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Shweta Saloni
M. Tech Food Technology &
Management, NIFTEM,
Haryana, India

Sindhu
M. Tech Food Technology &
Management, NIFTEM,
Haryana, India

Dr. Komal Chauhan
Assistant Professor, Dept. of
Food Science & Technology,
NIFTEM, Haryana, India

Soumitra Tiwari
Assistant Professor, Dept. of
Food processing & technology,
Bilaspur university, Bilaspur,
Chhattisgarh, India

Correspondence
Shweta Saloni
M. Tech Food Technology &
Management, NIFTEM,
Haryana, India

Pineapple production and processing in north eastern India

Shweta Saloni, Sindhu, Dr. Komal Chauhan and Soumitra Tiwari

Abstract

Pineapple is one of the most important tropical fruit grown in the north – eastern part of India. India is the fifth largest producer of pineapple with annual output of about 1.2 millions. The ministry of commerce and industry has recently sanctioned the Agri-export zone scheme for the entire NER at Tripura. Under this scheme, enhanced international market access would be provided to farmers besides necessary infrastructure, flow of credit, transport assistance and other facilities for promoting agricultural export through pineapple cultivation. In spite of having numerous developments in the field of food processing most of the fruits grown is not getting processed which leads to post harvest losses. Ultimately this leads to less revenue for farmers in turn of their investment. So, there is a need to make cultivators aware of recent developments in the field of pineapple processing and related value added products. The full potential of pineapple cultivation in the region is yet to be tapped and for this, efforts are being put in various organization and the government both at central and state level, to help the growers in marketing their produce, which is considered to be the key factor for boosting this industry.

Keywords: Pineapple, commerce and industry, infrastructure.

Introduction

Pineapple and its origin

Pineapple (*Ananas comosus*) belongs to the family of Bromeliaceae; is a tropical fruit with edible multiple fruit consisting of coalesced berries. It is common name for the member of Bromeliaceae, a family of chiefly epiphytic herbs and small shrubs. Some varieties of *Ananas* yields a very hard fibre from spiny leaves known as Gravata in South America used in the manufacturing of clothes. The fruit whose spiny skin is yellowish brown when ripe is sweet and juicy; it is topped by distinctive rosette of green leaves. It is grown throughout in the warmer regions. Pineapple is one of the important commercial fruit crops of India. The total annual world production of pineapple was 25439366 tonnes during the year 2014 (FAO stat). India is the fifth largest producer of pineapple with annual output of about 1.2 millions. During the year 2014-15 the area and production was 116000Ha and 1984000MT while for the year 2015-16 the estimated production is 1964000MT in 110000Ha area (NHB, India).

Other leading producers are Thailand, Philippines, Brazil, China, Nigeria, Mexico, Indonesia, Columbia, and USA. Pineapple is said to be native to South America particularly in Brazil and Paraguay. Pineapple is also known as Piña, Nanas and Ananas. It was Christopher Columbus who first introduced the fruit into Europe. A very little information is there about its origin; it is believed that the fruit is local to South America and originated in some places between Southern Brazil and Paraguay. Further the fruit was spread to entire South America, Caribbean, central America & Mexico by the natives of southern Brazil & Paraguay where it was grown by Mayas and the Aztecs. Jhon Kidwell is credited with the introduction of the pineapple industry in Hawaii. Large-scale pineapple cultivation by U.S. companies began in early 1990s on Hawaii. James Dole was believed to be one of the famous pineapple industrialists who moved to Hawaii in 1899 and started a pineapple plantation in 1990. Dole's pineapple company began with acquisition of 60 Acres (24 ha) of land in 1901, and previously mentioned, has grown into major company today. The pineapple cultivation by Maui Pineapple Company began in the year 1909 on the island of Maui. Del Monte in the year 2006, announced its withdrawal from pineapple cultivation in Hawaii, thus only Dole and Maui Pineapple Company was left in Hawaii as the USA's largest growers of pineapples. The Maui Gold brand is marketed by Maui Pineapple Company whereas Hawaii Gold brand is marketed by Dole. During the year 1986, the assets of pineapple research institute in USA in 1986, the pineapple research institute, USA were allocated between Del Monte and Maui. Del Monte received the variety 73-114, which it dubbed from MD-2, and further carried out plantations in Costa Rica and found it to be well suited to be growing there; then in the year 1996 it was publicly launched. In 1997, Del Monte began marketing its gold extra sweet pineapple,

which was known internally as MD-2. MD-2; which is a hybrid variety was developed in the breeding program of the of the now-defunct pineapple research institute in Hawaii, which conducted research on the behalf of Del Monte, Maui land and Pineapple Company and dole.

Structure of Pineapple

The stem of pineapple is a stick with a wider upper portion and narrower and usually curved lower part. Top of the fruit is covered with Phylotaxia leaves; below this there is a zone of dry leaves and curved section underground from which many roots protrude. The main stem of the plant extend to the flower butt; whereas in central axis the flower buds and forms a single mass that that reach to the apex of a crown of leaves in few pineapple varieties and other wild Ananas the flower butt is well developed; in contrast the butt of commercial clones are short and covered leaves (Medina *et al*, 2005). The main stem of pineapple gives rise to side sprouts which have different names. The sprouts initially emerge at the base of stem having long & narrow leaves, are shorter near bottom; these helps in vegetative propagation. Another category of shorter sprouts arise from stem spuds also helps in vegetative propagation. A third type emerges from butt underneath the fruit; this type has shorter and compact leaves resembling a small pineapple fruit. These sprout have curved base as they originated from horizontal spuds and then have grown vertically. In wild species and plants derived from vegetative propagation these basal side sprouts functions, since once the flowers and end fruit have dried out and disappeared, side stems developed, finally then the fruits and new sides originates; because of this pineapple is considered as a perennial plant (Collins, 1949). There are a few ways of propagating the pineapple plant: from seeds to using the suckers of the mother plants have already borne fruit. But the common and easiest way is to grow the plant from the crowns or tops of the other pineapple.

Agro-climatic conditions

Pineapple is grown mostly in the humid tropical region. The optimum temperature required for successful cultivation is 22°-32°C. High temperature at night is deleterious for the growth plant and a difference of at least 4°C between day and night temperature is desirable. It can be grown up to 1000m. Above sea level if the area is frost free. The rainfall require for pineapple cultivation ranges from 100-150cm. sandy loam soils with pH ranging from 5.0-6.0 are ideal for the growth of the plants.

Significance of the pineapple processing industry

Pineapple is produced in bulk in several parts of the country especially in north-east india. Usually the pineapples are sold and consumed in raw form only a few companies like pineapple India, Dabur, Kissan, Delmonte Ltd, utilize the pineapple for processing and manufacturing products like jam, squash, jelly, juices etc. Food processing in general is useful in extending shelf life of food products and so it helps in prevention of wastage. The given table no. -1 gives an insight on the longevity of raw pineapples.

The shelf life of processed pineapple products is at least two-three months and also the fresh pineapples that would deteriorate due to unsuitable post-harvest condition are utilized before hand.

1. The cost of 1 kg of pineapple processed pineapple products is more than a 1 kg of raw pineapple thus it is a value addition process.

2. Setting up of a processing industry provides employment to the people living in and around the area.
3. Fortification of plain pineapple extract or pulp may be done to manufacture processed products that enhance the health benefits it provides to consumers.

Nutritional Composition

The fruit is a pack of balanced nutrients comprising of vitamins, minerals, fiber and enzymes that aids in the process of digestion. Pineapples are a good source of Vitamin C and can be eaten raw or used in cooking. Pineapple has minimal fat and sodium with no-cholesterol. The table no. - 2 & 3 present the chemical composition and nutritional value of pineapple.

Major Pineapple producing countries in the World

The statistics obtained from FAO gives details of the major pineapple producing countries in the world from 1994-2014; Thailand and Brazil were highest producers of pineapples with 21,70,029 and 2115901.81 MT respectively.

Pineapple Producing States in India

The statistics obtained from FAO website and Indian horticulture database 2013-14, shown in table - 4 gives details of the major pineapple producing states in the India. During the period of 2012-13, the state with highest production was west Bengal and that with the highest productivity was noted in Karnataka.

Agri-Export zone for pineapple in north east India

The ministry of commerce and industry has recently sanctioned the Agri-export zone scheme for the entire NER at Tripura. under this scheme, enhanced international market access would be provided to farmers besides necessary infrastructure, flow of credit, transport assistance and other facilities for promoting agricultural export through pineapple cultivation.

Agri-Export zone for pineapple in West Bengal

In view of the international demand for processed pineapple products and also on account of the concentration of pineapple growing in the district of Siliguri and Jalpaiguri of West Bengal, A proposal was given for setting up an Agri-export zone in west Bengal. This project entails development of the produce through research and extension by dedicated team of personnel, setting up of processing plants by private entrepreneurs and concerted market efforts. as per the proposed project Crores is envisaged, out of which rs.31.44 Crores will come from private entrepreneurs for setting up of processing plants. The remaining amounts will come from various government agencies like ministry of food processing industry, national horticulture board, ministry of agriculture and APEDA. This Investment Is anticipated to lead to projected exports of around Rs.127 crores in the next 5 years.

Pineapple varieties

World-wide varieties

There are four important varieties of pineapple available worldwide: Smooth Cayenne, Red Spanish, Queen, and Abacaxi.

Smooth Cayenne also known as Cayenne was selected and cultivated by Indians in Venezuela long ago; from there it reached the Royal Botanical Gardens, Kew, England, where it was improved and distributed to Jamaica and Queensland, Australia.

Hilo is considered to be the variant of 'Smooth Cayenne' taken from Hawaii in 1960. This plant is very compact, fruit size is smaller, more cylindrical in shape and produces large number of suckers.

St. Michael, is another strain of 'Smooth Cayenne' and is considered to be the famous product of the Azores. The fruit weighs 5 to 6 lbs (2.25-2.75 kg), crown size is small, has a small core, it is sweet in taste and has low acidity, and is regarded to be insipid when fully ripe.

Giant Kew, is a common variety in India, has a large fruit size near to 6 lbs (2.75 kg) going to a maximum of 10 lbs (4.5 kg) and is occasionally up to 22 lbs (10 kg). The core size is large and its extraction results in a large hole in canned slices.

Charlotte Rothschild, second to 'Giant Kew' in size in India, tapers toward the crown, is orange-yellow when ripe, aromatic, very juicy. The crop comes in early. 'Baron Rothschild', a Cayenne strain, grown in Guinea, has a smaller fruit 1 3/4 to 5 lbs (0.8-2 kg) in weight, marketed fresh.

Perolera (also called as Tachirense, Capachera, Motilona, and Lebrija) is a Smooth Cayenne variant ranking next to Red Spanish in Venezuela. It has long been cultivated in Colombia. The plant has no spine at the leaf tip and is entirely smooth. The fruit is yellow in colour, large in size i.e. 7 to 9 lbs (3-4 kg) and cylindrical in shape.

Bumanguesa, cultivated in Venezuela and Colombia, is probably a mutant of Perolera. The fruit is red or purple from external, cylindrical in shape with square ends, shallow eyes, deep-yellow flesh, very slender core and has slips around the crown and has large number of basal slips to suit modern commercial requirements.

Red Spanish is the most popular variety in West Indies, Venezuela and Mexico. It contributes to 85% of all commercial planting in Puerto Rico and 75% of the production for the fresh fruit market. It is good for canning. The fruit is close to round in shape, orange-red from externally, have deep eyes, and ranges from 3 to 6 lbs (1.36-2.7 kg). The flesh of the fruit is pale-yellow, fibrous, with a large core, and has aromatic flavour. The fruit becomes hard at maturity, breaks off easily during harvesting.

Valera (Negrita or Andina) is an old cultivar originated in Puerto Rico; it is mostly grown in the States of Lara, Merida and Trujillo in Venezuela. The plant ranges from small to medium with long, narrow spiny, purple green leaves. The fruit is conical to cylindrical, weighing 3 1/2 to 5 1/2 lbs (1.5-2.5 kg); is purple from outside with white flesh.

Valera Amarilla is a Red Spanish strain cultivated in the States of Lara and Trujillo in Venezuela. The fruit is broad cylindrical in shape and tall with a large crown size; weighs 4 1/2 to 9 lbs (2-4 kg); is yellow externally with very deep eyes, about 72 to 88 in number. The flesh is pale-yellow in colour and very sweet in flavor.

Valera Roja grown in the states of Lara, Trujillo and Merida of Venezuela, has small-to-medium plant with cylindrical fruit weighs 1 1/2 to 2.2 lbs (0.6-1 kg), reddish externally, with 100 eyes. It has a pale-yellow flesh.

Abacaxi is well known variety in Brazil, the Bahamas and Florida. The plant is generally spiny and disease-resistant. Leaves are bluish-green with red-purple tinge in the bud. The fruit weighs 2.2 to 11 lbs (1-5 kg), is tall and straight-sided; sunburns even when erect. The flesh of the fruit is white or very pale yellowish, with sweet flavour, succulent and juicy. This has been rated as the most delicious pineapple.

Sugarloaf is similar to 'Abacaxi', and is mostly cultivated in Central and South America, Puerto Rico, Cuba and the Philippines. Since the leaves of the plants and crowns get

pulled out easily and this fact gave rise to an unreliable theory that ripeness of pineapple is indicated by the looseness of the leaves. This fruit is almost conical in shape; round mostly colourless and weighs 1 1/2 to 3 lbs (0.68-1.36 kg). Flesh is white to yellow, very sweet, juicy. This cultivar is not suitable for shipping due to its tenderness.

Brecheche, grown at a smaller extent in southern Venezuela, is a small fruit with small spineless crown. Average weight of fruit is 1 1/2 to 2.2 lbs (0.7-1 kg). The fruit is yellow externally. Flesh is yellow, with little fibre, small core and is very juicy.

Caicara, grown at a smaller extent in the State of Bolivar, Venezuela; it is a large fruit weighing 4 to 5 1/2 lbs (1.8-2.5 kg). It has a large, spiny crown. It is cylindrical conical in shape with deep eyes; yellow externally with white flesh inside, with slight fibre content, very juicy, with large core size.

Mauritius is one of the important varieties found in India and Ceylon. The leaves are dark green with broad red central stripe and red spines on the margins. The fruit is small, 3 to 5 lbs (1.36-2.25 kg), yellow externally; has a thin core and very sweet flesh. It is sold fresh and utilized for juice.

Singapore Red ranks second to 'Mauritius' in popularity wise. The leaves are usually green but sometimes have a reddish stripe near the margins; they are rarely spiny except sometimes at the tip. The fruits are cylindrical in shape, reddish in colour, with deep eyes, small in size - 3 1/2 to 5 lbs (1.6-2.25 kg)—with slender core, fibrous, golden-yellow flesh; insipid raw but valued for canning process. The plant is generally disease and pest-resistant.

Queen also known as Common Rough in Australia is one of the leading cultivar of South Africa, Queensland and the Philippines. The plant is very compact and dwarf, more cold and disease-resistant than Smooth Cayenne variety. The fruit matures early but yield is low. The fruit weighs 1 to 2 1/2 lbs (0.45-1.13 kg); conical in shape, deep-yellow from outside, has deep eyes; is less fibrous compared to Smooth Cayenne, it is juicy with fine flavor and has a small, tender core. It is sold fresh and keeps well at room temperature. It is suitable for canning.

Natal Queen is grown in South Africa and El Salvador, produces many suckers. The fruit weighs 1 1/2 to 2 lbs (0.75-0.9 kg).

MacGregor is a variant of Nasal Queen selected from South Africa and grown in Queensland, it is a plant with broad leaves and large suckers produced. The fruit is cylindrical in shape, medium to large, with firm flesh and flavour resembles 'Queen' variety.

James Queen is a mutant of Nasal Queen that originated in South Africa. It has large fruit size with square shoulders.

Pineapple cultivar in India

The important varieties of pineapple cultivated in different states of India are –

Kew, Queen, Mauritius - Assam & other N.E. states
Mauritius, Kew, Queen - Kerala
Giant Kew, Queen – West Bengal

Pineapple cultivation in north east India

The north-eastern part of India has a total geographical area of 2.62 million km², consists of eight states having optimum condition for pineapple cultivation. The region has fertile and organically rich soils, ample rainfall, water resources and great climatic diversity supporting diverse cropping possibilities. The government of India has identified the

potential of the North East region for horticultural crops and started a project 'Horticulture Technology Mission' in the year 2001. This resulted in 140.7% increase in the area and production of pineapple. This part of India yields approximately more than 40% of country's total pineapple production out of which 90-95% is organic in nature. The common cultivars grown are 'Giant Kew' and 'Queen'. Pineapples produced from this region are qualitatively different and are said to be among the "Best in the world as they are very sweet (high TSS) and have less fibre.

Pineapple cultivation in different states of north east India

1) Arunachal Pradesh

Pineapple is one of the important focus fruit crops grown in the sub-tropical belt of Arunachal Pradesh and to some extent even in pockets of the temperate belt. Due to good production and quality of pineapple and visualising the future potentiality, the govt. of Arunachal Pradesh established a processing unit in the district which produces pineapple juice concentrate that are sold to other big companies in the country for making squash and other products. Pineapple cultivation in the state has been accelerated with the launch of TMNE. Growers Prefer 'giant kew' for its size and quality and also due to easier inter cultural operation, especially weeding, because of its non-serrated leaves.

2) Assam

Intervention by the technology mission for integrated development of horticulture through an area Expansion scheme has triggered the revolution of pineapple cultivation. Pineapple cultivation has drastically improved the economic conditions of the educated unemployed youths and farmers of Assam. Since 1916, Welsh Presbyterian evangelist Rev. Watkin Roberts, who led a band of 15 Hmar families from Tripura to settle in the Hmarkhawlien area of Assam's Cachar district, taught the people to cultivate pineapple in this hilltop settlement. The Hmarkhawlien pineapples are reckoned to be the sweetest among all pineapples in India as their sugar content varies between 16 to 28%.

3) Manipur

Pineapple has the largest production among the various fruits produced in Manipur. Pineapple is cultivated in all nine districts of Manipur. Chuachandpur district has largest area under pineapple cultivation (700ha), where about 350-400 farmers are engaged in pineapple cultivation, Imphal east is the largest producer of pineapple among all districts of the north eastern states. Khouabung village is the first place in Manipur where 'Kew' pineapple was cultivated. 'Queen' pineapple is mostly found in Thoubal district. The 8-months long availability of pineapples in Manipur makes the state highly advantageous for processing and export. Canned Pineapple are one of the major processed fruits exported from this state.

4) Meghalaya –

Among the various horticultural crops grown in the state, pineapple occupies an area of 10,500 ha with Annual production of 102,506 t (state directorate of horticulture). Giant Kew and queen are the most common cultivars in the state. They are cultivated along the slope and under rain-fed conditions. Pineapples are consumed fresh or utilized in processing units. Meghalaya industrial development co-operation (MIDC) has signed a memorandum with Yugoslavia and Goetze (India) Ltd. This encompasses all processing units in Meghalaya for storing, processing and preservation of locally available fruits and vegetables such as orange and pineapple. With the processing unit in the place,

government intervention through the TMNE scheme and technological intervention, the industry in the state is expected to grow tremendously.

5) Mizoram

Pineapple thrives well in Mizoram and it has been one of the important fruit crops in Mizoram during the past two decades. With the establishment of fruit juice concentrate plant in Chhingchhip, Mizoram food and allied industries corporation (MIFCO), farmers cultivated pineapple with the hope of earning good income as feeders for the processing unit. But due to high cost of production, the processor could not render the rates expected by farmers, pineapple cultivation was neglected and the farmers shifted to other crops which could earn more income. At present, the area and production of pineapple in Mizoram are 432ha and 2,390 t respectively, with the productivity of 5.53 t/ha (2008-9 census of state horticulture directorate, Mizoram).

6) Nagaland

Agro-climatic conditions of the state are highly suitable for the cultivation of pineapple on large scale. Pineapple fruits from the state are considered to be among best in the world due to its high TSS content with very little or no fiber. The cultivars grown in Nagaland at present are giant Kew (75%), queen (20%) and Mauritius (0.5%). With the introduction of TMNE scheme in the state, the horticultural industry has drastically improved and pineapple cultivation has greatly increased with more area being brought under cultivation. Prior to this, the area and the production of pineapple was 2045 ha with production of 5000 tonnes.

7) Sikkim

Pineapple is one of the important horticultural fruit crops in Sikkim. However, it is not a focus crop of the state under the TMNE scheme. Earlier the department of horticulture extended some help to the grower in terms of providing planting material and other inputs, especially queen cultivar.

8) Tripura

Among all north-eastern states Tripura leads in the production of pineapple. Tripura is turning into a commercial hub with large market in Japan, European countries and even in the United States. Experiments on high density planting, staggered planting and the use of flower including hormones are being carried out to increase the productivity of pineapples at the horticultural research centre at Nagicherra, in the west Tripura district. Preliminary result indicates the possibility of advancing the availability of pineapples by about two months ahead of the normal season. Pineapple growers in the state have benefited from these results in terms of yield and wider availability of fruit during the year. It has also helped in engaging the workers throughout the year, thus creating employment opportunities. Improved production methods, which were introduced in 2005 in 25 ha, have been expanded to 200 ha.

Post-Harvest Management

Grading

Fruits are graded on the basis of their weight, size and colour. The table no.- 7 shows different grades of pineapple on the basis of weight.

Packing

Fruits are packed in baskets woven with bamboo strips. For local markets, the fruits are arranged in baskets (each weighing 20-25 kg.) lined with paddy straw to stand on their stumps. The second layer of fruits is arranged on top of the crowns of the first layer of fruits. For distant markets, fruits

are wrapped individually with paddy straw and then packed. For export purpose the pineapples are packed into fiber board or wood containers. The fruit are placed vertically or horizontally in container. The inter space present between the fruits is filled with straw and the inner lining of container has a layer of straw. For long distance transportation, fruits are held at 7^o C for 10-20 days.

Storage

Fruits with crown can be kept without damage for 10-15 days after harvesting. When fruits are transported to long distances or for a period of several days, refrigerated transport is required to slow down ripening process. Pineapples when stored at 10-13^o C can be stored for a period of 20 days. The best storage is at 7.2^o C and 80 or 90% relative humidity.

Transportation

Road transport by trucks/lorries is the most popular mode of transport due to easy approach from orchards to the market.

Marketing

The growers usually dispose off their produce at the farm gate to the middlemen. Majority of the cultivators sell their crop either through trade agents at village level or commission agents at the market. The average yield is 50-80 tonnes/ha, depending upon spacing and cultural practices.

Pineapple Processing

Pineapple Processing Plant in North East India – Table no.-5 presents information regarding various processing units.

Processed Pineapple Products -

Pineapple juice

It is extracted from pineapple that can be marketed by bottling in to sterilized bottles or cans; by adding preservative at a specified level (KMS<70ppm or benzoic acid<120ppm), the shelf life of the juice can be extended to 6-7 months.

The preparation method of pineapple juice includes taking slices from under-sized pineapple fruits, broken slices, cores, peel meat and trimmings. The slices are then crushed with the help of grinder/mixer. Further juice is extracted with the help of filter press and pasteurized. Then it is filled into glass bottles and sealed with hand sealer; cooled down and finally stored. (Source: www.icar.org.in)

Pineapple squash

Pineapple squash should be prepared from fully matured and sound pineapple fruits free from insect infestation, diseases etc. for preparation of pineapple squash required quantity of juice, sugar, citric acid, preservatives(KMS OR Sodium Benzoate),water, essence and colour are calculated as per FPO specifications. It should be diluted 2-3 times with water at the of consumption.

The manufacturing process involves receiving slices from under sized pineapple fruits, broken slices cores, peel, meat and trimmings. Further the fruit is grated and filtered through a clean cloth and juice is collected. Squash is a concentrated form of fruit drink. The pineapple squash is generally diluted 2-3 times with water at the time of consumption.

Ready- to- serve (RTS) beverages

The preparation of pineapple RTS beverage involves adjustment of soluble solids and acidity of pineapple juice as per FPO specification. Colour and essence as per requirement are also added and mixed thoroughly. The beverage is filled

into bottle leaving head space of 2.5-3 cm, crown corked and processed in water for 15-20 minutes at 85 °C and air cooled.

Pineapple Jam

Pineapple Jam is a solid gel made from fruit pulp or juice; the pineapple pulp with water is allowed to cook on a low fire. Stir it continuously with a wooden ladle. While it boils slowly add sugar into it. Boil it well by stirring continuously. Add pectin powder and stir continuously. When the jam is done, add citric acid, lemon yellow colour and pineapple essence to it. Remove from fire and pour into a bottle. When the jam cools, close the mouth of the bottle To test whether the jam is formed, pour some jam on a dry plate. Allow it to cool and tilt the plate. If the jam is ready, it will fall in flakes.

Canned Pineapple

Pineapple in tin cans is safely packed in light sugar syrup or natural fruit juice so that the natural flavour and aroma remain intact and high quality product can be exported worldwide. Canned pineapple in syrup hold its shape, colour and flavour even after canning. The fruits canned in water or fruit juice help to reduce the sugar content of the canned fruit.

Wine

Pineapple wine is made from the fermentation of pineapple juice in a temperature controlled vat and is stopped near dryness.

Pineapple wine is made from the juice of pineapples. Fermentation of the pineapple juice takes place in temperature-controlled vats and is stopped at near-dryness. The result is a soft, dry, fruit wine with a strong pineapple flavor.

Vinegar

The manufacturing process of vinegar involves an acetic fermentation of alcohol solutions derived from sugar or starchy materials (fermentable sugar content of 8-20%). The fermentation is mostly done by strains isolated from the raw materials.

The by-products of pineapple processing industry like peels and cores are as raw materials to prepare natural vinegar and hence makes proper use of residuals. Vinegar should be pasteurized once it is prepared and bottled. It is stable at ambient temperature (Coveca, 2002).

Technologies Available For Pineapple Processing

The processing steps of pineapple reduces its nutritional quality but with the advancement in technology nowadays the loss can be minimized. This is to meet the consumer demand for healthy, nutritious and "natural" products (Deliza *et al.*, 2005).

Some of the processing methods using the new technologies are as follows:

Vacuum drying

A dehydration process that produces healthy fruit snacks (pineapple chips) which partially preserve the fruits original colour and nutritional compounds and have hydrophilic antioxidant capacity (Perez-Tinoco *et al.*, 2008) ^[18]

Radiation processing

The use of radiation dose of 2kGy doesn't not affect significantly the nutritional value as well as sensory properties of minimally processed pineapple (Hajare *et al.*, 2006) ^[17]

Thermal processing

Helps in the improvement of colour, as a quality attribute of processed pineapple puree. This is made possible by increase in the knowledge of kinetic of colour change (chutintrasri and Noomhorm, 2007).

Ultrasound

This is pre-treatment for drying of pineapple. The process of drying of pineapple minimises post harvest loss of fruits and also results in dried fruit which can be consumed or used in several processed food products. This method has affected the water effective diffusivity of pineapples during air –drying process (fernandes *et al.*, 2008)

Osmotic evaporation

This is a process whereby pineapple juice is concentrated at moderate temperatures and pressure with good nutritional and sensory qualities. This process has minor changes in the concentrated juices which make it more preferable (Hongvaleerat *et al.*, 2008)

High pressure technology

This method is used in food processing where food borne micro-organisms and enzymes are inactivated at low temperature, without the need for chemical preservation. This is done in fruit processing to preserve most of the nutritional qualities similar to fresh product (deliza *et al.*, 2005).

Waste and by-product utilization

The by-products of pineapple processing industry includes residual pulp, peels and skin. These waste can result in environmental problems if not utilised properly. Recently there are investigation/studies carried out on ways to utilise these wastes –

Pineapple peel has high content of cellulose, hemicellulose and other carbohydrates. It produces methane which can be used as a biogas. Anaerobic digestion takes place and digested slurry may find further application as animal, poultry and fish feeds. (Rani and nand 2004) ^[15]

Correia *et al* (2004) investigated the ability of rhizopus oligosporus to produce enhanced level of free phenolics from pineapple residue in combination with soya flour as a potential nitrogen source. From this investigation, they established a relationship between antioxidant activity, β -glycosidase and total phenolic content in these pineapple. They will further investigate these extract but from this, the value of pineapple wastes can be enhanced.

Bromelain is obtained from pineapple waste. Hebbler *et al* (2008) ^[16] carried out a study in which they used reverse micellar extraction (RME) technique to extract and purify bromelain from pineapple wastes. They found that CTAB/isooctane /hexanol/butanol system resulted in a fairly good extraction of bromelain from pineapple core.

Tran and Mitchell (1995) reported that citric acid production in solid- state fermentation by *Aspergillus foetidus* ACM3996 was better on pineapple wastes than on apple pomace, wheat bran or rice bran. The highest citric acid content achieved on pineapple waste was 16.1 g per 100g dried pineapple wastes, with moisture content of 70% and in presence of 3% methanol. This represents a yield of 62.4% based on sugar consumed.

J.N. NIGAM depicted that cells of *saccharomyces cerevisiae* ATCC 24553, were immobilised in κ -carrageenan and packed in a tapered glass column reactor for ethanol production from pineapple cannery waste at temperature 30 °C AND pH 4.5.

Other Uses

Bromelain: The proteolytic enzyme, bromelain, or bromelin, was earlier derived solely from pineapple juice; but now it is also obtained from the mature plant stems recovered when fields are being cleared. The enzyme is used same as papain obtained from papaya for tenderization of meat and in chill proofing beer; is added to gelatin to increase its solubility for drinking.

Fiber: The fibres from pineapple leaves were extracted by Filipinos before 1591 and are highly strong like silky fibre. Some cultivars of pineapple are grown especially for fiber production and their young fruits are removed to give the plant maximum vitality. The 'Perolera' is an ideal cultivar for fiber extraction since its leaves are long, wide and rigid. Chinese people in Kwantung Province and on the island of Hainan weave this fiber into coarse textiles resembling grass cloth. This was long ago used as thread in Malacca and Borneo. In India the thread is prized by shoemakers and it was formerly used in the Celebes. Approximately 22,000 leaves would constitute one ton and would yield 50-60 lbs (22-27 kg) of fiber.

Juice: Pineapple juice has been used for cleaning machete, knife blades and with sand for scrubbing boat decks.

Animal Feed: The waste generated from industry is dehydrated called as bran and used as feed for cattle, pigs and chicken. "Bran" is also made from the stumps left after bromelain extraction. The expendable plants from old fields is processed as silage and then is used for maintaining cattle when other feed is scarce. The silage is low in protein and but high in fiber and is best mixed with urea, molasses and water to improve its nutritional value.

Folk Medicine: Pineapple juice acts as a diuretic and to expedite labor, also as a gargle in cases of sore throat and as an antidote for seasickness. The flesh of very young pineapple is toxic in nature and is often consumed to achieve abortion; also to expel out intestinal worms; and as a drastic treatment for venereal diseases. In Africa the dried, powdered root is a remedy for oedema. The rind decoction of fruit with rosemary and the crushed rind is applied on haemorrhoids and fractures respectively.

Ornamental Value

The pineapple fruit along with its crown is used for decorative purpose. The potted and ethylene treated plant with fruits have been shipped annually from southern Florida to northern cities as indoor ornamentals since 1963.

Conclusion

Pineapple are widely cultivated in various parts of India especially north-east region. there are several products that can be made from pineapple such as canned pineapple, pineapple jam, juices, squash and many more.

Pineapple cultivation doesn't have standard procedure and very little emphasis is being given to organic farming. Jhum Cultivation techniques lead to destruction of the fertility of land. Participation of farmers in international symposiums and conferences must be encouraged so that they become aware about the modern techniques and development in this field. These modern techniques must be adapted and applied in India.

Nowadays the processed pineapples are consumed worldwide at a higher pace and processing industries are trying to use new technologies to retain the nutritional quality of the pineapple fruit. This is to meet the demand of consumers who need healthy, nutritious and natural products. Pineapple

wastes from these processing industries can be utilised to produce methane, animal feed, phenolic compounds and Bromelain.

The pineapple processing business is very lucrative since it

helps in value addition as well as but many problems are faced such as the tendency of pineapple growers towards selling fresh fruits rather than processing it themselves or supplying to the fruit processing industries.

Table 1: Shelf life of pineapples (whole and cut) in different storage conditions.

| Condition | Counter | Refrigerator | Freezer |
|------------------|----------|--------------|------------|
| Pineapple(whole) | 2-3 days | 4-5 days | 0-1 day |
| Pineapple (cut) | 0-1 day | 3-4 days | 3-5 months |

(Source: www.eatbydate.com)

Table 2: Chemical Composition of Pineapple

| Ripe & Raw Pineapple | Per 100g | Vitamins | Per 100g |
|----------------------|----------|---------------------------|------------|
| Water | 86 g | Ascorbic Acid (Vitamin C) | 15 mg |
| Energy | 49 kcal | Vitamin B-12 | 0 mcg |
| Energy | 205 kJ | Vitamin B-6 | 0.09 mg |
| Protein | 0.50 g | Vitamin A, IU | 50 IU |
| Total dietary fiber | 1.2 g | Vitamin A, RE/p> | 3 mcg_RE |
| Lipid Fat | 0.20 g | Vitamin E | 1.0 mg_ATE |
| Ash | 0.29 g | Vitamin K | 0.7 mcg |
| Calcium | 7 mg | Folate (total) | 11 mcg |
| Phosphorus | 7 mg | Folate, food | 11 mcg |
| Iron | 0.37 mg | Folate, DFE | 11 mcg_DFE |
| Sodium | 1 mg | Thiamine | 0.09 ug |
| Potassium | 113 mg | Riboflavin | 0.036 mg |
| Magnesium | 14 mg | Niacin | 0.42 mg |
| Copper | 0.11 mg | Pantothenic acid | 0.16 mg |
| Manganese | 1.65 mg | Tocopherol, alpha | 0.10 mg |
| Selenium | 0.6 mcg | | |
| Glucose (Dextrose) | 1.7 g | Beta Carotene | 31 mcg |
| Fructose | 1.9 g | Alpha Carotene | 0 mcg |
| Total sugars | 8 g | Cryptoxanthin, beta | 0 mcg |

(Source: <http://ndb.nal.usda.gov/>)

Table 3: Pineapple Fruit Nutritional Value Based On Preparation

| Preparation | Serving Size | Carbs | Fiber | Fat | Energy |
|--|---------------|-------|-------|-----|--------|
| Raw Pineapple | 1 slice, 110g | 25g | 2.5g | 0 g | 175 kJ |
| Canned Pineapple, juice drained | 1 cup, 205ml | 25 | 4 g | 0 g | 470 kJ |
| Canned Pineapple in syrup, drained | 1 slice, 40g | 8 | 0.5 g | 0 g | 140 kJ |
| Canned & Crushed Pineapple in juice, drained | 1 cup, 270g | 27 | 4.5 g | 0 g | 510 kJ |
| Canned Pineapple Juice, unsweetened | 250ml | 27 | 0 g | 0 g | 465 kJ |

(Source : <http://ndb.nal.usda.gov/>)

Table 4: State-wise area, production and productivity of pineapple

| S. No. | States/UTs | Area in '000 ha Production in '000 Tonne | | | | | |
|--------|---------------------------|---|----------------|---------------|----------------|----------------------------|----------------|
| | | 2012-13 | | 2013-14 | | 2014-15 (2nd Adv. Est.) | |
| | | A | P | A | P | A | P |
| 1 | West Bengal | 10.50 | 310.00 | 10.70 | 316.00 | 10.83 | 320.00 |
| 2 | Assam | 16.24 | 268.82 | 16.54 | 288.60 | 16.56 | 290.21 |
| 3 | Kerala | 8.54 | 72.86 | 8.54 | 72.86 | 9.35 | 255.90 |
| 4 | Karnataka | 2.70 | 169.30 | 2.72 | 160.31 | 2.53 | 158.12 |
| 5 | Tripura | 11.84 | 165.01 | 11.59 | 162.26 | 11.59 | 150.00 |
| 6 | Nagaland | 9.00 | 85.00 | 9.50 | 142.50 | 9.50 | 142.50 |
| 7 | Manipur | 13.06 | 124.14 | 13.70 | 136.31 | 14.28 | 142.16 |
| 8 | Meghalaya | 10.82 | 109.39 | 11.31 | 117.77 | 11.59 | 124.60 |
| 9 | Bihar | 5.13 | 139.22 | 4.16 | 113.91 | 4.21 | 116.37 |
| 10 | Arunachal Pradesh | 12.28 | 67.58 | 12.78 | 69.61 | 13.00 | 70.00 |
| 11 | Andhra Pradesh | - | - | 2.30 | 86.00 | 2.79 | 41.82 |
| 12 | Mizoram | 3.00 | 21.96 | 4.09 | 30.14 | 5.07 | 36.87 |
| 13 | Tamil Nadu | 0.65 | 20.82 | 0.69 | 22.90 | 0.72 | 25.07 |
| 14 | Odisha | 0.90 | 11.00 | 0.84 | 10.38 | 0.90 | 11.15 |
| 15 | Goa | 0.29 | 4.80 | 0.30 | 4.90 | 0.30 | 4.98 |
| 16 | Andaman & Nicobar Islands | 0.23 | 0.69 | 0.12 | 2.30 | 0.12 | 2.31 |
| | Total | 105.17 | 1570.59 | 109.88 | 1736.74 | 113.34 | 1892.07 |

Source: Horticulture Statistics Division, DAC&FW.

Table 5: Pineapple India has several pineapple processing plants all over the NER

| Canned Pineapple | | | |
|------------------------------------|--------------------|--------------------|------------------|
| Processing Plant | Season | Installed Capacity | Total Qty/Season |
| Manipur – Imphal | May-Aug | 7.5 Mt/Day | 788 MT |
| Dimapur –Nagaland 1 | July –Sep, Nov-Dec | 5 Mt/Day | 450 MT |
| Dimapur –Nagaland 2 | July –Sep, Nov-Dec | 5 Mt/Day | 60 MT |
| Dimapur –Nagaland 3 | July –Sep, Nov-Dec | 5 Mt/Day | 450 MT |
| Agartala –Tripura | May –Aug, Oct-Dec | 5 Mt/Day | 900 MT |
| Meghalaya | July –Sep, Nov-Dec | 7 Mt/Day | 400 MT |
| Pineapple Juice Concentrate | | | |
| Manipur-Imphal | May-Aug | 17.8mt/Day | 1400 MT |
| Pineapple Fruit Pulp | | | |
| Dimapur-Nagaland | July –Sep, Nov-Dec | | 10 MT |

(SOURCE: www.pineappleindia.com)

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