A Review paper on Fruit Jam products

Abhishek Biswas*

Agricultural and Food Processing Department, Indian Institute of Technology, Kharagpur

Abstract

Fruits are perishable, so, for preventing spoilage, it is converted into fruit jam or jelly product to minimize the food spoilage. Fruits are an excellent source of essential vitamins like C, gallic acid, tannins, and anthocyanins and have many beneficial effects due to bioactive compounds (pigments and phenolic compounds). The fruit jam has a smooth consistency, which is made by crushing fruit and disintegrating the solid chunky leftovers. The fruit juice is mixed with pectin and heated to form the gelatinous spread containing 65% sugar in preparing the fruit jam. In the storage study of Fruit Jam, it was found that the TSS, titrable acidity, reducing sugars, and total sugar were increased. Whereas moisture, organoleptic quality, and ascorbic acid content were slightly decreased with an increased storage period. The essential components in preparing the fruit jam are pectin, sugar, and acid, which are added in the correct proportion for proper gel formation. In this review paper, we review the nutrient composition of jam, chemical constituents of Fruit Jam, theory of jam formation, cause of food jam failure, and the enzyme involved in food jam formation.

Keywords: *pectin, organoleptic*

Introduction

India is a vast country with various agro-climatic conditions that help grow many horticultural crops. The second-largest producer of fruits and vegetables produces about 326.58 million tons (mt) of fruits. India also contributes nearly about 30% of the world's production of fruits.

Fruits are high in sugar content and rich in vitamins A and C. it plays a critical role in human diet and nutrition. Due to the perishable nature and season availability, about 16 to 72 percent of fruits are gone waste due to spoilage because of poor storage conditions and transportation conditions. Hence, preservation of fruit is required to reduce fruit wastage.

Fruit jam is a food product made from whole fruit that is crushed or cut into pieces and then heated with sugar and water until it reaches the "setting" or "jelling" point, which is achieved through natural or added pectin. Lawrence and Franklin defined the Fruit Jams as a thick, sweet spread made by crushing/chopped fruits with sugar, pectin, water, and cooking. Bloomfield, in 1998, defined jam as a mixture of fruits and sweeting agents brought to a gelled consistency with or without a permitted ingredient.

The Fruit Jam should have good constancy to spread quickly and should be firm enough to not flow like fluid. The Fruit Jam should contribute at least 68.5% of total soluble solids, and the fruit should contribute at least 45%. The study shows that 27% of essential nutrients are found in the fruit jam during the analysis using the AOAC (Association of Official Agricultural Chemists) method. The fruits jam provides a good source of carbohydrates and energy, and the sugar content lowers the water activity and increases shelf life. Fruit jams are deficient in fatty acid content.

There is a wide variety of fruits jams like Strawberry Jam, Raspberry Jam, Wild Plum Jam, Strawberry Watermelon Jam, Mango Jam, Mixed Fruit Jam, etc. It is used to make different food products like pancakes, Ice cream, toast, etc.

Nutrients composition of the Fruit Jam

The nutrients composition of the fruit jam is given in the following table

	%GDA (Guideline Daily Amount)/serve (serving size: 1 Tbsp (20g))	Per serve
ENERGY (Kcal)	3%	57
PROTEINS (g)		0.1
CARBOHYDRATES (g)		14.2
DIETARY FIBERS (g)	15%	13.6
FAT (g)	Trace	Trace
SATURATED FAT (g)	0%	Nil
TRANS FAT (g)		Nil
SODIUM (mg)	<1%	3.9
*Typical value **% of an adult guidelines daily amount (2000 kcal diet)		

Chemical Constituent

Three main chemical constituents used during fruit jam production are sugar, pectin, and acids. Pectin plays a vital role in jam production as it forms the 'setting point' of jam and makes the jam firm by creating a long pectin chain during the boiling of fruit pulp at a high temperature of 104℃. The level of pectin varies for different fruit. Fruits that contain a high amount of pectins like blackcurrants, guavas, quince, apple, plums, gooseberries, pears, and oranges have higher levels of pectin than those such as strawberries, cherries, grapes, and raspberries. When the fruit jam is made from fruit containing low pectin, either a higher pectin amount of fruit is added, or commercial pectin is added in the fruit jam to increase the pectin content. The Commercial pectins are obtained from the peel of citrus fruits, which naturally contain high pectin content. During ripening, the pectin is converted into a non-gel-forming substance due to enzymatic breakdown by the enzymes pectinase and pectinesterase, which results in the softening of fruits and the breakdown of middle lamellae and cells become separated from each other.

Sugar

Sucrose is usually the most used sweetener in domestic as well as commercial fruit jam products. Many Fruit Jam manufacturers recommend using the 1:1 ratio of fruit to sugar in jam-making. Adding sugar in fruit jam products is essential to produce an ideal flavor, yield, and appearance. The sugar content also influences in maintaining minimal gel strength and maintaining the PH and acidity. The presence of sugar in a jam reduces water activity and provides a preservative effect by binding water molecules to themselves. Due to the reduction of the water activity, microbial growth becomes negligible. The sugar content in fruit jam should be around 65-69%. The sugar proportion added to the fruit juice extract should be appropriate for pectin concentration and depends on the acid concentration. The amount of sugar for the food jam production depends on the acidity. If the sugar content in the fruit jam is low, the resulting jelly will be tough. The presence of excessive sugar makes the fruit jam soft and create a "soft set" that can break easily., From the practical viewpoint, the advantage of substituting the sugar for sucrose is either because of cost or for flavor modification or to reduce crystallization. The Partial replacement of sucrose in fruit jam with other sugars such as maltose, glucose, syrups, and high fructose helps alter the setting time and many other rheological properties. Sweeteners like sorghum, molasses, and brown sugar are not recommended because their presence will overpower the flavor of the fruit. Artificial sweeteners like saccharin and aspartame cannot be substituted in jam products as they cannot form the gel matrix.

Honey is more healthful and requires less processing compared to sugar. However, it loses the complexity of its flavor, fragrance, and some of its health-promoting properties when heated. The use of honey takes longer boiling due to the presence of excessive water. It produces excessive foam during cooking, and gelled preserves made with honey are soft. So, honey is not used in making jam products.

Acidity in fruit jam

Acids play a crucial role in the production of fruit jam by helping the pectin to set. The Acetic acid group in the pectin usually gets ionized. The negative charges on the molecules this ionization causes repulsion and prevents

the pectin chains from forming the gel network. To avoid this pH of the fruit jam mixture to be roughly in the range of 2.8-3.3. At these more acidic PHs, the Acetic acid (COOH) groups are not ionized, lowering the magnitude of the repulsive forces.

Gelling

To get the desired consistency and firmness, adding sugar is essential for the gelling process in fruit jam products. The ability of pectin to form gel takes place only in the presence of both acid and sugar. During the gelling process, the sugar attracts and holds water. The gel consistency is determined by pectin concentration, ranging from 0.5 to 1.5% by weight, depending on the type of pectin utilized.

Chemical Preservatives

Processed foods contain many chemicals added to preserve the food by extending the shelf life and preventing spoilage. Benzoic acids in the form of sodium salts are widely used to preserve fruit jam and jellies. Most food products also use other chemical preservatives like potassium metabisulphite, sorbic acid, calcium propionate, and sodium benzoate.

Theory of Fruit Jam Formation

Fibril theory

This theory states that when the sugar is added to the pectin solution, it destabilizes the pectin conglomerates and pectin-water equilibrium, forming a fibrils network through the fruit Jam. The fibrils network holds the sugar solution in the inter-fibrillar spaces. The firmness of the network in the fruit jam depends on sugar and the acid concentration. The fibrils of pectin become rigid/stiff in the acid presence and weak fibrillar structure due to low acid. Excessive acid will hydrolyze pectin, and the fibrils network loses elasticity, and the fruit jam becomes syrupy.

Spencer's theory

This theory state that sugar acts as a precipitating agent in the presence of acid. And the fact that a greater quantity of acid decreases the sugar requirement in the fruit jam.

Olsen's theory

This theory states that sugar acts as a dehydrating agent, disturbing the equilibrium between pectin & water. The negative charge presence of pectin is reduced with the help of H(+) ion concentration. The pectin precipitates coalesce in a network of insoluble fibers, and the sugar is present in the desired concentration. And when the system reaches equilibrium, the fruit jam strength becomes the maximum.

Causes for Fruit Jam Making Failure

Failure of Fruit Jam to set

1. ***Lack of acid or pectin***: The most common cause of fruit jam failure to gel. Addition of excess acid results breakdown of the fruit jam structure due to the pectin hydrolysis or degradations. The fruit jam also fails to set due to insufficient fruit cooking, resulting in inadequate pectin and acid extraction.

2. ***Excess Boiling***: Results in the hydrolysis of the pectin and the formulation of a syrupy caramelized mass of natural fruit flavors. The fruit juice and sugar are concentrated to the gel point to avoid pectin hydrolysis. The solution is tested with a refractometer as it nears the 65 degrees Brix endpoint.

3. ***Excess Sugar content***: Excess Sugar causes the conversion of the fruit to jam into a syrupy or highly soft jelly, and the texture is corrected/maintained by adding fresh clarified fruit juice rich in pectin content.

4. ***Cooking below the endpoint***: If cooking is stopped before reaching the 65 percent sugar concentration, the texture of the fruit jam will fail to set and remain syrupy and soft.

5. ***Cooking beyond the endpoint*:** The fruit jam texture becomes rigid due to over-concentration if the cooking is beyond the boiling point. This rigidness occurs when the fruit juice is rich in acid and pectin but does not have enough sugar.

Synersis / weeping of fruit jam

The weeping / synersis of fruit jam is a phenomenon of spontaneous exudation of fluid from a gel. The following factors which cause the weeping of fruit jam are:

1. ***low sugar or soluble solids concentration***: The low presence of soluble solids and sugar causes the pectin network to hold more liquid under normal conditions.

2. ***Low pectin***: The low pectin content in the fruit jam results in pectin network formation that is not sufficiently dense and rigid enough to hold the sugar syrup.

3. ***Premature gelation***: The pre maturation gelation of fruit jam is caused due to breakdown of pectin during the pouring of fruit jam into the containers, making the fruit jam weak and broken.

4. ***Excessive presence of an acid***: The presence of excess acid content results in the breakdown of fruit jam structure due to the pectin hydrolysis or decomposition.

Crystal Formation

Crystals are formed in the fruit jam due to excess sugar and grow at ordinary temperature if the finished product concentration exceeds 70 degrees, Brix. The solids of the boiling fruit solution are monitored with a refractometer as the endpoint is reached and should eliminate over crystallization and concentration of sugars.

Role of Enzymes in Fruit Products

Pectinase: Pectinase is the most crucial enzyme present in fruit jam. Pectinase breaks down the pectin into sugars and galacturonic acid. It is derived from other organisms such as fungi. Pectinase becomes activated at 45-55 degrees Celsius and works well at a PH of 4.5-5.5. It catalyzes the random hydrolysis of 1,4-α-Dgalactosiduronic linkages in pectate and other galacturonans and degrades the plant cell wall structure. So the speeding up the release of juice and also helps the industries to save time and money.

The Pectinase presence improves the colour and the aroma of the fruit juice. The pectin breakdown with the Pectinase enzyme removes the cloudiness presence in the fruit juice and reduces the Fruit juice density, which increases the volume of fruit juice and makes it easier to pour. The Pectinase enzyme also breaks down the starches present in the fruit juice, which eliminates any leftover plant materials in the juice.

Invertase: It is another important enzyme in fruit products. It is derived from the beneficial strain of Saccharomyces cerevisiae. It is a carbohydrate digesting enzyme that hydrolysis the sucrose into its parts, glucose, and fructose, by cleaving α-1, β-2-glycosidic linkage. In preparing fruit products, added sugar contact with water and invertase enzyme activates and split the sucrose. This chemical change in the mixture produces benefits in the quality of the fruit jam, including its flavor enhancement, brightness, and the avoidance of crystallization if the sugar concentration is higher than usual. The degree of inversion depends on the hydrogen ion (H+) concentration and the boiling duration. To get sufficient inversion, boil the pectin extract for 10 min at pH 3.0 or 30 min at pH 3.5. In the finished fruit jam, 30-50% inverted sugar/glucose should be present. If greater than 30%, there is a chance of crystallization, and if it is less than 50%, it develops a honey-like mass.

Conclusion

This review paper attempts to shed light on the preparation of fruit jam, increasing the shelf life by using different techniques, nutrient composition of jam product, chemical constituents present in a jam, the theory behind the jam product formation, and the role of the enzyme involved in jam product formation and at last, discussed the failure of jam product. The results reviewed in this article are aimed to find the best blends of the raw material to prepare the food jam. Thus, increasing pectin extract is required by adding more water in the extraction process that dilutes the concentration of TSS, acidity, ascorbic acid (COOH), reducing sugars, and non-reducing sugar, and total sugars and water-soluble pectin in the extract.

References

Akintunde BO., Tunde Akintunde TY., Adejumo AO. (2004) Development of a manual fruit juice extra to, NIFOL, 22, 178-182

Chaudhary R, Yadav M, Singh DB. Changes in physicochemical characteristics of karonda jelly during the storage period. Plant archives. 2007; 792): 885-887.

Kumar A, Deen B, Studies on preparation and storage of jelly from wood apple (Limonia acidissima L.) fruits, Journal of Pharmacognosy and Phytochemistry 2017; 6(6): 224-229.

Sindumathi G., Amutha S., (2014) Processing and quality evaluation of coconut based jam. IOSR J. Environ. Sci. Toxicol. Food Technol., 8(1), 10-14.

Ajenifujah-Solebo, S.O., and J.O. Aina. 2011. Physico-chemical properties and sensory evaluation of jam made from black-plum fruit (Vitex doniana). Afr. J. Food, Agriculture, Nutr. Dev. 11:3. doi: 10.4314/ajfand.v11i3.66629.