

Student: Ms Bharti P. Budhrani

Advisor: Prof. D. M. Vyas

Abstract

Indian gooseberry (Emblica officinalis Geartn. Syn. Phyllanthus emblica L.)

fruit, commonly known as Aonla or Amla is one of the oldest minor fruits of India.The ascorbic acid content of fresh Amla fruit can range from 500 to 1500 mg per 100 gm of pulp, which is said to be highest among all fruits next only to Barbados cherry. The fresh Aonla fruits are not popular as a table fruit due to their high astringency taste. Its storability after harvesting is also limited due to its high perishable nature. But it has a great potential in processed forms.

Generally, drying rates are comparatively higher in foamed pulps because of increased surface area at the liquid-gas interface thus allowing rapid drying through internal moisture movement within the pulp. The dehydrated powder/flakes are superior to drum dried and spray dried products because of its honeycomb structure and better reconstitution properties.

The Aonla pulp was prepared and foam was produced using two foaming agents i.e. Glycerol monostearate (5, 10 and 15 %) and Egg albumin (5, 10 and 15 %), while methylcellulose (0.5 %) was used as a stabilizing agent throughout the experiment. For getting uniform foam and its proper expansion, the Aonla pulp was whipped with hand blender for 25 minutes for all the treatments and replications were taken. Thereafter, each treatment sample was analyzed for the determination of foaming behavior for all the treatments undertaken in terms of foam expansion, foam stability and foam density

Amongst both the foaming agent (Egg albumin and Glycerol monostearate) at all the concentration taken (5%, 10% and 15 %) and whipping time (5, 10, 15 20 and 25 minutes), Glycerol monostearate with 10 % concentration gives the maximum foam expansion as 142.00 %, after 15 minutes of whipping, maximum foam density (0.42 g/cm3) and maximum foam stability (70.59 %) amongst all the foam characteristics treatments. Hence the further research was carried using Glycerol monostearate with 10 % concentration.

The foamed Aonla pulp was dried in Industrial tray dryer. The drying was carried out in three level of temperature (50, 60 and 70 °C) and three level of thickness (4mm, 6mm and 8 mm). The observations on reduction in weight were taken regularly with increase in time during the experiment. All the drying runs were evaluated in terms of drying characteristics.

The Exponential model and Modified Page's model which are commonly used grain models were tested for their validity to foamed Aonla pulp drying. For all the drying treatments taken the value of drying constants k and n were varying from 0.06 to 0.56 hr-1 and 1.73 to 2.62 respectively. Considering the average drying rate, drying

time, drying constant, fitness of models and cost of drying, foamed Aonla pulp should be dried at 60 °C air temperatures with either 6 or 8 mm thickness of foam.

From the observations on functional properties it was observed that lowest solution time (39.77), maximum solubility (60.00 %) and maximum water holding capacity (355.0 %) was found in the powder produced with 50 ^{0}C and 4 mm thickness, 60 °C with 6 mm thickness and 60 °C with 8 mm thickness. Both the maximum bulk density (0.41 g/ml) and minimum porosity (13.79 %) was found in the samples prepared by drying at 60 ^{0}C temperature with 8 mm and 6 mm foam bed thickness respectively indicating good quality powder. The foam dried Aonla powder obtained from the different treatments was biochemically analyzed in terms of moisture content, pH, ascorbic acid, titratable acidity and ash content.

The foam dried Aonla powder obtained from the different treatments was stored at room temperature in plastic coated aluminum foil bag. During storage different observations in terms of moisture content, ascorbic acid, visual colour change and microbial count were recorded at 15 days interval for 2 months. The samples of powder dried at 50 °C inducing microbial growth even during the short term storage of two months and therefore the drying temperature should be more than 50 °C.

From the analytical and statistical observations it was concluded that for effective drying and quality retention during the foam drying of Aonla pulp, foam of Aonla pulp should be produced by using Glycerol monostearate with 10 % concentration as foaming agent added with methylcellulose (0.5 % concentration) as stabilizing agent followed by 15 minutes whipping and then the produced foam of Aonla pulp should be dried at 60 °C air temperature with 6 or 8 mm bed thickness in tray dryer.

The re-hydration ratio was found to be 1.72 to 2.26 % and coefficient of re-hydration was 0.018 to 0.027. The density data obtained for all the combinations was found to be more or less same and lies between 0.65 to 0.68 g/cm^{3}. The maximum solubility 92.24 % was found for steaming and chemical treatments at 500C temperature and 5 mm slice thickness.

The bio-chemical parameters for banana flour such as total ash and soluble sugar were found to be 3.19 to 3.50 % and 6.29 to 10.82%. The starch and Ascorbic acid was found to be 46.82 to 50.57% and 6.17 to 7.10 mg/100g. Whereas free amino acid and total phenol content was 0.23 to 0.38% and 1.16 to 1.83% respectively. The amount of flour obtained from the various treatments was varying between 157.29 g to 174.83 g. The higher recovery 174.83 g was obtained in steaming and chemical

treatment (0.25 % KMS + 1 % $CaCl_2$) at 50^0 C temperatures and 5 mm banana slice thickness.

Studies on Extraction of Essential Oil from Mandarin Orange Peel (2011)

Student: Priyanka P. Desai

Advisor: Dr. A. K. Varshney

Abstract

India is popularly known as the fruit and vegetable basket of the world and it accounts nearly 10 per cent of the total fruit production of the world. Mandarin orange (Citrus reticulata) is one of the most common among fruits grown in India. It occupies nearly 40 per cent of the total area under citrus cultivation in India. The mandarin oranges are highly valued for their vitamin C content. The mandarin orange fruit comprises of about 25-30 per cent peel, from which essential oil is extracted. Essential oils are extracted from flowers, leaves, stems, roots, seeds, bark, and fruit rinds. The amount of essential oils found in these plants varies from 0.01 percent to 10 percent. These oils are often used for their flavor and their therapeutic or odoriferous properties, in a wide range of products such as foods, medicine, and cosmetics. The common commercial methods to extract the oils from mandarin orange fruits peels are cold pressing by machine and distillation.

Experiment was done to study the extraction of essential oil from mandarin orange peels. The raw peels of mandarin orange (Citrus reticulata) were collected from the local markets of Junagadh. The peels were dried by two different methods viz., shade drying and dry aeration. The dried peels obtained from both the drying methods were ground and distributed in three different particle sizes i.e. 2 mm, 3 mm and 4 mm. Water distillation process was used to extract the essential oil from prepared samples at three different times of extraction i. e. 2 h, 3 h and 4 h and at a fixed temperature of 65˚C. The different physico-chemical properties of essential oil, viz., specific gravity, refractive index, solubility in alcohol, viscosity and colour were determined to evaluate the quality of essential oil. The effect of drying methods (D), particle size (S) and extraction time (T) on yield of essential oil and quality parameters was statistically analyzed by completely randomized design with three factors.

The study revealed that the maximum yield of essential oil (3.94 %) was obtained from d1s2t2 (dry aeration, 3 mm particle size & 3 h extraction time) and d1s2t3 (dry aeration, 3 mm particle size & 4 h extraction time) combinations and these

two combinations were found optimum and best conditions for maximum oil recovery among all the treatment combinations.

The specific gravity, refractive index and relative viscosity of essential oil were measured at 35°C temperature and found to be in the range of 0.8167 to 0.8381, 1.439 to 1.460 and 1.050 to 1.117 respectively. The volume of alcohol required to dissolve 1.0 ml of essential oil was recorded in the range of 7.10 to 9.10 ml. The essential oil extracted from mandarin orange peel was found to be colourless.

Extraction of Oil from Mango Kernel By Hydraulic Pressing (2011)

Student: Parth M. Babaria

Advisor: Dr. A. K. Varshney

Abstract

Mango kernel oil is one of the by-product from the mango fruit and mostly used in cosmetic and soap industry. Hydraulic pressing is one of the ways to extract the oil from mango kernel. The hydraulic pressing is more useful for small scale processors due to relatively lower initial and operating cost. Moreover, it gives uncontaminated oil and pure cake residue as compared to screw press or solvent extraction method. The present research work was undertaken to study the different process parameters responsible in obtaining better quality mango kernels oil efficiently as well as better quality cake through hydraulic pressing. Hydraulic pressing of mango kernel was done using Universal Testing Machine and specially designed test cell. Mango kernels of kesar variety were used for the study.

Before final experiments could be taken up, numbers of preliminary trials were conducted to standardize process of hydraulic pressing in context to the levels of pressing load and sample size of mango kernels. Based on preliminary trials and some earlier studies, efforts were made to study the effects of steaming of mango kernels on oil yield, oil recovery and quality of oil. The study was conducted by taking two levels of steam pressure i. e. 1.0 kg/cm2 and 1.5 kg/cm2, 5 minutes and 10 minutes steaming time, 2 mm, 4 mm and 6 mm particle size and 55-65 kN and 65-75 kN pressing load.

For hydraulic pressing, 500 g of pre-treated mango kernels was used. After placing each 100 g kernels in test cell, a GI plate was placed on it. Mango kernels oil and cake obtained by hydraulic pressing were analyzed for their quality parameters. The data obtained from steam treated mango kernels samples were analyzed statistically using four factor completely randomized design (CRD).

In steaming, it was found that the maximum per cent oil yield and per cent oil recovery from mango kernels was found to be 5.29 % and 44.13 % respectively for the treatment P1T2S1L2 i.e. steam pressure 1.0 kg/cm2, 10 minutes time of steaming, 2 mm particle size and 65–75 kN pressing load with 92.40 cP viscosity, 1.4535 refractive index, 4.74 mg/g acid value/FFA and 184.27 saponification value.

The cake obtained through hydraulic pressing of mango kernels, the minimum oil content 5.34 per cent was obtained from crushed mango kernels steam treated at 1.5 kg/cm2 for 5 minutes for 2 mm particle size subjected to 65 – 75 kN pressing load (P2T1S1L2) and the maximum protein content 11.92 % was obtained from crushed mango kernels steam treated at 1.5 kg/cm2 for 10 minutes for 4 mm particle size subjected to 55 – 65 kN pressing load (P2T2S2L1).

Based on the above study it may be concluded that, considering the oil recovery and good quality of mango kernels oil, it could be recommended that hydraulic pressing of mango kernels oil should be carried out using 2 mm particle size, subjected to 1.0 kg/cm2 steam pressure, 65-75 kN pressing load and 10 minutes steaming time (P1T2S1L2). This may give 5.29 per cent oil yield and 44.13 per cent oil recovery with 92.40 cP viscosity, 1.4535 refractive index, 4.74 mg/g acid value/FFA and 184.27 saponification values. Based on the above study and considering the results of physical properties & biochemical properties of mango kernels oil, it may be recommended that the mango kernels oil may be used for cosmetics and soap industries.

Studies on Osmotic-Air Drying Characteristics of Prickly Pear Fruit Slices (2011)

Student: Himanshu R. Sojaliya

Advisor: Prof. D. M. Vyas

Abstract

Prickly pear fruits crop grown in boundry line on the field of farm or any wasted land in our country, but large amount of prickly pear fruits are lost due to their highly perishable nature and lack of processing techniques. Prickly pear fruit contains approximately 91 % moisture content (wb). Removal of water from product, to make it unavailable for microbial growth is one of the important principles used in food processing. Tough and woody texture, loss of juicyness, shrinkage and poor nutritional quality are few common problems of hot air drying. Osmotic dehydration followed by other means of drying removes the water to a safe storage without much deterioration in quality.

The uniformly proper matured prickly pear fruits were washed, cleaned, peeled and sliced to 4 mm thickness. The slices were pre treated by dipping them in 1 % calcium chloride solution for 10 minutes to maintain the firmness. The pre treated slices were then dipped in sugar syrup of 50, 60 and 70 °Brix added with 0.1 % citric acid, as preservatives in beakers having syrup to fruit ratio as 1:4, 1:6 and 1:8. The beakers were then placed in temperature controlled water bath at 40, 50, 60 °C and at room temperature for 5 hours. The weight reduction, water loss and sugar gain during osmotic dehydration were studied. The osmotically dehydrated prickly pear fruit slices were then dried in a tray dryer at 60 °C drying temperature with 3 m/s air velocity.

It was found that the weight reduction, water loss and sugar gain increased with temperature and concentration of sugar syrup. The weight reduction of prickly pear fruit slices were found to vary in the range of 41.45 to 70.54 % after 5 hours of osmotic dehydration. Similarly, the water loss and sugar gain were also found to vary from 44.74 to 76.33 and 3.29 to 4.89% respectively. The weight reduction, water loss and sugar gain data were statistically analyzed and regression equation of third order polynomial was found to best fit for all the experimental data. The subsequent air drying experiments showed that the complete drying of osmotically dehydrated prickly pear fruit slices was took place in the falling rate period. In general, 5 hours of air drying at 60 °C temperature and 3 m/s velocity was required to reduce the moisture to the safe storage limit (5 % wb).

Process Technology for Preparation of Peanut Milk (2011)

Student: Kushal D. Bhatt

Advisor: Prof. D. M. Vyas

Abstract

The production of vegetable milk, such as soymilk and peanut milk is being vigorously promoted in many developing countries to supplement animal milk and become a cheaper alternative to the latter. Among the foods of vegetable or plant origin, oil seeds including peanut are particularly a rich source of both energy and protein, containing about 50 % oil, 25% protein, 20% carbohydrate in addition to certain vitamin and minerals, as compared to cow's milk protein content as 3.5 %, peanut has protein content of 28.5 %. The quality including biochemical and sensory characteristics of aqueous extracts of peanuts (peanut milk) is greatly influenced by the processing parameters besides the variety of Peanut. Therefore, an experiment was undertaken targeted to standardize the process parameters for preparation of

good quality peanut milk

The experiment was mainly consisted of Selection of peanut variety, preparation of samples, splitting and removal of skin and germ [by roasting and soaking in Sodium Bicarbonate (NaHCO3)], cooking, grinding, extraction of peanut milk, boiling the aqueous solution and analysis of prepared milk's quality in terms of biochemical and sensory of prepared milk.

The varieties with less oil content and have good size and color, besides its availability at local level is considered as suitable for the milk. Accordingly, GG-11 and GG-20 was used in the experiment. For removal of skin and splitting, the peanut kernels were sand roasted by three different temperatures i.e. 100, 120 and 140 oC and for three different time periods i.e. 5, 10 and 15 minutes. For easy skinning besides roasting the kernels were also soaked in Sodium Bicarbonate (NaHCO3) of solution of 0.5 % concentrations % for 5 minutes. For removal of skin and splitting, simply hand rubbing or rubbing with coarsely woven cotton fibrous cloth was carried out. The roasted / soaked split kernels without skin and germ were cooked with three kernel-water ratios 1:5, 1:6 and 1:7 at 100°C. While the cooking time variations for NaHCO3 soaked kernels as well as roasted kernels was considered as 5 and 10 minutes. Thereafter, the kernels along with hot water were crushed in grinder. To decrease the fat content from the milk, it was boiled and allowed to cool at room temperature.

To standardize the parameters, the prepared milk obtained by different treatment parameters was analyzed biochemically (Protein, fat and SNF) and sensory (appearance/colour, taste, aroma, flavor and overall acceptability) and the best treatments were sorted out and thereafter the treatments which satisfied both the attributes (biochemical and sensory) were recommended.

It was observed that GG-11 variety kernels were found more suitable than GG-20 as the milk of GG-11 kernels was containing more protein, fat, SNF and also got better ranking for all the sensory attributes irrespective of treatment parameters. The milk prepared by roasting observed better as the protein, fat, SNF and all the all the sensory attributes were better irrespective to variety and treatment parameters as compared to the milk obtained by soaking in Sodium Bicarbonate (NaHCO3).

To prepare good quality milk by roasting from GG-11 variety peanut kernels, considering biochemical and sensory analysis, it should be prepared by roasting the kernel of GG-11 at 120 ^{0}C for 5 minutes followed by cooking the germless and skinless split kernels with water in the ratio (Kernel : water) of 1:5 at 100 ^{0}C for 10 minutes. The aqueous solution then should be boiled. While to prepare good quality milk by

roasting from GG-20 variety peanut kernels, considering biochemical and sensory analysis, it should be prepared by roasting the kernel of GG20 at 140 ^{0}C for 5 minutes followed by cooking the germless and skinless split kernels with water in the ratio (Kernel : water) of 1:5 at 100 ^{0}C for 10 minutes. The aqueous solution then should be boiled, while preparing good quality milk by roasting from GG-20 variety peanut kernels.

For the preparation of peanut milk by soaking the kernels in Sodium Bicarbonate (NaHCO3) solution from GG11 variety peanut kernels, considering biochemical and sensory analysis, it should be prepared by soaking of GG-11 variety kernels in 0.5 % solution of Sodium Bicarbonate (NaHCO3) for 5 minutes followed by cooking the germless and skinless splitted kernels with water in the ratio (Kernel: water) of 1:5 at 100 ^{0}C for 10 minutes. The aqueous solution then should be boiled. While to prepare good quality milk by soaking the kernels in Sodium Bicarbonate (NaHCO3) solution from GG-20 variety peanut kernels, considering biochemical and sensory analysis, it should be prepared by soaking of GG-20 variety kernels in 0.5 % solution of Sodium Bicarbonate (NaHCO3) for 5 minutes followed by cooking the germless and skinless split kernels with water in the ratio (Kernel: water) of 1:5 at 100 ^{0}C for 10 minutes. The aqueous solution then should be boiled.

Studies on Osmo-Air Drying of Ber Candy (2012)

Student: Ms Nisha G. Kate

Advisor: Dr. A. K. Varshney

Abstract

Ber (Zizyphus mauritiana Lamk) is one of the most ancient fruits of India and ranked third in fruit production. Conventionally, ber fruit is considered as a poor man's apple. Improved processing and packaging technology and storage reduces post-harvest losses and increases the shelf life of processed product. It also reduces the glut in the market and improves socio-economic conditions of farmers, processors and entrepreneurs.

The ber fruits of good quality and well matured, ready for ripening of “Umran” cultivar were procured from a local fruit market of Junagadh for osmotic dehydration. The selected fruits were then cleaned under running tap water to remove impurities and dust from the surface of the ber fruit and then graded manually, de-stoned and sliced into 10 mm thickness. The ber slices were blanched in boiling water at 98 ± 2 ^{0}C

for 2-3 min. After blanching, 500 g ber slices having 10 mm thickness were immersed into a glass jar containing 500 ml of concentrated sucrose syrup having 50, 60 and 70 0Brix with sample to syrup ratio as 1:1 (w/w) and 0.1 % citric acid and (1 % CaCl2) was added in the sucrose syrup to prevent any microbial activity and discoloration of ber slices during dehydration and subsequent storage. The prepared samples were kept at 60 0C temperature in the B.O.D. incubator for different immersion time i.e., 40, 60 and 80 hours respectively without any agitation. After completion of immersion time, the ber slices were removed from the sucrose syrup. The sucrose syrup was drained and the ber slices were rinsed with clean water to remove the syrup adhered on the surface. The osmotic dehydrated ber slices were dried in a single layer in a tray dryer at 60 ± 2 0C drying temperature and 2.5 m/s air velocity. After tray drying packaging of ber candy of each treatment was done in polyethylene polymer (pp) pouches of 50µ thickness with and without vacuum packaging technology and was stored during February-April, 2012 at room temperature (18.2-38.2 0C and 17.2-79.3 % Rh) for a period of 3 months & observations were recorded at an interval of 15 days.

The observations of various characteristics viz., solid gain, and water loss, water loss to solid gain ratio, weight loss and moisture content of ber slices were recorded during osmotic dehydration. The drying characteristics of ber slices were observed during tray drying. The observations on various biochemicals, sensory and microbial characteristics of ber candy were evaluated after osmotic-air dehydration of ber slices, packaging and during storage period of 3 months. The initial moisture content of ber slices reduced from 80.67 % (w.b) to 68.00-59.00 % (w.b) after osmotic dehydration and after osmotic-air dehydration, it reduced from 68.00-59.00 % (w.b) to19.66-18.03 % (d.b). The highest water loss to solid gain ratio of ber slices was found to be 2.70 % for 60 0Brix sucrose solution and 60 h immersion time. The highest ascorbic acid i.e., 21.86 mg/100g and sensory score i.e., 7.9 was found for 60 0Brix sucrose solution, 60 h immersion time and with vacuum packaging. No bacterial and fungal species were present in ber candy prepared with 60 ^{0}Brix sucrose solution, 60 h immersion time and with vacuum packaging technology throughout the storage period of 3 months.

It may be concluded that 60 ^{0}Brix sucrose solution, 60 h immersion time and with vacuum packaging technology showed best quality in terms of osmo-air drying, biochemical, sensory and microbial characteristics of ber candy and could be stored for a period of 3 months without much changes in these parameters.

Studies on Ambient Storage of Lime Juice Concentrate Packed in Sachet (2012)

Student: Ravikumar A. Kachhadia

Advisor: Prof. D. M. Vyas

Abstract

Lime (Citrus aurantifoliaSwingle L.) is one of the important citrus fruits appreciably not only for its beautiful appearance, pleasing and flavour but also for its excellent food qualities. In terms of acreage, it occupies probably the third position among the sub-tropical countries after mango and banana in production of fruits. The origin of lime fruit is India, with around 26.92 Lakh tones of annual production, ranking 1st in the world.

Lime fruits, due to its acidic nature, are not consumed fresh but their juice is diluted to lemonades/sherbets for consumption. Lime is used for seasoning of various culinary preparations, salad and for making pickles. It is also used in alcoholic /non-alcoholic beverages. Lemon, considered as commonly used citrus fruit, if its juice is concentrated and packed in a consumer pack then it makes it more valuable, available throughout the year, easily transportation and better storage. In market and in processing industry, lime juice concentrate has a big role for their different purposes (e.g. RTS). Therefore a project was undertaken to study it the factors which affect the shelf life of lime juice concentrate.

Under the experiment lime juice concentrate with 300, 400 and 500 GPL citric acid concentration was by heating it in thin film evaporator at 60 o C and 610 mm of Hg vacuum for about 1.5 to 3 hours according to concentration levels. Subsequently, potassium meta-bisulphate (0, 50 and 100 ppm) was added as a preservative. Sugar syrup with 50 oBrix, 60 oBrix and 70 0Brix was also added along with 1% salt to enhance the taste. The prepared lime juice concentrate was packed in sachet and stored at room temperature for 3- months.

During storage, the quality parameters of stored lime juice concentrate such as total soluble solids, titrable acidity, total sugar, reducing sugar, non-reducing sugar, ascorbic acid, browning and pH were determine were determined at 15 days interval. Microbial analysis in terms of total plate count and sensory analysis of the samples were also carried out.. These observations were analyzed statistically in Factorial Completely Randomized Design (CRD) at 0.05 % level of significance, taking concentration level as first, preservative level as second and sugar syrup level as third factor.

During the storage period TSS, total sugars, non-reducing sugars in stored lime

juice concentrate was increased with the advancement of storage period but declined towards the end of storage. The acidity, browning increased throughout the storage while pH decreased marginally during the entire storage period. The microbial status and sensory acceptability of the samples was satisfactory for storage period considered and the level was differed according to treatment.

Maximum storability and consumer acceptability were recorded by lime juice concentrate prepared by using concentration level with 500 GPL, preservative level of PMS with 100 ppm and sugar syrup level 70 0Brix. Thus prepared lime juice concentrate, packed in sachet gives better taste, aroma, flavor and could be stored up to 90 days at ambient temperature.

Studies on Effect of Variety, Maturity and Concentration of Tamato Crush During Storage (2012)

Student: Yogesh B. Kalnar

Advisor: Prof. D. M. Vyas

Abstract

Tomato is originated from Peruvian and Mexican region. India is popularly known as the fruit and vegetable basket of the world and it accounts for around 10 per cent of the total fruit production of the world. It also holds a premium position in terms of the production of various kinds of fruits in fresh form. Tomato belongs to a species most frequently referred to as Lycopersicon esculentum Mill, is an herbaceous plant belonging to the Solanaceae or Nightshade family. At least 30-40% of production of fruits and vegetables in country is lost due to wastage.

To achieve the target of feeding the increasing population as well as meeting the requirements of the raw materials for processing industry and export trade, only increasing productivity of crop is not enough. Much attention needs to be given on post-harvest management and value addition of this perishable vegetable crop.

For this experimentation premature, mature and over mature oval shaped and uniform sized tomato fruits were selected and washed in tap water. Crushing of tomatoes was done with motor operated fruit crusher followed by straining of crush with strainer of size 0.6 to 0.8mm. Concentrations of crush according to different treatment were carried out with the help of gas burner. Concentrates were preserved and packed in glass bottles of 200 g capacity fitted with lids. Sterilization of bottles with crush was carried out in water bath canner at 100 $^{\circ}$C for 2 hrs. Bottles were stored at

room temperature (10-39° C) for three months. The stored tomato crush concentrate was subjected to biochemical, sensory and microbial analysis. The total soluble solid of the stored TCC was decreasing with the increase in storage period when stored at room temperature. The maximum loss in TSS was found in US-440 followed by Nunhems and Seminis. The maximum reduction in total sugar was observed in Nunhems followed by Seminis and minimum in US-440. The total sugar content of the stored TCC was decreasing with the increase in storage period. The crush of variety V3, maturity stage (M3) i.e. over mature tomatoes and concentration (C1) i.e. 30 percent of initial volume, containing maximum amount of reducing sugar. The TCC prepared from premature tomatoes (M1) with concentration C1 was having highest value of acidity. Heavy loss in ascorbic acid content occurs during three months of storage period in TCC. Maximum lycopene content (mg/100g) was found in US-440 (V3).

From the microbial loading point of view, the tomato concentrated crush of treatments V1M1C1 (Seminis variety, pre mature, 30 % concentration), V1M2C1 (Seminis variety, mature, 30 % concentration), V3M1C1 (Nunhems variety, pre mature, 30 % concentration) and V3M2C1 (Numhems variety, mature, 30 % concentration) could be stored at room temperature without microbial load for almost 90 days. Considering ascorbic acid content and retention during storage treatment combination V1M3C1 (Seminis variety, over mature, 30 % concentration) is superior among all treatments. Considering lycopene content in tomato crush concentrate variety V1 (Seminis) in combination with M3 (over mature) stage of tomatoes and C1 (30 %) concentration level (i.e. V3M3C1) was better than other combinations

Extraction of Oleoresin from Rotten Onion by Supercritical Co_2 Extraction Method. (2012)

Student: Ms Poonam C. Balani

Advisor: Prof. D. M. Vyas

Abstract

Onion (Allium cepa L.) is a popular horticulture crop valued for its distinct pungent flavour and aroma, grown in many regions of the world. Its pungency is due to a volatile compound known as allyl-propyl disulphide, and is used for various purposes in food and pharmaceutical industry. The present investigation was undertaken to optimize supercritical fluid extraction parameters to obtain superior quality of onion oleoresin from dried rotten onion. The dried rotten onion powder was contained moisture content 5.7 %, ash 7.5 %, protein 9.87 %, carbohydrate 71.38 %, crude fat 1.05

% and crude fiber 4.5 %. The effects of temperature (50, 60, 70, 80 and 90 °C), pressure (150, 225, 300, 375 and 450 bar), dynamic time (30, 60, 90, 120 and 150 min) and particle size (0.4, 0.6, 0.8, 1.0 and 1.2 mm) were evaluated with respect to oleoresin yield, sulphur content and pyruvate content in oleoresin.

The optimization of supercritical fluid extraction was carried out by using central composite rotatable design (CCRD). Optimized condition for SFE of onion oleoresin was found as 80 °C temperature, 400 bar pressure, 0.53 mm particle size and 60 min dynamic time. Oleoresin extracted at optimized SFE condition had yield of 1.012 % oleoresin, 31 g sulphur content per kg of oleoresin and 10.41 µmole pyruvate per g fresh weight of onion. Similar response trend of effects of processing parameters on sulphur and pyruvate content showed that the problem of finding out sulphur content to measure pungency by cumbersome process can be avoided by finding out pyruvate content by simpler process as these are quite similar characteristics to present and compare quality of oleoresin.

Oleoresin of onion obtained by SFE and Solvent Extraction methods were compared. It was observed that SFE provided shorter extraction time, comparatively similar oleoresin yield and higher percentage of sulphur content which represents the useful sulphur containing compounds in onion. The rotten onion, can also be used to get oleoresin - a very useful product, which otherwise goes as waste, without generating any revenue.