Development of nutrition rich mixed fruit leather from Apple and Papaya: A review

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Abstract. Apple and papaya are renowned for its nutritional properties, being a rich source of vitamin C, fiber, antioxidants, vitamin K and E and minerals. Post Harvest loss would be very high, to address this issue in the present review developing of fruit leather with different fruits such as apple and papaya. Processing apple and papaya into alternative products become essential to address these issues. One such product is papaya and apple leather, which aids in better utilization and preservation of the fruit's qualities. In the present review with different combinations of apple and papaya would check the physiochemical properties and organoleptic acceptability. The present review revels the different enzymes, antioxidants, vitamins and minerals which are present in different combinates of fruit leather. In the present review novel development of fruit leathers prepared from apple and papaya, further research focusing on fruit leather and latest combinations and technologies used in fruit leather development would revel.

Keywords: Antioxidants, Apple, Papaya, Fruit leather, Enzymes.

1. Introduction

Apple (*Malus domestica*) is the pomaceous fruit of the apple tree, species Malus domestica in the rose family (Rosaceae). They belong to kingdom plantae, genus *Malus* as shown in table 1. Apples have been farmed for millennia in Asia and Europe, and European settlers brought them to North America. Numerous civilizations, including the Norse, Greek, and European Christian traditions, attribute religious and mythical significance to apples. The apple ranks second in terms of global fruit production, behind grape, banana, and orange [1]. It is the most significant temperate fruit from a commercial standpoint. The world's largest producer of apples is China. In temperate climates, apples (*Malus domestica* Borkh.) are among the most extensively produced and economically significant fruits. Because of its excellent nutritional value and strong ecological resilience, it is well-liked by both growers and consumers. Apples from seed often have very different qualities from their parents, and the fruit that is produced often is not what is desired. Apple trees planted without rootstocks typically grow larger and bear fruit considerably later. To facilitate simpler harvesting, rootstocks are utilised to regulate the rate of growth and the size of the final tree [2]. A tree planted on standard (seedling) rootstock would typically grow to a height of 30 feet (9 metres) with a similarly great crown diameter if left untrimmed. Typically, the bark is rough and dark. Simple leaves typically have fine teeth along their borders and have an oval form [3].

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The ripening ovary and surrounding tissue of the apple become fleshy and edible, making the apple itself a pome (fleshy) fruit. When they are harvested, apples are typically round, 4-5 cm (2–4 inches) in diameter, and coloured in shades of red, green, or yellow. Depending on the variety there are thousands of them apples can vary in size, shape, and acidity [4].

Papaya (*Carica papaya* L.) is a tropical American fruit tree that is a member of the Caricaceae family. Papaya belongs to kingdom plantae, subkingdom tracheobionta as shown in table 2. The papaya is an elongated berry with smooth, thin skin that is greenish-yellow in colour. It is a climacteric fruit that grows all year round. Its flesh has a soft, pleasant flavour and is thick, varying in colour from yellow to red [5]. Papaya is a year-round vegetable that is a nutritional powerhouse. It is a great source of vitamin C, vitamin A, and vitamin E, three potent antioxidants. The vitamins B pantothenic acid, magnesium, potassium, folate, and fibre. Moreover, it has papain, a digestive enzyme, which helps heal sports injuries, allergies, and trauma-related conditions [6]. One of the world's most nutrient-dense and significant medicinal crops is the papaya (*Carica papaya* L.), which grows in tropical and subtropical climates. Over the past few decades, the market demand for tropical fruits like papaya has been gradually increasing. Because of its high nutritional value, year-round availability, and high productivity, this fruit has become increasingly significant. Of late, the industrial significance of this crop has surged up due to the enzyme 'papain' which has

been found to have numerous applications in the food and leather industries. Due to the growing demand for papaya fruits and papain, papaya output and area have been growing over the past few decades, providing farmers with higher returns. Papayas are grown in around 60 countries worldwide, with developing nations like Brazil, India, and others producing the majority of the crop [7]. This tree can grow to a height of 3–10 m and has a palm-like form. A terminal flourish of leaves with 5-7 lobes and long petioles sits atop the freshly cut stem, which is spotted with scars from fallen leaves [8]. Large, solitary or in few flowered racemes, fragrant male flowers are held at the terminals of pendulous, fistular rachis in lax, many-flowered, densely pubescent cymes; female flowers have various types of enzymes [9].

1.1 Botany

1.1.1 *Apple*

Tree**,** a small- to medium-sized, branched, deciduous tree with a single trunk and a broadly spreading canopy. The trees range in height from 7 to 10 metres. In cultivation, rootstock and training planting scheme have a significant impact on the size and shape of the trees. While elder branches are smooth, young stems and twigs are slightly tomentose (hairy). Spurs are extremely short stems that mostly bear flowers and later fruits. They grow very slowly. On shoots that are a year old, they form. The rootstock may give rise to root suckers. Alternately arranged, dark green, simple oval-shaped leaves with a serrated edge measure 4–13 cm long by 3–7 cm wide [10]. The margins are unevenly sawtoothed, and the undersides are typically hairy [11]. Buds are ovoid, thickly hairy, and purple brown. Vegetative buds give rise to shoots and leaves, whereas floral buds give life to flowers. Compared to growth buds, flower buds are plumper, bigger, and have a downy surface. Flowers have a diameter of 3–4 cm [12]. Each flower bloom includes five sepals, five petals that range in colour from white to pink, and roughly twenty stamens arranged in three whorls with yellow anthers. The stigma and five styles are joined at the base to form the pistil. The stamen is shorter than the five styles by a small amount. The ovary is situated behind the stamen, petals, and sepals in an inferior position. All sepals except the calyx and peduncle are typically fuzzy, and the calyx remains inside the fruit. Flowers are often carried in clusters of four to six in inflorescences that have been variously referred to as corymbs, corymbose racemes, cymes, and false cymes. However, in certain cultivars, they may grow laterally from one-year-old branches. Fruit is a globe-shaped, ellipsoid to obovoid pome that has indentations on both the base and the apex [13]. Typically, the fruits have a diameter of more than 5 cm and weigh between 200 and 350 grammes. Fruits can have two colours can be evenly red, green, or yellow in hue. Fruit that is bi-colored may be flushed crimson or striped against a green or yellow backdrop. Between the skin and the core line of every fruit is a layer of edible flesh called the cortex. Five fused carpels are contained in a papery capsule surrounded by a fleshy pith in the centre. Every carpel typically contains two seeds. Seeds are smooth, shiny, and chestnut brown [14].

Table 1. Scientific classification of Apple

Domain	Eukarya
Kingdom	Plantae
Phylum	Magnoliophyta
Class	Magnoliopsida
Order	Rosales
Family	Rosaceae
Genus	*Malus*
Species	*Malus domestica*

1.1.2 *Papaya*

Papaya, *Carica papaya L*. (2n =18), belongs to the family Caricaceae. It has shrubby, arborescent, or herbaceous plants with a sophisticated network of articulated laticifers. The often thinly branching plants are primarily dioecious and produce fruits that resemble berries [15]. With the exception of Cylicomorpha, which is native to West Africa, the 35 species that make up the relatively tiny six genera that make up the Caricaceae are all American. The stem is hollow, solitary, and straight, with noticeable leaf scars. Papayas rarely branch unless the apical meristem is destroyed or eliminated, exhibiting a high apical dominance [16]. Large, palmately lobed leaves are often clustered at the crown and arranged spirally; however, there have been reports of variations in leaf structure and arrangement with Malaysian cultivars. Papaya cultivars can be distinguished from one another primarily by the number of main veins on the leaves, the number of lobes at the borders of the leaves, the shape of the leaves, the kind of stomata, the wax structures on the surface of the leaves, and the petiole colour. The fruit is elongated club-shaped, 15–50 cm long, 10–20 cm thick, and up to 9 kg in weight [17]. It resembles a melon and is oval to almost spherical, somewhat pyriform, or elongated. Fruits on semi-wild (naturalised) plants range in size from 2.5 to 15 cm. The skin is thin, waxy, and quite durable. The fruit's skin is hard and green when it is young, and it contains a lot of white latex. Papaya fruits become light or deep orange in colour as they ripen, and the thick wall of juicy flesh turns aromatic and yellow-orange or a variety of salmon or red hues [18].

Table 2. Taxonomic classification of Papaya

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Violales
Family	Caricacea
Genus	*Carica L.*
Species	*Carica papaya L.*

1.2 Origin and distribution

Apple is one of the well-known temperate fruit which is being cultivated in Europe and Asia since the dawn of recorded history [19]. There is evidence of apple cultivation dating back to 600 BC. The apple is the foundational crop for the horticultural industry and the cornerstone of the state of J&K's temperate fruit industry. Apple growing is mostly limited to mountainous regions in the dry temperate zone, which are between 1600 and 2400 metres above sea level [20]. Apples do best when grown in temperatures between 15 and 21°C. The soil types loamy, sandy, loam, and silt loam are good for growing apple trees. Apple farming generally requires well-drained, weed-free, porous, loamy subsoils. The planting depth for the sapling should be 45 cm [21]. The ideal soil pH range for growing apples is 5.5–6.5. For trees to flower, the winter's chill and snow are necessary. Apple trees require a well-distributed rainfall of 1000–1250 mm during the growing season in order to grow and fruit [22].

Carica papaya is believed to have originated in the lowlands of eastern Central America, from Mexico to Panama [23]. It is assumed that the genus *Carica L.* resulted via natural hybridization involving C. peltata Hook. In the sixteenth century, it made its way to Southeast Asia and the Caribbean [24]. With only one species of papaya, *Carica papaya*, it was brought to India from the Philippines in the early 16th century via Malaysia. Dioecious cultivars comprise a distinct group from monoecious cultivars, according to genetic diversity studies conducted among thirteen commercially produced Indian varieties [25].

1.3 Nutritional value

Papaya fruit is low in calories and rich in vitamins and minerals. Fruit variety, growth environment, and ripeness upon eating all affect how nutritious it is [26]. Hawaiian papaya cultivars range in average in ascorbic acid (vitamin C) concentration from 45.3 to 65.4 mg 100−1. Thus, for adult males and females, one cup (140 g) of papaya cubes can supply approximately 80–96% of the dietary reference intakes (DRI) for vitamin C and 8–11% of the DRI for magnesium, as determined by the US Food and Nutrition Board, National Academy of Sciences [27]. In the fruit flesh, ascorbic acid (48.4 mg 100 g−1) accounted for almost 97% of the fruit's overall hydrophilic antioxidant capability. Fruit flesh's carotenoids enhance its vitamin A content and lipophilic antioxidant potential [28]. Approximately 63% of the overall carotenoid content is found in the red-fleshed cultivars, which also have lower retinol activity equivalents than their yellow counterparts, where the main carotenoid pigments are β-cryptoxanthin and β-carotene. Although lycopene lacks vitamin A, it is a more potent antioxidant than β-carotene and has been associated with a lower risk of cancer, particularly stomach, prostate, and lung cancers [29]. Consequently, red-fleshed cultivars' antioxidant activity may be more beneficial to human health than their vitamin A activity. Fiber is another star component of papaya, promoting digestive health and aiding in weight management by promoting a feeling of fullness. Additionally, papaya contains protein, potassium, energy, carbohydrate and small amounts of other vitamins contributing to its overall nutritional profile as shown in table 3. One of the most notable characteristics of papaya is its enzyme content, particularly papain [30]. Due to its digestive benefits, papaya is often include in enzyme supplements and digestive enzymes blends [31].

Table 3. Nutritional value of papaya [32]

For 100 g	
Water	88.83 g
Potassium	275 mg
Energy	39 kcal
Carotene	276 µg
Carbohydrate	9.81 g
Protein	0.61 g
Sugar	10.39 g
Vitamin C	61.8 mg
Dietary fiber	1.8 g

Apple is categorized as sub acid food (3.5–6.5) and a good source of pectin [33]. Even though they have a moderate energy content, fresh apples are frequently referred to as "miracle fruit" due to the numerous biochemical reactions that occur in them that promote human growth, development, and general wellness. Apples are low in cholesterol and high in dietary fibre, which not only limits the gut's ability to absorb dietary LDL but also binds to carcinogens to shield the colon's mucous membrane from harmful substances [34]. While apples do include a considerable amount of potassium and vitamin C, they are not as concentrated a source of vitamins and minerals as other fruits but are rich in iron, dietary fiber as shown in table 4. About 95 calories, 0 grammes fat, 1 gramme protein, 25 grammes carbohydrates, 19 grammes naturally occurring sugar, and 3 grammes fibre are found in one serving, or one medium apple [35]. Among common fruits, fresh apples are regarded as having a moderate energy value, however processed apple products have an energy content that is either higher than fresh apples or comparable due to concentration (dehydration) or the addition of sugars during processing. Like other fruits, apples have negligible levels of fat (less than 0.4%), and protein (less than 0.2%). While they do include some vitamin C and potassium, apples do not have as many vitamins and minerals as some other fruits. Nonetheless, apples have a low glycemic index and are a good source of soluble fibre, particularly pectin, which lowers blood sugar levels by delaying the absorption of sugar into the bloodstream. Pectin is also known to suppress insulin production, which lowers cholesterol levels [36]. Apples

are primarily a food source of carbohydrates. They consist of cellulose, pectin, sugars, starches, and hemicellulose. Fructose (5-7%), sucrose (3-5%), and glucose (1-2%) are the three most prevalent sugars. Compared to oranges (0.34 – 0.50%), bananas (0.50%), apricots (0.60%), grapefruit (0.20%), or peaches (0.64%), apples with skin have a greater fibre content (0.77%). Eating apples has been linked to a lower risk of obesity, diabetes, asthma, cardiovascular disease, and some types of cancer. Research conducted in laboratories has revealed that apples possess a range of bioactivities, such as potent antioxidant, anticancer, and anti-neurodegenerative properties [37].

Table 4. Nutritional value of apple [38]

For 100 g	
Calories	43 kcal
Total fat	0.3 g
Sodium	8 g
Carbohydrate	11 g
Sugar	7.8 g
Vitamin A	950 IU
Iron	0.25 mg
Dietary fiber	1.7 g
Calcium	20 g

1.4 Post harvest losses in apple

Harvesting, storing, packing, shipping, and marketing are the factors that result in postharvest losses of apple fruits. Cultivars, cultivation techniques, fertiliser, irrigation, environmental factors (temperature, relative humidity, atmosphere condition), and soil type are some other pre-harvest factors that affect the postharvest quality of apples. Inadequate apple harvesting, transportation, packing, storing, sorting, grading, and marketing can all lead to postharvest losses [39]. Physiological disorders (resulting from freezing, high temperatures, mechanical damage, and pathological disorders) are the main causes of postharvest losses in apples. The best way to preserve apple fruit quality and increase its shelf life after harvest is to control its temperature and relative humidity [40]. Apple fruit losses are a significant issue in the postharvest chain and are brought on by a number of variables, including pre-harvest circumstances, retailer, and consumer behaviour. Premature harvesting is one of the contributing factors. Apple postharvest illnesses account for a significant portion of the financial losses experienced during apple production. Annual losses can range from 5 to 35%, and before the product reaches the consumer, they can range from 20 to 50% in underdeveloped nations [41]. Apple harvesting before optimal maturity occurs for several reasons among farmers. Optimal maturity may be delayed by various variables such as early arrival of labourers for harvesting, inaccurate harvesting date estimate, or differing climatic conditions. As thus, the apple's sensory properties are diminished [42]. When apples are handled at different stages, like on the farm, during grading, storage, and distribution, they are subjected to a variety of loading actions that might cause bruising. 20% to 50% of the apples overall sustain bruises as a result of various handling procedures. Apple bruise intensity is mostly influenced by the apple variety, harvesting conditions, and the source of the bruise [43]. Optimising the gas levels during CA storage is crucial for safeguarding the fruit against atmospheric-induced illnesses like low oxygen or excessive carbon dioxide harm. Anaerobic fermentation can produce alcoholic flavour if the oxygen level is too low. Excessive carbon dioxide levels can cause interior browning and tough fruit skin. Apples are normally kept in storage at 0°C, while some types are more prone to internal problems and are kept in storage at temperatures higher than 0°C. Apples vary in their sensitivity to damage from low temperatures. A significant portion of the losses in the apple production chain are caused by postharvest diseases [44]. It has been determined that apples deteriorate during storage due to over 90 different fungus species. The climate and storage conditions affect each pathogen's relative relevance. Because postharvest pathogens thrive at significantly higher temperatures, cold storage temperature is essential for controlling these pathogens [45]. Even so, some fungi may thrive in environments as cold as -2°C. As such, unless the storage time is restricted, they cannot be completely managed. Common fungi species that are responsible for the losses of stored apple fruits include *Botrytis cinerea*, *Penicillium expansum* and *Mucor piriformis*. These fungi frequently induce diseases that lead to excessive yield and financial losses during storage [46]. After harvest, the quality of an apple can only be maintained; it cannot be enhanced by postharvest handling techniques or treatments. Producing high-quality fruit at harvest requires an understanding of and commitment to managing the numerous roles that pre-harvest factors, such as fertiliser use, cultivars, farming practices, maturity stage, and irrigation, can play in fruit quality [47]. Utilising optimal postharvest handling techniques, including the best physical handling methods, postharvest treatment, and optimal temperature, relative humidity, and moisture, is essential to maintaining quality following harvest. We may conclude that, in addition to postharvest issues, some preharvest factors during production also affect the quality of apples after harvest. Until these factors are correctly handled, quality loss will be minimised and fruit quality will be maintained. Apple produce ethylene gas, a natural ripening hormone that can accelerate the ripening [48].

1.5 Post harvest losses in papaya

The post-harvest losses in papaya may be due to various factors such as improper harvesting, mishandling of the fruits, improper storage, transportation and postharvest diseases. Papayas can lose their quality due to mechanical damage, overripening, and rot. Inadequate harvesting techniques, hard handling, inadequate

packaging, and unfavourable transportation circumstances are all responsible for these losses. Reduced losses are necessary if farmers are to benefit [49]. When papaya is managed properly after harvest, postharvest losses are decreased, ensuring both optimal returns for agro-industries and farmers as well as nutritional security [50]. Because papayas are perishable, a significant amount of their produce—roughly 40–60% of the overall production at various papaya growing regions—goes to waste despite being the fruit grown in India with the highest yield. Papaya post-harvest losses can result from a number of factors, including inappropriate fruit handling, faulty harvesting, inadequate storage, packaging, and transportation, as well as post-harvest illnesses. Post-harvest losses reduce the amount and quality of the product, which has an impact on marketing and farmer income [51]. In developing countries, the loss ranges from 46-50%. With a maximum shelf life of four weeks, the loss in Hawaii was estimated to be as high as 75%. Numerous variables, including pre-harvest, environmental, incorrect marketing chain, poor storage, improper transportation, post-harvest pest and disease, chilling injury, physiological disturbance, and senescence, may contribute to postharvest loss. These variables cause various alterations in fruit quality and nutritional content, as well as affecting the fruit's look, texture, firmness, and flavour [52]. These effects result in subpar marketing and lower the fruit's monitory value. One of the key elements in preserving the freshness of papaya fruit for an extended period of time is postharvest treatment [53]. Papaya postharvest losses can be reduced with appropriate postharvest management techniques, ensuring the produce's quality and safety. Harvesting at the proper ripeness, cleaning, sorting, grading, processing, storing, and shipping can all help reduce post-harvest losses. Farmers or businesses that grow papayas can also purchase processing, which will not only supply the commodity all year long but also increase the price of the limited items. There are numerous opportunities to benefit from post-harvest management technology [54].

1.6 Medicinal uses and pharmacological properties

Papaya fruit is low in calories and rich in vitamins and minerals. Fruit variety, growth environment, and ripeness upon eating all affect how nutritious it is. Hawaiian papaya cultivars have an average ascorbic acid (vitamin C) value ranging from 45.3 to 65.4 mg 100−1 [55]. Thus, for adult males and females, one cup (140 g) of papaya cubes can supply approximately 80–96% of the dietary reference intakes (DRI) for vitamin C and 8–11% of the DRI for magnesium, as determined by the US Food and Nutrition Board, National Academy of Sciences. The fruit's ascorbic acid content (48.4 mg 100 g−1) accounted for almost 97% of its overall hydrophilic antioxidant capability [56]. The fruit flesh's lipophilic antioxidant activity and vitamin A content are attributed to the carotenoids found in it. Approximately 63% of the overall carotenoid content is found in the red-fleshed cultivars, which also have lower retinol activity equivalents than their yellow counterparts, where the main carotenoid pigments are β-cryptoxanthin and β-carotene. Although lycopene lacks vitamin A, it is a more potent antioxidant than β-carotene and has been associated with a lower risk of cancer, particularly stomach, prostate, and lung cancers. Consequently, red-fleshed cultivars' antioxidant activity may be more beneficial to human health than their vitamin A activity [57]. Apples are considered to be a good source of pectin and a subacid food (3.5–6.5). Even though they have a moderate energy content, fresh apples are frequently referred to as "miracle fruit" due to the numerous biochemical reactions that occur in them that promote human growth, development, and general wellness. Apples are low in cholesterol and high in dietary fibre, which not only limits the gut's ability to absorb dietary LDL but also binds to carcinogens to shield the colon's mucous membrane from harmful substances [58]. While apples do contain a good amount of potassium and vitamin C, they are not as concentrated a source of vitamins and minerals as other fruits [59]. About 95 calories, 0 grammes fat, 1 gramme protein, 25 grammes carbohydrates, 19 grammes naturally occurring sugar, and 3 grammes fibre are found in one serving, or one medium apple. Among common fruits, fresh apples are regarded as having a moderate energy value, however processed apple products have an energy content that is either higher than fresh apples or comparable due to concentration (dehydration) or the addition of sugars during processing. Like other fruits, apples have negligible levels of fat (less than 0.4%), and protein (less than 0.2%). While they do include some vitamin C and potassium, apples do not have as many vitamins and minerals as some other fruits [60]. Nonetheless, apples have a low glycemic index and are a good source of soluble fibre, particularly pectin, which lowers blood sugar levels by delaying the absorption of sugar into the bloodstream. Pectin is also known to suppress insulin production, which lowers cholesterol levels. Apples are primarily a food source of carbohydrates. These include cellulose, hemicellulose, pectin, starches, and sugars. The three most prevalent sugars are sucrose (3-5%), fructose (5-7%) and glucose (1 – 2%) [61]. Compared to oranges (0.34 – 0.50%), bananas (0.50%), apricots (0.60%), grapefruit (0.20%), or peaches (0.64%), apples with skin have a greater fibre content (0.77%). Eating apples has been linked to a lower risk of obesity, diabetes, asthma, cardiovascular disease, and some types of cancer. Research conducted in laboratories has revealed that apples possess a range of bioactivities, such as potent antioxidant, anticancer, and anti-neurodegenerative properties [62].

2. Fruit leather

A dehydrated snack with a soft, gel-like consistency is called mixed fruit leather, sometimes referred to as a bar, slab or self-stable confection. It is commonly eaten as a

snack or dessert. The shelf life of mixed fruit leather is longer, and it doesn't require refrigeration when kept in storage. It is easy to pack and store and is lightweight. Fresh fruit pulp, canned fruit, or frozen fruit can all be used to prepare it [63]. Mixed fruit leather is a tasty and nourishing snack made by pureeing a variety of fruits, which is then dried. The purée is spread thinly and then dried until it forms flexible, chewy sheets [64]. It is a great way to enjoy the flavours of various fruits in a convenient and portable way. Fruit puree is combined with additional components such sugar, pectin, acid, glucose syrup, colour, and potassium metabisulphite to make most fruit leathers. The mixture is then dried using a specific method. Leather is produced using a range of drying methods, including as tray drying, sun drying, microwave drying, and hot air drying. Consuming fruit leather is an economical and useful approach to enhance food quality by obtaining all the nutrients found in naturally occurring fruits [65]. Fruit bars made from natural fruit pulp are more healthful and tasty since it has significant amounts of vitamins, minerals, fibre, and other phytonutrients. Fruit leather gives fruit an additional premium that isn't suitable for the fresh food market. Since many fresh fruits have a short harvest season and are particularly prone to deterioration even when stored in a refrigerator, making fruit leather from fresh fruit is an economical way to use and preserve the fruits [66].

2.1 Health benefits of fruit leather

2.1.1 *Good source of nutrients*

Fruit leather is the product in which all the nutrients present in the fruit are conserved for a long time. It is generally packed with the nutrients such as fiber, minerals, calcium, phosphorous and iron. The high content of nutrients ensures one's health and combat fatigue and other health problems [67].

2.1.2. *Helps in digestion*

It comprises of numerous fibers and so they assist in easy digestion. It cleanses the digestive system and prevents constipation and other bladder problems. It also plays a major role in flushing out of toxin from the skin and improves skin health [68].

2.1.3. *Helps in weight loss*

The fruit leathers are the smartest choice to shed off the weight. The fiber content present in the fruits makes one feel full for longer time period. It is also better alternative for sweet tooth crave. The effective control in intake of carbohydrates and sugars automatically supports healthy weight loss [69].

3. Fruit leather prepared from apple and papaya combining other fruits

3.1. Black current-Apple leather

A temperate fruit crop, apples are a potential source of iron and vitamins. They are included in standard prescribed diets and are associated with the proverb "an apple a day keeps the doctor away." Similarly, black currants are rich in antioxidants and are beneficial to health. Apples and black currant leather can be successfully prepared using a combination of apple pulp, apple juice, and black currant concentrate mixed in different proportions along with additives [70]. The most acceptable method was found to be adding apple pulp, apple juice, and black currant concentrate in the ratio of 30: 6: 2 and drying them in a hot air dryer at 70 °C with an air velocity of 0.2 m/s [71].

3.2. Apricot-Apple leather

Apricot and apple leather was processed using the puree which contains apricot puree 16.5%, apple juice 1.5% and apple pulp of 82% [72]. After being standardised on stainless steel trays, the sample was dried in a cabinet dryer for approximately six hours at a temperature of 85 °C and 5% relative humidity. Good-quality leather was obtained by a two-stage process in which the leather was dried twice: once for two hours at 102 °C and again for three hours at 85 °C [73].

3.3. Papaya-Guava Leather

Blended guava-papaya leathers were made by mixing the pulps of guava and papaya in different ratios [74]. The guava and papaya were cut into pieces after being cleaned and peeled. Papaya pulp was made by crushing the fruit pieces in a mixer and discarding the seeds. Guava slices were run through a superfine pulper/finisher to create the guava pulp. All of the mixes had their brix and acidity adjusted to 25∘ Brix and 0.5%, respectively. After cooling to roughly 45°C, the pulp mixture was heated to 85°C to render the enzymes inactive. Prior to pouring the liquid into stainless steel trays that had been previously coated with glycerol, potassium metabisulphite (0.2%) was added as a preservative. The mixture was then dried in a cross-flow cabinet dryer at 60°C until the final moisture content of the product reached 15–20% [75].

3.4. Pine apple, Apple and Banana Leather

Because of their increased metabolic activity, fruits like apples, bananas, and pineapples are more perishable and are therefore further processed into pulps, jellies, jams, and leathers. Different ratios of banana, pineapple, apple, S443 (20:40:40), S314 (60:20:20), S819 (40:40:20), and various additional components were used to make the mixed fruit pestil. For almost ten hours, the samples were dried at a temperature between 60 and 80°C. Overall, banana, pineapple and apple leather are convenient, portable and delicious ways to enjoy the natural goodness of fruit while providing essential nutrients, vitamins and energy [76].

3.5. Durian Leather

Durian aril was used to make durian leather. After blanching the durian aril for five minutes in a closed water bath, 10% glucose syrup solid, 5% sucrose, water, 2.67% hydrogenated palm oil, and 0.45% soy-lecithin were added to the mixture [77]. A colourant of 100 ppm

egg yolk was also used. The mixture was shaped into sheets that were 1.2 mm thick, and it was dried at a specific temperature in a forced-air cabinet dryer. The mixture that was employed determined how long the drying process took. Additionally, durian leather from durian aril was treated by blanching it in a hot water bath at 85 to 100 degrees Celsius for five minutes. It was then mixed with the same proportions of additional components, with the exception of the addition of 200 mg/kg of sorbic acid as a preservative. The mixture was all shaped into sheets that were 1.2 mm thick, and they were then dried in ovens or cabinet dryers. In the oven, it took 12.6 hours to dry at 50°C, and in the cabinet dryer, it took 10 hours at 52.5°C [78].

3.6. Pineapple Leather

In order to make pineapple puree, first remove the stalk and clean each whole pineapple. Next, remove the skin, divots, and leafy crown. Finally, rinse the treated pineapple flesh with tap water, chop the pieces into a puree, and chop for 30 seconds. Before being utilised, the puree was put into plastic bags and kept at −18∘C for a maximum of two weeks. Before using the puree the next day, it should be refrigerated for the entire night. After heating the pineapple puree to 85 ± 5°C and stirring it for 15 minutes at 57 rpm with an automatic pot stirrer, the puree was combined with pectin, glucose syrup, sugar (fixed at 15%), and maltodextrin (fixed at 2%) [79]. To make pineapple paste, the puree was cooked and stirred for an additional 80 minutes. To obtain a flat rectangular paste, they fed 500 g portions of pineapple paste through a cylinder (with an inner diameter of 42 mm) on top of the leather forming machine. A pneumatically driven ram pressed the paste into the extruder zone at a pressure of two bars. They then extruded them through a die (27 mm width × 2.2 mm thickness) at a screw speed of 50 rpm. To create pineapple leather, the flat pineapple paste was laid out on a conveyor belt covered in polypropylene plastic sheets, sliced, and then dried for ten hours at 60°C in a hot air dryer [80].

4. Latesh research in fruit leather

4.1 Fruit leather by blending process

Reports on fruit bars typically focus on the usage of a specific fruit or pulp variety. Aside from the standard method, it has also been reported that fruit bars can be made by combining various fruit pulps. The primary goal of selecting two or more fruits for blending is to enhance the product's nutritional value, sensory aspects (such as colour, texture, and flavour), and storage stability by balancing the contributions of each fruit during the product formulation process [81]. Additionally, it provides a chance to work with year-round fruit availability when conducting an acceptability research on blended papaya leather. 10% soy paste, 15% other fruit pulp, and 75% sapota puree were used to successfully make sapota leather [82]. Additional studies on tolerable blended fruit bars have been documented in apricot-soy fruit bars and blended fruit leather made with sprouted soya slurry combined with peach, plum, and apricot. The finest blended fruit bar was one that had 40% guava and 60% papaya pulp, which had better nutritional and sensory qualities and was also quite affordable. Similarly, mixed fruit leathers have also been made from purees of apple, banana, and pineapple [83].

4.2 Fortified fruit leather

Since fruits and vegetables are poor sources of protein, numerous attempts have been made to create fruit bars that are rich in protein by fortifying them with concentrated protein sources. When food is fortified, vital nutrients like vitamins that were either lacking or destroyed during food processing are added. Thus, protein fortification, which raises the final food value, may make it feasible to produce extremely nutritious and useful fruit bars [84]. Sports and dieting consumers are searching for high-protein snack bars that can be used in place of meals. These products could be developed as replacements for traditional snacks by fortifying bars with nutritionally significant ingredients that have high protein content (15–35%, w/w). Additionally, it has carried out comparison research on different functional snack bars. High-protein nutrition bars are widely used in industries including military cuisine, sports nutrition, space food and emergency food during natural calamities. Whey protein's usefulness as a functional food has been thoroughly examined. The most popular protein sources for creating nutrition bars that are high in protein are whey protein concentrate or isolate and soy protein concentrate [85]. Nonetheless, the primary area of concern that needs to be addressed in order to make protein fortification a standard procedure when creating nutrition bars is sensory issues. A fruit bar with pears, bananas and cacti supplemented with protein has been created. A number of employees have mentioned adding soy and whey protein concentrates, which are also great and affordable sources of high-quality protein [86]. It has been discovered that adding soy and whey protein isolates increased the protein content of the mango leather. It has been reported that inulin and fructooligosaccharides can be produced to fortify papaya and banana bars. As mentioned above, different workers have created a variety of fruit bars. Additional fortification of these bars is possible without significantly affecting other desired attributes like colour, taste, fragrance, texture, and shelf life. A new market for the creation of inventive and creative items is emerging as a result of shifts in customer attitudes and desires. Concern over the persistent issues of micronutrient deficiencies and protein energy malnutrition (PEM) among the burgeoning youth population is growing [87]. A perfect meal should contain 0.7–1.0 g of protein per kilogramme for adults and 1.2–2.0 g per kg for kids, according to the ICMR. Fruit leather has low in fat and high in dietary fibre [88]. Thus, the creation of fruit bars enhanced with protein has the potential to create a new

avenue for the introduction of protein-enriched goods in the battle against malnutrition and to ensure dietary security. [89].

4.3 Using different types of sweeteners

The most widely used sugar is sucrose, which is typically added to fruit purees to create fruit leather or fruit bars as well as other food industry products to provide sweetness to other culinary preparations. In addition to modifying texture and mouth feel and enhancing flavour, sucrose also serves as a bulking agent [90]. It serves as a preservative as well. But there are also a lot of sugar substitutes on the market, which is opening up new avenues for product creation [91]. There are two categories of sweeteners: nutritive and nonnutritive sugar substitutes. Nutritive sweeteners are sugar alcohols including sorbitol, xylitol, isomalt, lactitol, and mannitol; non-nutritive sweeteners are aspartame, saccharin, sucralose, stevia, and acesulfame-K [92]. Because most polyols only partially breakdown, they are poorly absorbed. Their calorie content is lower than sugars for this main reason. The fructans class of carbohydrates includes the products of chicory and Jerusalem artichokes, such as inulin and oligofructose. It has been demonstrated that oligofructose and inulin lower the risk of numerous diseases. As a result, they are regarded as useful culinary ingredients for creating food products that are healthier [93].

4.4 Using corn syrup solids (maltodextrin)

A low-digestible carbohydrate polymer called maltodextrin may be used as a sugar substitute when creating fruit bars. Maltodextrin is made from corn starch that has been heated and acid-treated. Maltodextrin molecules are particularly soluble because they are usually big and highly branched. It has been discovered that adding different additives, such as oligofructose, inulin, and combinations of agave fructans, changed the textural characteristics of the dehydrated apple bars, such as their stickiness and hardness, in comparison to the control sample, which led to low customer approval [94]. The texture of the fruit bar produced with agave fructans was superior, though. Apple leather strips that were crispy at low moisture levels also had less hygroscopicity when maltodextrin was added during the manufacturing process. In samples conditioned at 44%RH, the addition of 15% maltodextrin effectively reduced the moisture uptake by 45%. An extremely well-liked mango fruit bar was produced by developing a nutritionally enhanced mango bar with 32% jaggary, pulp TSS 45 Brix and drying at 70°C [95].

4.5 Using additives to make the products last longer on the shelf

Fruit bars typically endure browning and an increase in microbial load, particularly when being stored. Preservative addition thus becomes a necessary step to improve fruit leathers' capacity to be stored. It was mentioned that adding sucrose to papaya leathers after they were treated with SO decreased browning during storage [96]. Papaya fruit bars' enzymatic browning has been significantly decreased by adding sodium 2 metabisulphite to fruit pulps prior to drying and leather apple products. Moreover, asorbic acid, rice flour, and sucrose are added to sapota pulp to create sapota bars with a three-month shelf life, which are then preserved using sodium metabisulphite [97].

5. Application of fruit leather

Fruit leather is a tasty and convenient snack made from pried fruits that have been dried. It is a great way to preserve the natural flavors and nutrients of fruits while creating a chewy and portable treat. One of the main application of fruit leather is as a healthy alternative to traditional snacks. It is a good option for those looking for a sweet and flavorful treat without added sugars or artificial ingredients. Fruit leather is also a great way to incorporate more fruits into diet, especially for those who may not enjoying whole fruits [98]. Another application of fruit leather is in baking and cooking. It can used as a natural sweetener or flavoring agent in various recipes. For example, we can add fruit leather to muffins, cookies or granola bars for an extra burst of fruity goodness. Fruit leathers can be eaten as snacks or used in pie fillings, in cooking and as a dessert topping. Fruit leather can also be a versatile ingredients in homemade trail mixes or energy bars [99]. It can made by cutting into small pieces and mix it with nuts, seeds and other dried fruits to create customised and nutritious snack mix as well as energy-boosting snack. They can be made into a beverage by combining five parts water with one part leather in a food blender. There has been a growing interest in utilizing apple and apple by-products powder in bread and bakery products (as baked goods are suitable foods to be fortified) [100]. Apple can be eaten as fresh, their crisp texture and natural sweetness make them a popular choice for healthy snack. Apples can also be sliced and added to salads, providing a refreshing and crunchy element to the dish. Apples can be used in various desserts such as pies, tarts and crumbles. The natural sweetness and slight tartness of apples add depth of flavor to these treats. Apple sauce is another creation made from apples, often used as a topping or filling in desserts or as a healthier alternative to oil or butter in baking recipes. The addition of dried apple powder (5 and 10%) increased the antioxidant capacity of wheat bread up to 38.5% and 61.9% when compared with control bread. Apples are also widely used in the production of juices and ciders. Their natural juice is extracted and processed to create refreshing and flavorful beverages [101]. Apple juice is a popular choice for both kids and adults, while apple cider is often enjoyed during the fall season, known for its warm and comforting flavors. Additionally, apples can be transformed into various apple-based products. Apple butter, for example, is a spread made by slow-cooking apples with sugar and spices until they reach a smooth and rich consistency. It is commonly used as a topping for toast or pancakes. Apple chips are another popular

snack made by thinly slicing apples and dehydrating them until they become crispy and flavorful. Beyond the culinary world, apples have other application as well. They are often used in the production of fragrances and cosmetics due to their pleasant aroma [102]. The natural acids in apples make them useful for cleaning purposes such as removing stains or freshening up surfaces. Overall, the sensory properties were acceptable regardless of the control samples. For instance, increased antioxidant properties with improved sensory attributes (fruity flavor) were observed when muffins were prepared with 20% of apple pomace. Natural antioxidants derived from apples have gained much interest for their anti-oxidative characteristics. Thus, they become an important factor in the preservation of food products (containing long-chain unsaturated fatty acids) to prevent lipid oxidation [103]. For example, application of two different apple peel extracts to protect fish products from the oxidation. For this purpose, an initial apple peel extract was pre-pared using 95% ethanol (including primary and secondary metabolites) whereas the second extract was collected from the first after removing two metabolites (sugars and organic acids). The demand for functional packaging materials has gained increasing attention as they are formulated either by adding antioxidants or coating on food packaging materials. The purpose of using functional packaging materials is to reduce food oxidation (main cause of food spoilage) [104]. Functional packaging materials made from polyvinyl alcohol (PVA) matrix incorporated with apple pomace powder (from 1 up to 10% w/w) showed higher antioxidant activity when used as packaging material by preserving soybean oil stored at 23 or 60° C. The antioxidant activity was directly proportional to the concentration of apple powder added to PVA [105]. As the papaya fruit grows faster with higher yields and as it has various varieties which are diverse in range, this fruit can be used for development of economically viable products on commercial scale, with ample scope for blending with other fruits. Papaya is a tropical fruit that is not only delicious but also offers a wide range of applications in various aspect of life. Papaya is commonly enjoyed fresh as a sweet and juicy snack. It can be eaten on its own or added to fruit salads for a tropical twist. Besides consumption as a fresh fruit, a number of processed food products developed using papaya are used in the form of puree [106]. Papaya is a popular ingredient in smoothies and juices. Its naturally sweet and tropical flavor adds a refreshing taste to these beverages. Papaya can be used to make salsas and chutneys. Its slight tangy and sweet flavor pairs well with spices, making it a great addition to savory dishes and it can also be used in desserts like cakes, pies and icecreams. Papaya are also used for medicinal purpose such as anti-inflammatory, immune support, digestive health and skin health [107]. Wen-Jun studied the brewing technology of papaya and jujube to make healthy wine. A method was described for preparation of wine by fermentation of papaya, jujubes, powdered Eucommia extract and honey for 48 hours at 30-34° C. It has been studied that the impact of amino acid addition on aroma compounds in papaya wine fermented with Will iopsis mrakii. The study suggested that papaya juice fermentation with *W.saturnus mrakii* in conjunction with the addition of selected amino acid (L-leucine, L-isoleucine, L-valine and L-phenylalanine) can be an effective way to modulate the aroma of papaya wine [108]. Papaya puree is the major semi processed product that finds use in juices, nectars, fruit cocktails, jams, jellies and fruit leather. A number of low-moisture products such as fruit leather, powder, toffees, chunks, rolls, and slices have been prepared from papaya puree, which finds their place in food commodity market. It is reported that pulp can also be dried after adding 5–7.5% sugar, 0.5% citric acid, and0.3% potassium metasulphite. For cheese product containing fruit blends, optimal ratio of papaya puree to pineapple puree was 2:1 with 2% pectin and processed to 77–80° Brix [109].

6. Storage for shelf life

Since apples are a seasonal fruit, they are prepared for medium- or long-term storage (10–11 months, depending on the cultivar) after they are harvested at their peak ripeness. This prolongs the fruit's shelf life and guarantees the market's supply of high-quality, high-nutrition fruit. Apples produced in industrial gardens are increasingly preserved in regulated climatic conditions in order to meet these goals. According to scientific research, fruits are stored in chambers with low oxygen levels (approximately 1 kPa) or ultralow oxygen levels (0.5 and 0.7–0.8 kPa), high carbon dioxide levels (2-4 kPa), low temperature ranges (0.5–1.0 °C), and high relative humidity levels (94–96%) [110]. Fruit storage under low temperature and anaerobic conditions slows down the cell's fermentation, ethylene synthesis, and metabolism. These elements affect the fruit's ability to withstand illnesses brought on by fungus strains and enable the preservation of fruit quality and extension of its storage life. In controlled environment chambers, apples can be commercially preserved for several months in order to postpone ethylene-induced ripening. Apples are often kept in rooms with high levels of air filtration and carbon dioxide concentrations. This keeps the concentration of ethylene from increasing and stops ripening from happening too soon [111]. The majority of apple varieties can be stored at home for up to two weeks if kept in the refrigerator's coldest section (below 5 °C). Some don't really deteriorate after being stored for up to a year. Apples with storability lengths greater than three times longer than others include 'Granny Smith' and 'Fuji' kinds. Apples that are not organic can be sprayed with 1-methylcyclopropene, which blocks the ethylene receptors in the apples and stops them from ripening for a short while. Papaya CV: Red woman, picked at the two-streak stage, wrapped in Kraft paper. Papaya packaged in board boxes with dimensions of 450x300x300 mm, five plies, and a bursting strength of 20 kg/cm² with built-in cushioning withstands drop tests and vibration better than those packed in CFB boxes with a bursting strength of 18 kg/cm² [112]. When

compared to those other containers, the fruits wrapped in these boxes and stored at 18°C showed reduced weight loss (3.75%), more firmness (2.38 kg/cm2), less spoilage (14.27%), TSS (12°Brix), acidity (0.16%), and carotenoids concentration (1.13 mg/100g) [113]. The papaya fruits were viable for sale for 12 days when stored at low temperatures (18°C, 80% RH) and for 6 days when stored at room temperature (28–30°C, 55% RH). Papayas had a six-day shelf life in ambient storage conditions. Papayas kept in an ambient setting were judged to have reached the end of their shelf life when they began to shrivel, overripen, discolour, and sprout mould. Papaya fruits stored at room temperature may shrink due to a faster transpiration rate at a comparably higher temperature. Moreover, senescence may result from increased respiration rate at higher temperatures because the food supply that supplies energy may be depleted. For up to 12 days, papayas kept in low-temperature storage stayed firm and fresh. Low temperature storage also caused a delay in the rate of ripening. When compared to those kept in ambient settings, they were more glossy and had a more appealing colour. This could be explained by the fruits' decreased rate of respiration and transpiration as a result of the low temperature storage's higher relative humidity and lower temperature. The usage of low temperature is said to be the most essential way to improve the storage life of postharvest food since a higher rate of respiration reduces shelf life [114].

7. Future perspective in papaya

In the future, we can expect further research and discoveries about the health benefits of papaya. It is already known for its rich content of vitamins, minerals and antioxidants, which contributes to its potential anti-inflammatory and immune -boosting properties. Scientists might explore its potential in preventing and managing various health conditions. Papaya has already shown some promising medicinal properties and researchers believe that there is even more potential to uncover. For example, papaya contains an enzyme called papain, which has anti-inflammatory properties. This could help in managing conditions like arthritis. Papaya is also rich in antioxidants, like beta-carotene and lycopene. Theses antioxidants help protect our bodies from damage caused by harmful free radicals. In the future, scientists may explore how these antioxidants can be used to fight against diseases and slow down the aging process. Another area of research is the antiviral properties of papaya. Some studies have found that compounds in papaya leaves may have inhibitory effects against certain viruses, such as dengue and chikungunya. This could potentially lead to the development of new antiviral therapies. Additionally, there could be advancements in papaya cultivation of disease-resistant varieties, improved farming practices, and sustainable agricultural methods. This could lead to increased production and availability of high-quality papayas. In terms of culinary application, we might see more innovative uses of papaya in both sweet and savory dishes. Chefs and food enthusiasts could experiment with incorporating papaya into salads, salsas, desserts, smoothies and more. This could open up new flavor profiles and culinary experiences. Furthermore, with the growing interest in plant-based diets and sustainable food sources, papaya could gain even more popularity as a versatile and nutritious fruit. Its ability to processed into various forms, such as purees, powders and extracts could make it a sought-after ingredient in the food and beverage industry. Taking into consideration various issues, the development of new and efficient postharvest management's techniques, instruments and method are of greatest importance as these techniques, instruments and methods will lower the cost, operation time and will have high efficiency. Overall, the future of papaya can have potential advancements in research, cultivation, culinary applications and its role in promoting health and wellness.

8. Future perspective in apple

Apples are a great source of dietary fiber, which is essential for a healthy digestive system. Future research may explore how the fiber content in apples can contribute to gut health and potentially help with conditions like irritable bowel syndrome (IBS) or inflammatory bowel disease (IBD). We can expect continued advancements in apple cultivation and breeding. Scientists and farmers are always working to develop new apple varieties with enhanced flavor profiles, improved disease resistance and longer shelf-life. This could result in a wider range of apple options for consumers to enjoy. There will also be advancements in apple storage and preservation techniques. Innovations in controlled atmosphere storage and modified atmosphere packaging could help extend the shelf-life of apples, allowing them to remain fresh for longer periods. This would benefits both consumers and producers by reducing food waste. Furthermore, with the increasing demand for organic and sustainable produce, we may see a rise in organic apple farming practices. This would involve minimizing the use of synthetic pesticides and fertilizers, promoting biodiversity and prioritizing soil health. Organic apple could become more readily available and appealing to health-conscious consumers. In terms of apple consumption, we could see more creative uses of apples in various culinary applications. Chefs and food enthusiasts may experiment with incorporating apples into savory dishes such as salads, stews and even as a toppings for some dishes. Additionally, the popularity of apple-based beverages like ciders and apple-based cocktails could continue to rise. Another area of potential development is the utilization of apple byproducts. As the focus on sustainability grows, there could be increased efforts to repurpose apple waste, such as peels and cores, for the production of biofuels, animal feed or even as ingredients in other food products. This would help reduce waste and maximize the use of entire apple. With this, the future of apples looks promising with potential advancements in cultivation, storage, sustainability, culinary applications and utilization of byproducts. Apple-Papaya leather is a delightful and nutritious snack that brings together the flavors and benefit of both apples and papayas. It is made by

blending these two fruits into a smooth paste, which is then dried to create a creamy texture. This process help to preserve the natural goodness of the fruits while creating a convenient and portable snack. One of the key advantage of apple-papaya leather is its nutritional content. Apples are known for their high fiber content, which aids in digestion and helps promote a healthy gut. They are also a good source of vitamin C, which supports the immune system and antioxidants that helps protect the body against the oxidative stress. On the other hand, papayas are packed with essential vitamins and minerals, including vitamin C, vitamin A and folate. They are also rich in antioxidants like beta-carotene, which is converted into vitamin A in the body. These antioxidants helps protect the body's cells from damage caused by harmful free radical. By combining these two fruits in the form of leather, we will get a snack that offers a wide range of health benefits. The vitamins, minerals and antioxidants present in apple-papaya leather support overall well-being and can contribute to balanced diet.

9. Summary and Conclusion

Apples and papayas are two extremely perishable fruits. Therefore, if fruits are not handled soon after harvest, they may rot or have issues like leather formation, which can reduce their value and make them less desirable. Fruits have a tendency to deteriorate quickly if they are not handled or kept properly. It could result from physical harm, bruises, or even exposure to unfavourable temperatures and humidity. Humans often suffer from vitamin deficiencies as a result of hectic lifestyles and poorly balanced diets. Additionally, vitamin and mineral deficiencies cause a host of health problems for people. People must have a healthy, balanced diet that includes plenty of fruits and vegetables in order to overcome this issue. In this experiment, we are trying to lower post-harvest losses by turning apples and papaya into nutritious products that include a variety of vitamins, minerals, fibres, and antioxidants to assist farmers in reducing post-harvest losses. The benefits of both fruits' phytonutrients can be obtained by blending papaya and apple fruit and turning them into an extremely nutrient-dense fruit leather. Apples are crisp and refreshing, and papayas are sweet and tropical in flavour. They will combine to provide a flavour combination that is both distinctive and wonderful when blended. The combination of papaya and apple not only gives the fruit leather a wonderful flavour, but it also gives it a unique texture and colour. Papaya adds a creamy, smooth texture, and apples give it a little bite. The fruit leather is also aesthetically pleasing because of the vivid orange papaya and the vivid red or green apples. These two fruits' nutritional advantages will also be combined by adding them together. While papayas are high in vitamins A and C, apples are a fantastic source of dietary fibre and antioxidants. Not only are papaya and apple fruit leathers delicious, but they are also nutrient-dense. All things considered, combining papaya and apple fruit to make leather delivers a delicious taste combination as well as other nutritional advantages. Fruits are the good source of minerals, vitamins, phytochemical compounds and many other such essential components which are major part of our daily diet. Consuming fruits daily results in building up of the best immune system and keeps the diseases at a distance. India is the major producer of the fruits and vegetables among the other countries. In order to avoid the post harvest losses the produced fruits are further processed into different type of value added products. Leather is one such product which is liked by everyone. The leather is prepared by single fruit or by blending of different fruits. Leathers are made by using different types of fruits like guava, apple, mango, banana, apricot, papaya, pineapple, kiwi, grapes, strawberry etc. The leather is made by washing, peeling and pulping of the fruits and then addition of ingredients like sugar, honey for taste KMS, citric acid to prolong the shelf life, maltodextrin, wheat starch, pectin and gums to prevent the stickiness of the leather. The pulp is then placed on the greased trays and is then dried till the moisture content reaches till 15-20%. Drying slows down the activation of enzymes but does not deactivate them. The change in the colour, texture and flavour is due to changes in the chemical and biochemical reactions. Many types of drying methods are used like Sun drying, Cabinet drying, Freeze drying, Vaccum drying, Micro oven drying, Hot air drying etc. From all the studies made on drying it was noted that the fastest type of drying is the Microwave oven drying which involves the usage of high temperature and the slowest type of drying is the sun drying. The brighter colour of the leather was obtained when dried under sun and Vaccum drying was noted to give the good product. It was observed that when dried under the highest temperature for the short time loss of nutrients, colour, taste and flavour was observed. After the leathers are dried they are further packed with different types of packaging materials for storing and for the safe transport for long distances. It has been observed that the quality of the product decreases when there is increase in the period of storage. Some of thematerials used for packaging are PET jars, Low density polyethylene, aluminium foil, High density polyethylene, Butter paper, Polyester etc. are used.

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