



Science

HORTICULTURAL CROPS VALUE ADDITION FOR NUTRITIONAL SECURITY

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Abstract

Nutritional well-being is a sustainable force for health and development of people and maximization of human genetic potential. From the beginning of human history, food has been considered as the major factor in maintaining well-being and health of individuals. Active ingredients in food which are effective in promoting human health include amino acids, fats dietary fiber, antioxidants, pigments, vitamins and minerals which are present in different food groups such as pulses, cereals, legumes, oilseeds, fruits and vegetables.

Among all these food groups, fruits and vegetables play a significant role in human nutrition, especially as a source of vitamins, minerals and dietary fiber. The different fruits and vegetables like carrots, tomatoes potatoes, ginger, green leafy vegetables and the like are important protective foods because of their nutritional value and antioxidant properties. Value addition of such fruits and vegetables by formulation of different value-added products are an important source of nutritional security.

Keywords: Horticultural; Value Addition; Nutritional; Security.

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1. Introduction

Importance of Fruits and Vegetables

Fruits and vegetables, as well as roots and tuber crops are among the best sources of calories, natural vitamins and minerals essential for healthful living. Green leafy vegetables such as amaranth, spinach fenugreek leaves, chenopodium album (*bathua*), mint etc. and roots and tubers such as carrots are rich sources of beta carotene, the most important precursor of vitamin A in human nutrition Beta carotene has an important antioxidant fraction which deactivates oxygen and free radicals and thereby gives protection against cancer. Vitamin A is essential for normal growth and vision, reproduction, maintenance of epithelial cells, immune properties and its deficient intake results in a decreased levels in the blood and low levels in serum, showing sign of vitamin A deficiency.

It has been observed that the current availability of fruits and vegetables meets only about half of the requirement of different vitamins and minerals and hence there is a need to boost the production and handling of vegetables and fruits, to enhance the nutrition of rural and urban poor. Therefore it becomes necessary that the processing of vegetables must be augmented by developing such techniques, which would be not only feasible but also would suffice to produce economic quality products. This makes availability of off season vegetables round the year. In India less than 2 percent of the vegetables of the total production, is being processed as against 70 percent in Brazil and 83 percent in Malaysia. The most common method for preservation of fruits and vegetables is the dehydration method. The vegetables can be dried by hot air drying method for small scale operation or by conventional tray drier or vacuum drier and at home level can be processed by sun drying method. These dehydrated forms of vegetables may be eaten as such or may be consumed in several forms, without affecting its nutrition and palatability.

Vegetable powders such as carrot, tomato and fenugreek leaves powder can be prepared with simple technologies and can be incorporated in traditional food preparations, thereby adding value to the products and attaining food and nutrition security both. On account of poor post harvest management, the losses in farm produce to be of a very high order. Various studies have estimated post production losses in food commodities to the tune of Rs. 75,000-1, 00,000 crore per annum. It is also estimated that the extent of losses could be brought down to less than 50 per cent of the existing level on proper transfer and adoption of agro processing technology.

Among large number of technologies developed, the most popular ones include:

- 1) Agriculture produces refinement equipment such as, cleaners, graders and driers for on-farm operations as well as industrial operations.
- 2) Processes and equipment for parboiling of rice, preparation of puffed rice and flaked rice.
- 3) Development of processes and equipment for processing of pulses to produce dhal for higher recovery and better quality.
- 4) Development of driers using agricultural residues, by-products and solar energy.
- 5) Adoption and development of processes, and equipment for production of protein rich produces such as full fat soy flour, soy drink/ soy milk, soy paneer (TOFU) and soy fortified baked products.
- 6) Development of equipment such as, leaf cup and *dona* making machine, multipurpose mills, mini flour mill, grain pearlers, maize dehuskers, shellers, groundnut decorticators, fruit graders, juice extractors, high recovery mechanical oil expellers and improved storage structures for cereals, pulses, oilseeds, onion and potato.
- 7) Processes and equipment for production of high quality ground spices and spice mix, development of raw materials and processes for production of instant sweets, curries, snack foods, instant soft drinks, *idli*, *dosa*, *sambhar* mixes/powders, egg powder, production and packaging of milk products such as *shrikhand*, butter milk, *paneer*, *ghee* and sweets.
- 8) Equipment for high recovery of sugarcane juice processes for production of high quality jiggery and liquid jaggery.
- 9) Processes, equipment and pilot plants for production of various industrial raw materials from lac including dyes and pharmaceutical products.
- 10) Improved technology for processing of jute sticks to yield jute fibre and impregnation, preparation of jute based textile materials and bags.

- 11) Control of stored grain insects by using chemical and physical methods, storage structures for on-farm, trade, and process plant level operations.
- 12) Processing and canning of meat, meat products and fish.
- 13) Some work has also been done in the area of processing forest produce such as oil extraction from oil bearing materials, collection and processing of resins and production of dyes, chemicals and pharmaceutical products.
- 14) The latest developments have been in the area of floriculture. Due to high export potential, R&D work has been initiated at some centres on pre-cooling, packaging, and transport of cut flowers and low cost designs of green houses. Agro-processing models have also been developed for some of the agro-climatic regions in the Country.

In the area of agro-processing of fruits and vegetables, development of tools and techniques for harvesting, pre-cooling of freshly harvested produce, minimal processing, controlled ripening, juice extraction, concentration and storage has been done. Similarly, in the area of spices & condiments, floriculture, production of mushrooms, honey, eggs and fish, technologies have been developed for post harvest loss reduction and value addition.

Processing of Fruits and Vegetables

Joint effort of R&D institutions, farmers, government agencies and the trade has resulted in India as a emerging major producer of fruits and vegetables in the world.

In the year 2000-2001, the country produced about 45 millions tonnes of fruits and 80 million tonnes of vegetables. It was next to China in production of vegetables and topped in production of fruits. However, the growth in post harvest sector has not kept pace with the production. Even during the year 2000-2001, there were only 6,000 fruits and vegetable units in the country that had grown from a figure of about 1,000 during 1950-51. Less than one per cent of the total produce was processed, though the installed capacity of the processing industry has grown steadily from 0.27 Mt in 1980 to about 3 Mt in 2000-2001.

Significant developments in technology include better understanding of the process of ripening of fruits, optimum harvesting time, pre-cooling of freshly harvested produce, cold storing of the raw fruits and vegetables, sorting, cleaning, waxing, packaging technology for fruits. At CFTRI, DFRL, IIHR, Bangalore; IARI, New Delhi; GBPUA&T, Pantnagar; IIVR, Varanasi and HPKV, Palampur; a number of technologies have been developed. Most significant work has been recorded in the technology for ripening of the fruits under controlled conditions. Production of juices and value-added products including jams, jellies, pickles, canned products etc. has become a commercial success. The industry using indigenous technology includes units engaged in juice extraction, concentration of juices, canning and production of several of the products like jams, jellies, canned fruits, dried vegetables etc. Technology is still being imported for establishment of large scale exported oriented units for production of items like banana paste, concentrates of various fruit juices, sorting, cleaning, washing, waxing and packaging of raw fruits and vegetables. By the year 1998-99, share of different products in the total processed fruits and vegetables was; pulp and juice 27%, jams and jellies 10%, pickles 12%, ready-to-serve beverages 13%, syrups 8%, squashes 4%, tomato products 4%, by canned vegetables 4% and other products 18%. The industry has been facing problems of low capacity utilization, technological obsolescence and marketing. It has to work under the constraints of high fluctuations in raw material quality and fluctuating

market price, poor technology for handling and storage, inadequate R&D support for product development, high cost of energy and uncertainty in availability of adequate quantity for processing purposes, inadequate and expensive cold chain facilities and varying requirement of processing conditions from one material to another. Future R&D has to focus on the issues of economically producing value-added products and product diversification, besides the issues mentioned above.

Role of Processing

Vegetables are classified as green leafy vegetables, roots and tubers and others. Carrots among roots and tubers and fenugreek leaves among green leafy vegetables grown in winter season occupy an important place. These vegetables are rich sources of beta carotene and are generally marketed fresh and consumed as raw or cooked vegetables. Due to the seasonal availability, efforts are made to process the vegetables in large quantity to extend the shelf life and to make them available during rest of the year and in the areas where they are not available. Preservation of vegetables by processing not only involves the inhibition of microbial growth but also preserves their color, texture, flavor and nutritive value. The vegetables can be processed into different forms to extend their shelf life such as powders, grits, flakes, pulp, puree, etc.

The uses of these powders are unlimited and they can be used to prepare processed products as well as for culinary purposes. The processing of the food in the forms which are preferred by the consumer, have long shelf life and involve low cost of production. Studies need to be carried out to optimize the processing and storage of the food products by preventing the heat and oxidative damage on the antioxidants.

Research Studies on Value Addition of Fruits and Vegetables

In the department of Foods and Nutrition, College of Home Science, Pantnagar, various research studies have been conducted on value addition of different fruits and vegetables such as carrots, tomatoes, potatoes, sweet potatoes, ginger, green leafy vegetables, and spices wherein different value added products have been developed from them which are important sources of nutritional security. A systematic approach was followed to develop and standardize the process for the preparation of dehydrated carrot powder, tomato and ginger powder, fenugreek leaf powder, potato flour, potato grits, granules, sweet potato powder etc. appropriate processing at the time of gluts can be profitable to the farmers also as well as make available nutrient to the Indian dietaries thus meeting nutritional security of the population These are being described one by one as given below.

Tomatoes

Tomatoes are one of the most widely used and versatile vegetable crop ranking second in importance to potatoes in many countries. Tomatoes are important both for its large consumption and richness in health related food components. Tomato (*Solanum lycopersicon*) is an herbaceous plant of Solanaceae family which is one of the most popular protective foods because of its lycopene content, outstanding nutritive value, antioxidant properties and a powerhouse of medicinal properties. It is a rich source of minerals like calcium, magnesium, phosphorous, iron, sodium, potassium and vitamins especially A and C. Tomatoes are consumed mainly as a raw staple food, as an ingredient in different types of food products and in the form of processed products such as powder, tomato juice, paste, puree, sauce, etc. This horticultural crop is an excellent source of health promoting compounds being a balanced mixture of minerals and

antioxidant vitamins including vitamin C and E, as well as rich in lycopene, beta carotene, thiamine, riboflavin, niacin, lutein and flavonoids such as quercetin. The main antioxidants in the tomatoes are the carotenoids specially lycopene which have the highest lycopene levels among fruits and vegetables, ascorbic acid and phenolic compounds. In addition to lycopene, violaxanthin, neoxanthin, lutein, zeaxanthin a-cryptoxanthin, b- cryptoxanthin, carotene, neurosporene, phytoene and 5,6- epoxides are other carotenoids commonly cited in tomatoes and tomato derived products. Among the different carotenoids, lycopene, is the most abundant in human serum with important antioxidant activity involved in prevention of several types of cancer and degenerative diseases such as cardiovascular diseases. The production of tomato, an important horticultural crop of India has increased enormously during past few decades which emphasize more on processing and preservation of tomatoes thereby ensuring better availability and utilization during off season. India is the fourth largest producer of tomatoes accounting for 6.6 percent of the world production and second largest in acreage. However due to lack of proper processing, storage and transportation facilities, enormous quantities of tomatoes are lost during the peak harvesting season in India. Being a perishable crop, tomatoes cannot be stored for a longer time hence proper processing and storage in some preserved form during seasons of glut will ensure its availability and utilization during deficiency period. Hence processing of tomatoes in different forms which are preferred by the consumers, having long shelf life and involves low cost of production is required. Processing of fresh tomatoes can be done to prepare the following value added products like.

- Tomato pulp
- Tomato puree
- Tomato paste
- Tomato flakes
- Canned tomatoes
- Tomato ketchup
- Tomato soup and sauce
- Tomato powder
- Dehydrated tomato

Therefore, replacement of fresh tomatoes for example, with tomato powder can facilitate the processing sector with daily cuisines and preparation during off season. Tomato powder can be used in processed products such as soup mixes and confectionary items.

Carrots

Carrot (*Daucus Carota L.*) is another popular root vegetable which is cultivated and consumed throughout the world. It is well known for its nutrient contents viz., carotene and carotenoids, besides appreciable amount of vitamins and minerals such as ascorbic acid, tocopherol etc. Among roots and other vegetables, carrot is the best source of carotene, which is a precursor of vitamin A, an essential nutrient for maintaining health. Carrots possess' nutraceutical properties such as antimutagenic, chemopreventive, photo protective and immuno enhancing aspects. The presence of high concentration of antioxidant carotinoids especially beta-carotene, may account for the biological and medicinal properties of carrots. Carrot is also rich in fiber content and has been reported to be effective for its multifaceted applications which have resulted in development of various processing operation for making different products. Carrots are widely used as an ingredient for making curry, sweet meats and soups. Carrots have been reported to be effective in the elimination of uric acid. Carrots not only prevent vitamin A deficiency but also cancer and

other diet related human diseases. It has greater cytotoxic effect against cancer cells and reduces the enzymes that promote conversion of precarcinogens to carcinogens. It may also enhance the immune system protect against stroke, high blood pressure, osteoporosis, cataract, arthritis, heart disease and urinary tract infections. Processing of carrots would ensure its availability round year and reduction in cost of transportation and storage. During winter season when carrots are available in plenty, different processed products may be prepared and stored in air tight containers which may be incorporated in various recipes. Different processed products of carrots are:

- Carrot juice
- Carrot powder
- Carrot flakes
- Canned carrot
- Carrot candy
- Carrot Halwa
- Carrot grits
- Carrot soup
- Carrot Dalia
- Fabricated baby foods

Carrot powder prepared by dehydrating carrots is often incorporated in traditional food products to enhance the nutritional value and thereby produce value added products such as paratha, porridge and laddu. These processed carrot products are not only nutritionally adequate but also qualitatively sound for an extended period as indicated by the research study.

Spices (Ginger)

Spices have a special significance in various ways in human life because of their specific flavor, aroma, taste and keeping quality. Spices are generally used in a pulverized form as condiments for seasoning or garnishing foods and beverages. These are considered to act as preservative, besides improving texture and flavor of foods.

Ginger (*Zingiber Officinale*) is one of the five most important spices of India, standing next to chilli, garlic and turmeric. Ginger is an underground stem of the zingiberous herbaceous plant. It is cultivated in several parts of the world including India. Though ginger is grown throughout India, Kerala is the highest ginger producing state. In the year 2002, the total ginger production in India was 281.16 million tones, with Kerala and Meghalaya being the highest producing states. Among various spices grown in Uttarakhand, ginger occupies an important place with the production of 27,340 tonnes from an area of 2,250 hectare in year 2006-07. Ginger rhizomes are available for harvesting every 7-9 months after planting and stages of maturity of the rhizome have a significant influence in its quality and processing.

Ginger is commonly used as a food additive and as spice it is used in food preparation to impart its characteristic flavor. It has been attributed with antioxidant properties, proteolytic activity and tenderizing effect. It has been attributed with antioxidant properties which widens its use in preservation of meat and meat products. Ginger has been used to treat numerous types of nausea and vomiting. Ginger's therapeutic properties effectively stimulate circulation of the blood, remove toxins form the body, clean the bowels and kidneys and nourish skin. Other uses for ginger root include the treatment of asthma, bronchitis and other respiratory problems.

Besides therapeutic properties, ginger has been attributed with antioxidant properties, proteolytic activity and tenderizing effect. Ginger widens its use in preservation of meat and meat products, besides being used in fresh form.

Ginger is used in various food preparations to impart its characteristic flavor and is probably the only spice being used in production of beverages like ginger beer, ginger ale and ginger wine.

Although ginger production is very high but due to lack of proper storage and transportation facilities, about 20 percent of fresh ginger crop gets damaged due to respiration and microbial spoilage. Hence it becomes necessary to process the surplus ginger in different preserved forms, which is available throughout the year. The different processed products from ginger include

- Paste
- Candy
- Preserve
- Pickle
- Chocolates
- Beverages
- Powder
- Juice
- Ice cream
- Oleoresin
- Ginger ale

The research study involved development of value added products such as ginger powder, ginger ale, ginger tea.

Fenugreek leaves

Green leafy vegetables are gaining importance, because of being good sources of vitamins, minerals and dietary fiber. Fenugreek (*Trigonella foenum graecum*) is a popular green leafy vegetable available in plenty, at lower cost during winter season. Blanching treatment is used to preserve the color and nutritional value of GLVs. Fenugreek leaf powder obtained by dehydrating fenugreek leaves has been used to prepare paratha and saag in study conducted.

Potato

Potato (*Solanum tuberosum*) is an important and extensively grown horticultural crop in India. Potato is a versatile food, which can be eaten as a staple food, as a complementary vegetable, as a snack item or processed into several forms, and in any of these roles, it enhances the nutritional quality of the diets of people. Among the root crops, potatoes top the list and has the distinction of occupying largest area under any single vegetable in the world. Potatoes are versatile as they can be consumed in various forms as boiled, fried, baked, roasted, steamed and even in several pressed forms such as French fries, chips, papad, flakes, dice, cubes, granules, flour, canned potatoes etc. Potatoes contribute significantly to the nutritive value of a meal as it is not only a rich source of energy, but contain good quality edible grade protein, dietary fiber, several minerals and trace elements, essential vitamins and little or negligible fat. However, besides this added advantage, the principal disadvantage associated with the crop is that is seasonal and the crop produced has a shorter storage life. Hence under such circumstances, the post harvest processing of the bulky,

perishable potatoes into dehydrated potato products helps to extend the storage life and a serve as a means to increase the supply in off-seasons in different forms, in a price effective manner.

With this view in mind the research work was carried out to produce different processed products of potatoes such as

- potato flour
- potato grits
- potato flakes
- potato granules
- potato cubes

The research studies on potatoes involved preparation of different value added food products by incorporating potato flour such as *idli*, biscuit, *sev*, extruded snacks, etc. and thereby increasing the nutritional value of the products also potato cubes were use in preparation of different vegetables

Sweet Potato

Sweet potato (*Ipomoea batatas*) belongs to the morning glory family Convolvaceae. Sweet potato, a commonly grown root vegetable of winter season is valued for its high nutritive value, flavors and digestibility. Sweet potato is widely used in India for food consumption after boiling, baking or frying. However, in other countries, flour of the sweet potato is often used in biscuits, cakes and pudding. The advantage of sweet potato over other vegetables is that it has got the shorter growth period and adverse weather conditions rarely cause a complete crop loss. Sweet potatoes often referred to as “poor people’s food” or “poor men’s crop” has difficulties in marketing and processing. Processing of sweet potato tuber increases their availability and reduces post harvest wastage. The processed products of sweet potato include:

- Sweet potato flour
- Sweet potato granules
- Canned sweet potatoes

Sweet potato flour can be incorporated in wheat flour for bread and biscuit baking, hot cakes, gruel, noodles, candy, puddings and other preparations. It can be mixed with wheat flour for making chapati and bread. This flour functions as a stabilizing agent in ice-creams.

Sweet potatoes are an important source of dietary protein, substantial amount of vitamins (Beta carotene, B complex and vitamin C) minerals, trace elements and high energy value.

Research study involved different value added product formulated from sweet potato like kheer, gulabjamun, chapatti and poori.

Peach fruit is very susceptible to brown rot, or a dark reddish spot. Peaches and nectarines are best stored at temperatures of 0°C (32°F) and high-humidity. They are highly perishable, and typically consumed or canned within two weeks of harvest. Peaches are climacteric fruits and continue to ripen after being picked from the tree. Wonderfully delicious peaches are low in calories (100 g just provide 39 kilocalories) and contain no saturated fats. Nonetheless, they are packed with numerous health promoting compounds, minerals and vitamins. (Source: USDA National Nutrient data base). Fresh peaches are a moderate source of antioxidant, *vitamin C*. Vitamin-C has anti-oxidant effects and is required for connective tissue synthesis in the body. Consumption of foods

rich in vitamin C helps the body develop resistance against infectious agents, and help scavenges harmful free radicals. Fresh fruits are an also moderate source of vitamin A (326 IU per 100 gram) and β -carotene (162 μ g per 100 gram). β -carotene is a pro-vitamin, which converts into vitamin A in the body. Vitamin A is essential for vision. It is also required for maintaining healthy mucus membranes and skin. Consumption of natural fruits rich in vitamin A is known to offer protection from lung and oral cavity cancers. (Source: USDA National Nutrient data base). They are rich in many vital minerals such as potassium (190 mg per 100 gram), and iron (0.25 mg per 100 gram). Iron is required for red blood cell formation. Fluoride is a component of bones and teeth and is essential for prevention of dental caries. Potassium is an important component of cell and body fluids that help regulate heart rate and blood pressure (Source: USDA National Nutrient data base). Peaches contain health promoting flavonoid, poly phenolic antioxidants such as *lutein*, *zea-xanthin* and *β -cryptoxanthin*. These compounds help act as protective scavengers against oxygen-derived free radicals and reactive oxygen species (ROS) that play a role in aging and various disease processes. In view of their perishable nature we processed the pomace of peaches into powder after juice extraction as pomace is rich in several phytonutrients.

Peaches were procured by local market and juice was extracted, thermally processed and bottled as described by Lavelli et al, 2008 and powder from pomace was formed by drying Biscuits (Source: <http://www.tarladalal.com>) prepared by incorporation of peach powder to add phytonutrients to it. Sensory evaluation of control and Peach biscuits was done by using paired comparison test. Out of 30 panelists 29 like the peach pomace biscuits and one like the control one.

Guava (*Psidium guajava* L.) has been used traditionally as a medicinal plant throughout the world for a number of ailments. Guava is generally ovoid or pear shaped and depending on cultivator, their sizes vary from 2.5 to 10 cm in diameter, 6-25 ft in height and weight 50-500g. The flesh may be pink, white or yellow, either with seed or seedless. Guava fruit has a distinct musky flavour, which slightly reduces during processing. There are two most common varieties of guava: the red (*P. guajava* var. *pomifera*) and the white (*P. guajava* var. *pyrifer*). *Guava is considered to be the "apple of poor" due to its low cost, easy availability and high nutritive value.* It bears fruit twice a year but the best quality fruit is obtained in winters. Under subtropical conditions, guava has two crops in a year (summer and winter season crops) and remain available for 8-9 months. In India, the total area under guava cultivation was approximately 219.70 thousand hectares with an estimated annual production of 2,572 lakh tonnes.

Being perishable crop if it could also be processed in to powder during gluts for retaining its goodness by extraction of pulp and preparation of guava powder and used in baked products. Standardization of making guava powder and optimization of biscuits by incorporation of guava powder from two guava varieties, white and red, biscuits was also carried out. Three trials were done to develop the standard recipe of biscuit. With regular practice on biscuits preparation the dimensions (width and weight) were found to be constant. Sensory evaluation of control and guava biscuits was done by using paired comparison test. Guava biscuits of pink variety (Lalit) were liked by the panelists in comparison to control and white variety (Pant Prabhat).

Value addition of spices in form of convenience masala mixes/powders will not only reduce losses but also enhance the income in its peak period of harvesting: India is a very complex country

culturally, geographically and from culinary point of view. Foods of India are better known for its spices. Every dish in India is made in a base known as gravies. It is the mixture of herbs, spices and other thickening agents and commonly used are onion, ginger, garlic, green chilli. The ingredients used are either perishable or semi – perishable in nature. Rising prices upset the budgets. Thus, there is a need for a pre-processed ready-to-use and shelf-stable gravy mix formulation. It will make the preparation of meal easier add variety to diet.

Onion, ginger, garlic and green chilli were procured from local market, washing, grading and cutting of onion, ginger, garlic and green chilli done into slices of 5 mm thickness. Dried by placing in aluminium trays and drying in hot air tray dryer at 60°C. (Till moisture content become 4%) (Yadav *et al.*, 2010) Mixing of onion, ginger, garlic and green chilli in various proportions for formulation of gravy mixes using response surface methodology (RSM). Sensory evaluation of the product and analytical parameters of most acceptable gravy mix powder afterwards done

2. Conclusion

These days a lot of attention is being given on health and nutrition of individuals. Today consumers demand food products, which are nutritious as well as convenient to use. Lot of focus has been given to the food products having some additional health benefits rather than the conventional products. Fruit and vegetable powders contain the natural flavor and health benefits rather than artificial food flavoring substances and they can be used as natural food additives.

References

- [1] Evaluation of potato varieties for product manufacture. Ms Sunita Pant thesis submitted to GBPUAT for M.Sc Foods & Nutrition 1992
- [2] Potato flour production and product formulation. Ms Mamta Singh thesis submitted to GBPUAT for M.Sc Foods & Nutrition 1994
- [3] Carotene contents of common fruits/vegetables and its dietary adequacy among selected sample families. Ms Rachana Khullar, thesis submitted to GBPUAT for M.Sc Foods & Nutrition 1995
- [4] Incorporation of dried β -Carotene rich vegetable powder in formulation of traditional foods. Ms Bharti Joshi, thesis submitted to GBPUAT for M.Sc Foods & Nutrition 1996
- [5] Dehydration of Potato for food uses. Ms Meeta Dhyani, thesis submitted to GBPUAT for M.Sc Foods & Nutrition 1999
- [6] Preparation of sweet potato flour and product formulation. Ms Shikha Chaudhary thesis submitted to GBPUAT for M.Sc Foods & Nutrition 2000
- [7] Quality Characteristic & Utilization of potato flour. Ms Anupma Misra, thesis submitted to GBPUAT for PhD Human Nutrition ,2000.
- [8] Dehydrated Carrot Powder Quality Evaluation and product Formulation Ms Pratibha Singh, thesis submitted to GBPUAT for PhD Human Nutrition 2004
- [9] Chemical composition of ginger (*Zingiber officianale*) and development of value added products. Ms Parul Joshi, thesis submitted to GBPUAT for M.Sc Foods & Nutrition 2006
- [10] Quality characteristics and antioxidant activity of tomato powder and incorporated food products Ms Soma Srivastava, thesis submitted to GBPUAT for PhD Human Nutrition 2000
- [11] Siow, L.F., Hui, Y.W. 2013. Comparison on the antioxidant properties of fresh and convection oven-dried guava (*Psidium guajava* L.). *International Food Research Journal*. 20(2): 639-644.

- [12] Verma, M., Singh, J., Kaur D., Mishra, V. and Rai, G.K. 2015. Effect of various dehydration methods and storage on physicochemical properties of guava powder. *Journal of Food Science*. 52(1): 528-534.
- [13] Kadam, D.M., Kaushik, P. and Kumar, R. 2012. Evaluation of guava products quality. *International journal of Food Science and Nutrition Engineering*. 2(1): 7-11.
- [14] Chetia, J., Upadhyaya, S., Bora, D.K. and Sikia, L.R. 2014. Phenolic content, antioxidant and antimicrobial activity and nutritive value of young Twig of Psidium guajava from Dibrugarh, Assam. *International Journal of Pharmacy and Pharmaceuticals*. 6(2).
- [15] Kanwal, N., Randhawa, M. A. and Iqbal Z. 2016. A review of Production, Losses and Processing Technologies of Guava. *Asian Journal of Agriculture and Food Science*. 4(2).

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