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Processing of fruits and vegetables for its juicing: A Review

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ABSTRACT

Fruits and vegetable are important sources of vitamins, minerals, carbohydrates, phytochemicals and salts required for human nutrition in daily diet.Current food trend toward healthier diets makes fruit and vegetable juices consumption an important natural food alternative and improves the availability of its nutritive compounds.These commodities have higher edible index, which proves its importance for processing. By adopting some of the modern juice processing technologies after harvest, a significant portion at present that was getting spoilt can be salvaged. However, fruit and vegetable juices in its pure form have some typical colour, off-flavour and unpleasant taste due to their chemical compositions.Organoleptic quality of such fruit and vegetable blended juices could be increased by addition of spice extracts having anti-bacterial and anti-fungal properties. The presence of residual endogenous enzymes in fruit and vegetable which may cause quality changeshence required adequate thermal processing.Processing of juices by heat for a sufficient time is highly essential to kill micro-organisms which cause spoilage during storage period.Formulation and blending enables retaining more colour, consistency, fresh flavour and ascorbic acid content of juice products.The present review focuses on the various technical aspects of blanching of fruits and vegetables, formulations,blending, thermal processing and storage characteristicsfor the productionof blended juices, RTSbeverages and health drinks.

Key words : Juice, blanching, formulation, blending, thermal processing, storage

India is the second largest fruits and vegetables producing country in the world next only to China. Production of fruits is estimated about 88.97 million metric tons from an area of 7.21 million hectares at an average yield of 12.33 metric tons per hectare while vegetables is estimated about 162.89 million metric tons from an area of 9.39 million hectares at an average yield of 17.34 metric tons per hectare (National Horticulture Board, 2014). Vegetable and fruits are important sources of vitamins, minerals, carbohydrates, phytochemicals and salts required for human nutrition in daily diet and are available at a cheaper rate. Most fruit and vegetables are seasonal and supply is not uniform through the year. They are still underutilized in spite of being one of the cheapest source of nutrients and potential source of natural antioxidants and hence, steps should be taken to preserve it by extending the shelf -life in fresh form or in the processed form. As India is one of the major producers of these commodities and having higher edible index, which also proves its importance for processing (Sawate *et al.*, 2009). Production of juice is one way to make diversified process product from it to make best use of these commodities.

Current food trend toward healthier diets makes fruit and vegetablejuices consumption an important natural food alternative and improves the availability of its nutritive compounds. Traditionally, the Indian life style has a predilection for fresh fruits and vegetables or those processed at home. There is a sea change. People, are now increasingly going in for fresh fruit vending from kiosk fountains, which produce instant juices from fresh fruits and vegetables in the presence of the consumer. It could be due to the non-availability of hygienically produced and well-preserved products with the use of modern processing technology. The fluid expressed from excessively acid fruits is certainly juice, but the liquid is too sour to consume directly without dilution with sugar and water. The fruit drinks are mainly based on fruits andthey only differ in juice

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or pulp contents. The fruit drinks are mainly based on fruits and they only differ in juice or pulp contents. Many fruit juices are the obvious result of expressing the liquid from the whole or cut fruits. As per food safety and standards act; 2006, juice is the unfermented but fermentable product intended for direct consumption obtained from the edible part of one or more sound fruits or vegetables. It may be clear, turbid or pulpy, may have been concentrated and reconstituted with water suitable for the purpose of maintaining the essential composition and quality factors of the juice and processed by heat, in an appropriate manner, before or after being sealed in a container, so as to prevent spoilage (Nijhawan, 2012).

Fruit and vegetable juice consumption overall has increased in recent years probably due to public perception of juices as a healthy natural source of nutrients (USDA, 2012). Fruit and vegetable juices in the form of blended are also gaining popularity in the market as health drinks. Organoleptic quality of such fruit and vegetable blended juices could be increased by addition of spices extract of ginger, basil and mint, etc. Ginger juice has anti-bacterial and anti-fungal properties (Bhardwaj and Mukherjee, 2011). The ginger juice also acts as a good source of natural preservative (Kalpana *et al*, 2008). Ginger blended juice can improve the storability with minimal physicochemical changes and inhibits the microbial growth owing to its inherent antioxidant and antimicrobial properties (Ghosh *et al.*, 2011).This may be attributed to change in dietary habits, taste preferences, and the way of life of present-day consumers. By adopting some of the modern technologies for processing and preservation of it after harvest, a significant portion at present that was getting spoilt can be salvaged.

Processing

Fruit and vegetable juices have their best test, aroma and colour when they are freshly extracted or expressed. All subsequent efforts to process them adversely affect their quality to varying degrees, depending upon the method of production and preservation process employed. The most important problem therefore is to adopt only such methods as would help to retain their quality to the maximum extent possible.

Effect of blanching as pretreatment

Fruit and vegetable juices in general, in its pure form has some typical colour, off-flavour and unpleasant taste (Silva and Paul, 2004). The most probable enzymes responsible for this are peroxidase (POD) and poliphenoloxidase (PPO) (Calabrese *et al.*, 1999). Peroxidase (POD) is an enzyme conventionally used to monitor and evaluate the heat treatment extent, since it is one of the most heat stable enzymes(Silva and Paul, 2004). Peroxidase (POD) inactivation is usually used to indicate the adequacy of blanching treatments (Burnette, 1977). The presence of residual endogenous enzymes in juice may cause quality changes, such as texture changes and nutritional losses during storage.There is an empirical relationship between residual peroxidase activity and the development of off-flavors and off-odors in foods. Inadequate thermal processing may also result in regeneration of the enzyme.

Determining the quantitative peroxidase enzyme activities was carried in some vegetables and its resistance to heat by Muftugil, (1985) and concluded that the inactivation of peroxidase enzyme wasvery much depends on time and temperature of the blanching media and size of fruits and vegetables. Shivhare *et al.*, (2009) studied the optimization of blanching process for carrots. Investigations were carried out for evaluating the effect of selected blanching treatments on the quality of carrots over a temperature range of 80-100°C. They found that the most effective blanching treatment was 5 min in hot water at 95°C for 10 mm thick slices. At this time–temperature combination, POD and catalase were completely inactivated.To provide preliminary information on suitability of preparation for frozen and ready to use products,Calabrese *et al.*,(1999) studied bottle gourd (*L. siceraria*) fruit. For this 10 mm thick slices of fruits were blanched for 0-240 seconds in boiling water. After blanching, they were cooled in cold water for 5 minutes. POD and PPO activity were evaluated in relation to blanching period. The total enzymatic inactivation of blanched samples (residual peroxidase activity < 1 %) was obtained when blanched for 180 sec. James and Shen (2011) also described the most of the vegetables need to be blanched at a temperature high enough to inactivate the enzyme during the early stage of processing. Gajera *et al.*,(2014) carried out blanching process for the inactivation of the POD enzymein bottle gourd fruits prior to juicing and the best water blanching treatment was found at 100°C for 3.67 min in 5 mm bottle gourd slices based on selected process parameters.In addition to inactivation of enzymes, blanching of the aonla fruits prior to juice extraction significantly improved the juice recovery(Jain and Khurdiya, 2002).Preparing and evaluating bottle gourd fruit RTS beverage by Sawate *et al.*, (2008) concluded that blanching is effective for the extraction of juice.

Minimal blanching for not more than 5 min at 98 °C was also recommended by Amin and Lee, (2005) to prevent the major loss of antioxidant activity of vegetable components.Theabove results were very much similar to result reported by Liao *et al.*, (2007) studding the effect of enzymatic mash treatment of carrot juice concluding an increase of juice yield, TSS and carotenoid in carrot juice (20%, 1% and 26 mg/ kg, respectively).

Effect of formulations

Formulation is an important process enables retaining more color, consistency, fresh flavor, and ascorbic acid content of juice products. Microorganisms, including yeasts, molds and bacteria are sensitive at very low or high values of pH, yeasts and molds can tolerate lower pH conditions than most bacteria (William, 2011).The change in acidity may result in the protonation or de-protonation in juice, which leads to change the structure and functions (Beattie and Pedeeson, 2006; Derossi *et al.*, 2011). This is the mechanisms by which pH reduction allows to prevent the growth of spores, to reduce the heat resistance of microorganisms, and to decrease their growth rate.

Bawa and Bains (1977) developed watermelons juice extracted mechanically from cut fruit had an insipid taste. The possibility of improving taste of juice was studied by increasing the sugar content to about 3% and the acidity factor by 0.2% as citric acid. Similar studies were carried out by Gowda and Jalani, (1995) for juice making from watermelon by addition of salt (1%); sugar (2%), citric acid (0.3%) and ginger extract (0.3%) or spice extracts of cardamom, cinnamon and pepper @ 0.25% each and concluded that the adjustment of TSS and acidity along with ginger extract improved overall acceptability significantly but addition of salt and spices did not improve the overall acceptability of the juice. Grewal and Jain (1982) studied the physicochemical characteristics formulating carrot juice beverages. Fresh carrot juice was standardized as preserved carrot juice and milk based carrot juice beverage. The bitterness of carrot juice could easily be overcome by a common blend of 0.6% salt and 8.0% cane sugar. The preserved carrot juice beverage was quite acceptable at 3.6 pH adjusted by citric acid. A 20% mix of carrot juice with skim milk was easily sterilized at 116°C/30 minutes to yield acceptable quality. Jain and Khurdiya (2004) studied vitamin C enrichment of fruit juice based ready-to-serve beverages through blending with Indian gooseberry (*Emblica officinalis* gaertn.) juice. On the basis of overall sensory quality and vitamin C content, RTS beverage prepared by blending gooseberry juice in 20:80 ratios was found to be the best.Polyphenolrich beverages were prepared using lemon and pomegranate juices in different proportions (at 25%, 50% and 75% for both juices) by Molina *et al.*, (2009) and result suggested that the new drink made of 75% of pomegranate juice and 25% of lemon juice (v:v) has potential for development of new healthy beverages food products, emphasized by its high antioxidant capacity determined by its phenolic composition, anthocyanin and vitamin C and improved colour properties. Molina *et al.*, (2009) studied formulation of a new drink rich in healthy bioactive combining lemon and pomegranate juices. For this, polyphenol-rich beverages were prepared using lemon and pomegranate juices in different proportions (at 25%, 50% and 75% for both juices). The bioactive composition (flavonoids and vitamin C) of the mixtures as well as its stability, antioxidant capacity and changes in colour over a 70 days storage period were studied. The result suggested that the new drink made of 75% of pomegranate juice and 25% of lemon juice (v:v), has potential for development of new healthy beverages or food products, emphasized by its high antioxidant capacity (determined by its phenolic composition, anthocyanins and vitamin C) and improved colour properties.

Effect of blending

Blending of juice is a promising way of utilizing under-utilized vegetables, fruits and spices (Bhardwaj and Pandey, 2011). This may be attributed to change in dietary habits, taste preferences, and the way of life of present-day consumers. During the last few years the demand for fruit and vegetable blended juice has been increasing. Contrary to this, the fruit and vegetable blended juice industry in India is still not in sound footing. Therefore, to improve upon the taste, aroma, palatability, storability and nutritive value of juices, it is convenient to blend it with each otherto prepare natural health drink having adequate shelf-life.

Processing and storage stability of blended ash gourd (*Benincasa hispida*) and mint leaves (*Mentha spicata*) juice was studied by Majumdar *et al.*, (2009). The juice was blended in 75: 25 (ash gourd juice: mint leaves juice). Food grade sugar and lemon juice were added and final pH was adjusted to 4.0 using lemon juice itself. Naik *et al.*, (2009) studied the whey based watermelon beverage prepared by blending watermelon juice (15%), sugar (7%) and different concentrations of betel leaves distillate (0, 1, 2, and 3%) into chhanna

whey (78-75%). The sensory quality of fresh and stored (30 days) beverage containing 2% betel leaves distillate was highly acceptable. Addition of 3% betel leaves extended the storage life of the product.Evaluating the effects of fruit juice blending on kinnow juice preservation at ambient storage condition for improving flavour, nutritive and medicinal value by Bhardwaj and Mukherjee, (2011). For this different fruit juice blends were prepared as (Kinnow juice: Aonla juice: Ginger juice in 100: 0: 0, 95: 5: 0, 92: 5: 3 ratio and Kinnow juice: Pomegranate juice: Ginger juice in 90: 10: 0, 87: 10: 3 ratio) for improving flavour, nutritive and medicinal value. It was observed that the kinnow juice blend with pomegranate and ginger juice in the ratio of 87:10:3 was the most effective and the addition of ginger juice in blends improved the quality and reduced the microbial growth. Juice blends as a way of utilization of under-utilized fruits, vegetables, and spices was reviewed by Bhardwaj and Pandey (2011). Authors concluded that the utilization of highly nutritive fruits and vegetables is limited due to their high acidity, astringency, bitterness, and some other factors. For improving quality of various fruit juices such as aonla, mango, papaya, pineapple, citrus, ber, pear, apple, watermelon, and vegetables including bottle gourd, carrot, beet root, bitter gourd, medicinal plants like aloevera, blending can be effective and useful.

The effect of storage on physicochemical, microbiological and sensory quality of bottle gourd (*L.siceraria*)- basil leaves (*Ocimum sanctum*) juice blend was studied by Majumdar *et al.*, (2011). For this, individual blanching was carried out in boiling water for 2 min and juice was extracted by mechanical juice extractor. Bottle gourd juice, basil leaves juice and lemon juice were selected as independent variables having actual levels ranged from 50 to 75, 25 to 50 and 5 to 10 ml, respectively, while the overall sensory scores and acidity of the product were the responses. Food grade sugar and salt were added to the juice to improve the taste and flavour. The effects of independent variables revealed that bottle gourd and basil leaves juice showed the lowering in acidity of juice blend while lemon juice levels proportionately elevated acidity of the juice blend. The increase in the level of basil leaves had a reduced sensory response. A refreshing beverage from mature coconut water blended with lemon juice was studied by Chauhan *et al.*, (2012). Coconut water obtained from the mature coconuts and blended with lemon juice to develop a refreshing beverage. An optimum condition for the coconut water beverage was obtained at 13.5 °Brix blended with 2 % lemon juice. The mature coconut water beverage blended with lemon juice showed a shelf-life of 6 months in packed conditions at low (5 °C), ambient (25 ± 2 °C) and high (37 °C) temperatures on the basis of physicochemical, microbiological and sensory attributes. Jan *et al.*, (2012) evaluated quality of pineapple juice blend with carrot and orange juice in different ratios. The juices of carrot, pineapple and orange were blended in different ratios of 100:0:0, 80:10:10, 60:10:30, 50:20:30 respectively and sugar and citric acid were added. It was concluded that the pineapple juice: carrot juice: orange juice (60:10:30) was the most effective juice blend for minimum change in TSS (10 to 12 °Brix), acidity (0.97-1.83%), vitamin C (19.50) and beta carotene (1583µg). Sensory evaluation was also higher and better consistency score up to the end of storage. The product was microbiologically safe during 21 days of storage with good acceptability. Results revealed that the formulation of mixed blend juice beverage is possible to satisfy consumer taste and preferences. Kausar *et al.*, (2012) studied the development and storage stability of cucumber (*Cucumis sativus*) - melon(*Cucumis melo*) functional blend drink. These ready-to-use functional drinks were prepared by blending different ratios of cucumber and muskmelon (100:0, 90:10, 80:20, 70:30, and 60:40).The physicochemical parameters and sensory characteristics of blended drinks were evaluated for 4 months at 15 days of storage interval. It was observed that mean values of TSS (15.49-16.09%), acidity (0.41-0.51%) and reducing sugars (1.9-2.48 %) was increased while pH (4.89-4.82) and non-reducing sugars (9.36-8.70 %) was decrease during storage. Regarding sensory attributes, maximum scores (7.51) for overall acceptability was observed in cucumber and muskmelon ratio of 90:10. The study concluded that cucumber-melon pulp functional drink prepared at 90:10 was the most acceptable for minimum changes in TSS, acidity, pH, reducing and non-reducing sugar. Combinatory effect of thermal treatment and blending on the quality of pomegranate juices was studied by Mena *et al.*, (2012). A pure mono varietal juice, a combination of two widely distinct varietal juices (75 % Mollar de Elche + 25 % Wonderful) and a blend of pomegranate juice plus lemon (75 % + 25 %, respectively) were compared. Results displayed how blending can protect the desirable properties of pomegranate juices better than pure mono varietal juices.

Effect of thermal processing

Thermal processing of fruit juice by heat is the most popular method. The method consists essentially in heating the juice to 100 °c or slightly below for a sufficient time to kill micro-organisms, which cause spoilage. Usually, the juices are thermally processed at about 75-100 °c / 05-30 min according to the nature of the juice and the size of container (Bawa and Bains, 1977; GirdhariLal *et al.*, 1986; Gowda and Jalani, 1995; Jainand Khurdiya, 2004; Demir *et al.*, 2007; Li *et al.*, 2009; Jan and Masih, 2012).

Watermelon juice was processed by Bawa and Bains, (1977) heating it in a steam jacketed kettle at 75-80°C for about 5 minutes and hot filled to 650 ml glass bottles for further processing by immersion in boiling water for 50 min had higher shelf-life at room temperature.GirdhariLal *et al.*, (1986) described the most popular preservation method of fruit juices by application of thermal treatment up to 100°C or slightly below for a sufficient time.Further they described that the yeast and acid-tolerant bacteria are readily killed if the juice is heated at about 66°C for a few minutes andmould spores are destroyed at 79°C for 5 -10 min. Therefore, usually the juices are processed at about 85°C for 25-30 min according to the nature of the juices and size of the containers. Beattie and Pedeeson (2006) has also studied celery juice acidified to 0.3% acid and concluded that juice could be processed safely at 100°C, without coagulating and having more pleasing flavor than the non acidified juice. Demir *et al.*, (2007)studied the effect of processing method of carrot juicefilled in bottles and processed at 85°C for 15 minshowed that increasing the acidity of mash with citric acid addition increased the juice yield.

Effect of thermal processing at 91°C for 20 min on quality related attributes of longan juice was studied by Li *et al.*, (2009) concluded that the heat-treated juice had a higher translucency and lower concentrations of pectin, phenolic compounds and proteins, compared with the non heat-treated juice. Result suggests that the thermal processing exhibits a potential for quality maintenance of juice. Similarly, Majumdar *et al.*, (2009) and Majumdar *et al.*, (2011) studied processing of ash gourd (*Benincasa hispida*)-mint leaves (*Mentha spicata*) and bottle gourd- basil leaves juices, respectively pasteurizing in hot water at 95°C for 15 min concluding that there were slight changes of quality with no significance difference at 95% confidence level. Evaluating quality of pineapple juice blended with carrot and orange juice, Jan and Masih, (2012) carried out an experiment by fillingjuice in 400 ml PET bottles and sterilized at 110°C for 10 min followed by pasteurized at 90°C for 25 sconcluded that the product was microbiologically safe up to3 weeks with good acceptability. Mena *et al.*,(2012) studied effect of thermal treatment on the quality of blend pomegranate juices comparing after pasteurization at two different heat treatments concluded the HTST exhibited a higher protective role than LTLT. Gajera and Joshi (2014) carried out thermal processing of blend juice at various time and temperatures along with its pH stability test to optimize the process as per food safety andstandards rules and regulationsand,the best thermal process was found at 85°C hot filled, and processed at 85°C for 5 minin the glass bottles.

Effect of storage on quality

Storage studies are extremely important to check the quality and shelf- life of thermally processed juice or its products. Physicochemical and microbiological quality of such products should be stable as possible as during designated storage conditions.

Bawa and Bains (1977) processed water melon juice and stored at room temperature (35-38°C) found that the untreated juice bottles exhibited microbial fermentation within a week while, heat processed bottles had higher shelf-life. Studied an effect of storage on quality of stone apple ready-to-serve beverage by Kalpana *et al.*, (2008) found all the biochemical qualities changed with storage period irrespective of the treatments. Li *et al.*, (2009) studied changes in quality attributes of longan juice during storage concluded that the thermal processing maintained higher concentrations of total soluble solids and total acidity but a lower ascorbic acid concentration. Majumdar *et al.*, (2009) studied storage stability of blended ash gourd juicefound slight changes of pH, TSS and total acidity (as citric acid) of the juice during storage up to 6 months. Bhardwaj and Mukherjee (2011) evaluated kinnow based blended juice preservation at ambient storage conditionfor 6 months observed that the addition of ginger juice in blends improved the quality and reduced the microbiological growth. Jan and Masih (2012) stored pineapple juice blend with carrot and orange juicefor 21 days concluded that the pineapple juice: carrot juice: orange juice (60:10:30) was most effective juice blend for minimum change in TSS (10 to 12°Brix), acidity (0.97-1.83%), vitamin C (19.50) and beta carotene (1583µg). Studied the development and storage stability for 4 months of cucumber (*Cucumis sativus*)-melon(*Cucumis melo*) functional drink by Kausar

et al., (2012) observed that the mean values of TSS (15.49-16.09%), acidity (0.41-0.51%) and reducing sugars (1.9-2.48%) was increased while pH (4.89-4.82) and non-reducing sugars (9.36-8.70%) was decreased during storage. Similarly, Gajera and Joshi, (2015) studied the quality evaluation of bottle gourd (*L.Siceraria*) based blend juice during ambient storage conditionfound that the no significant difference (P>0.05) was inpH, total soluble solids, total acidityand most sensory attributes of the product during initial 30 days of storage. However, significant difference (P<0.05) was observed in ascorbic acid content, sugars and microbiological counts during further storage and theproductwas microbiologically safe up to 180 days storage.

CONCLUSION

Fruits and vegetables are available at relatively cheaper rate during glut season. Considerable portions of the produce are lost due to lack of processing at this time. To utilize the surplus production and avoid post-harvest losses, fruits and vegetables may be suitably processed into processed productslike juices, RTS beverages and health drinks which will containsfairamount of vitamin C (ascorbic acid), carbohydrate and minerals. Juice in its pure form has browning colour, off-flavour and unpleasant taste.To overcome this problem, blanching is an important unit operation and is necessary for inhibition of enzymes action prior to processing of fruits and vegetables.The proper formulation and blending ofthe juice productsare highly required for the market acceptance in terms of sensory attributes and the physicochemical parameters to meet the criteria of food safety and standard regulations, 2006. To preserve the quality and shelf- life of juice products along with maximizethe retention of ascorbic acid and to minimize the microbiological counts,thermal processing at various time and temperatures areutmost important.To check stability of the thermally processed juice products,storage study at different conditions exhibit an important role tohave an adequate self-life and good acceptability as it satisfies the sensory, physicochemical and required microbiological criteria.

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