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Importance of Some Chemical Preservatives Used in Mango Pulp: A Review

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Abstract: Mango is grown naturally or mainly cultivated in tropical and subtropical regions and well-known for its delicious taste, appealing aroma, color and nutritious benefits. It is easily deteriorated fruit due to its high water content hence, it exhibited shortest post- harvest life. Different types of food preservation methods have been applied to mango and mango products to make it available a year round. Natural or synthetic preservatives can be added to mango and mango products to prong storage life, keep sensory acceptability and safety by inhibiting microbial contamination. mango pulp which is a pectin rich product made from fully matured mango also exhibited shortest shelf life. The addition of chemical preservatives at optimum level could be preserved mango pulp to ensure availability of mango products throughout the year. Potassium sorbate, sodium benzoate and potassium metabisulphite were effective chemical preservatives used alone or in combination to preserve sensory characteristics and prolong storage life of mango pulp. potassium metabisulphite bleached the natural color of mango pulp and altered its flavor but extended its shelf life. Addition of potassium metabisulphite preserved mango pulp to one year at ambient temperature. Chemically preserved mango pulp samples with addition of different concentration of potassium sorbate and sodium benzoate were organoleptically satisfactory for 9 months at 30-45°C storage condition.

Keywords: Mango Pulp, Chemical Preservatives, Shelf Life, Sensory Attributes

1. Background and Justification

Mango (*Mangifera indica* L.), which belonged to the family Anacardiaceae, is grown naturally or mainly cultivated in tropical and subtropical regions [20]. It is well-known for its delicious flavor, appealing aroma, and nutritious benefits. Mango played a significant part in balancing a human's diet by delivering 64-86 calories of energy [16]. Mango fruit is high in carbohydrates, lipids and fatty acids, protein and amino acids, and organic acids. Mango also contained micronutrients such as vitamins and minerals. In addition to nutrients, non-nutrients like as phenolic compounds, flavonoids, other polyphenols like, chlorophyll, carotenoids, and volatile compounds are also presented [22].

Mango is the second most traded tropical fruit in the world and fifth in total production [18]. Because of its physiological nature and seasonal harvesting time, mangoes were underutilized in producing countries. Approximately 20% of mangoes are processed into products such as puree, nectar, pickles, leather, chutney, and canned slices [2]. In developing countries considerable amount of mangoes are wasted because of poor post-harvest handling and lack of adequate transport facilities [6]. Mangoes are also prone to insect-pest infestation and decomposition, resulting in post harvest losses due to poor pre-harvest techniques [3]. After harvest, mangoes remained living and undergo many of the biological processes common to living plants. These included consumption of energy and oxygen, production of heat, production of carbon dioxide, and deterioration of quality [27]. Mango fruit should be picked at the appropriate maturity level; otherwise, immature fruit will be of poor quality, while overripe mangoes would have a limited post harvest life. The process of converting fruits into food by peeling, slicing, chopping, etc. removes the natural components that can protect them from harm and makes fruits easily wilt, cool and disappear in a short time [9].

Shelf life is the period of time that a food can remain suitable for human consumption and safe in all aspects [32].

During this time period, a food product should be stayed acceptable without significantly, releasing its sensory, chemical, physical, functional, microbiological and nutritional properties under appropriate packaging and storage condition [32-33].

Mango is perishable tropical fruit and has a shorter storage life. Depending on storage conditions and varieties of mango seeds, mangoes can have different shelf life. It lasts 4 to 8 days at room temperature, while mango coated with edible films can last 2 to 3 weeks at a freezing temperature of 13 degrees Celsius without deteriorating [41]. Most of the food processing industries are keeping mango pulp for a long time and processing it to different types of mango based foods to ensure the availability of mango products throughout the year. In order to extend the storage life with retained quality attributes, different safe chemical preservatives at optimum level and condition needs to be applied to mango pulp. Mango pulp is not generally consumed directly rather used as fillings for pastries, jams, sauces, fruit juices and drinks [43]. The mango pulp is highly prone to microbial contamination due to high moisture content hence, it exhibited shortest shelf life. Food preservation is the art of preserving of nutritional characteristics, the sensory acceptability, and a prolongation of the food products storage life. Different types of food preservation methods have been applied to food to make it available throughout a year so far. Among that food preservatives which have capable of inhibiting, retarding or arresting the process of fermentation, acidification or other decomposition of food are broadly used during food processing. Chemical preservatives are intentionally added to many foods at the quantity required to control the bio-chemical changes, including the growth of microorganisms and oxidation of fatty acids, vitamins, colorants and flavors. The weak organic acid include benzoic, acetic, sorbic, propionic acids and together with sulfite are the most widely used acid preservatives in industrial food and beverage production. Sorbic, benzoic acid and sulphur-dioxide are added to foods individually or as mixtures, and their concentrations are up to 0.1% (by food weight), as permitted by codex standard [34].

Potassium sorbate, sodium benzoate and potassium metabisulphite have the ability to prevent the enzymatic, non-enzymatic, ascorbic acid and microbial reactions in fruit pulp and are more effective if used in combinations for better preservation. Sorbates are used in combination with sulphur dioxide to hinder chemical, enzymatic and microbial fermentation in high pulp fruit juices [35]. Preservatives are added in smaller amount since these are mostly toxic when consumed in larger amount [17]. When fruit is stored, it undergoes many chemical changes that degrade its quality and nutritive value due to microorganisms, oxygen, or internal enzymatic development [14]. Enzymatic browning is one of the most limiting factors on the shelf-life of fresh-cut products. During the preparation stages, produce is submitted to operations where cells are broken causing enzymes to be liberated from tissues and put in contact with their substrates. Preservatives are the most effective for a longer shelf life because they block or delay the growth of germs, suppress the response when food comes into contact with air or heat, and they also prevent the loss of some vital amino acids, vitamins [28] and also decrease enzymatic browning the discoloration which results from the action of a group of enzymes called poly phenol oxidase (PPO) [9].

Sodium benzoate (SB) is a widely used preservative and antimicrobial substance in many foods and soft drinks [37]. Sodium benzoate is thus nearly 170 times as soluble as benzoic acid, pure sodium benzoate is tasteless and odourless. Sodium benzoate is permitted to the maximum level of 0.1%. When sodium benzoate react with vitamin C can form the carcinogen benzene [23]. Sodium benzoate is more effective against yeasts and bacteria than molds. It is also most applicable for preserving foods and beverages that naturally are low in pH (2.5 – 4.0). The narrow pH range of its activity prevents this preservative from being used in a wider range of foods. These are used to preserve carbonated and non-carbonated beverages, as well as fruit pulps, jams, pickles, salad dressing and juices, at concentrations from 0.015–0.5% [39]. Benzoate-containing meals are absolutely prohibited for asthma patients since they aggravate the illness. Benzoates are also reported to cause rhinitis, chronic urticarial and flushing in some cases. Sodium benzoate which is used to enhance the self-life for a long time is found to form carcinogenic benzene while use with vitamin C or ascorbic acid [23].

Potassium meta bisulphite is widely used in food industry to preserves the natural color of food and protects food against bacteria. Potassium metabisulphite cannot preserve certain kinds of foods, including raw fruits, vegetables and meats. However, the substance can preserve fruits as part of the canning or dehydration process. As a stable supply of SO_2, potassium metabisulphite (K_2O $2SO_2$ (or) K_2 S_2 O_5) is often utilized. Because it is a solid, it is more convenient to utilize than liquid (or) gaseous SO_2. It is rather stable in neutral (or) alkaline environments, although it is degraded by weak acids such as carbonic, citric, tartaric, and malic acids. Mango pulp preserved with the addition of KMS (500ppm), (1000ppm) and in combination with sodium benzoate (500 + 500ppm) showed overall colour stability during 3 months of storage in polyethylene bags under dark conditions at room temperature [1]. Pulp produced from sand pear fruit was preserved up to one year at ambient temperature by adding KMS alone (1200 mg/kg) without a significant altering of sensory attributes of the fruit pulp [38]. Extended shelf life and retained in overall acceptability of mango pulp was obtained by addition of potassium sorbate along with potassium metabisulphite at the level of 0.05% each [6]. Similar research finding reported by Hashmi *et al*., also showed that mango pulp treated with 0.2% of potassium metasulphite and packed in bulk plastic containers exhibited ceased microbial growth and maintained in organoleptic properties [42].

Potassium sorbate is potassium salt of sorbic acid, a naturally occurring unsaturated fatty acid and is completely safe with regard to health and have the lowest allergenic potential of all food preservatives. Sorbic acid is blended with potassium hydroxide in equimolar portions and

recrystallized with aqueous ethylene hydroxide to form potassium sorbate. Potassium sorbate is effective against yeasts, molds, and select bacteria, and is widely used at 0.025 to 0.10 % levels in dairy products, beverages, fermented and acidified vegetables, and fruit products. Mango pulp samples preserved with addition of potassium metasulphite and poatassium sorbate in addition with citric acid maintained the overall eatable quality for colour, flavour and odour during 45 and 60 days of storage [6]. Sensory attributes of chemically preserved mango pulp samples with addition of different concentration of potassium sorbate and sodium benzoate were satisfactory up to 270 days during storage at 30-45°C [43].

Although most artificial preservatives are deemed harmless, a few have severe and possibly life-threatening adverse effects [44]. The health effects of food preservatives may be acute or may be chronic in the long run if someone have constant exposure or accumulations [45]. Immediate effects may include headaches, change in energy level, and alterations in mental concentration, behavior, or immune response [48]. Chronic effects may increase one's risk of cardiovascular disease, cancer and other degenerative conditions [45]. Benzoic acid exposure, whether repeated or continuous, can result in chronic health consequences including organ damage. Reproductive damage was detected in rats given benzoic acid at 0.5 g/kg body weight (BW) each day [22]. Therefore, this article aimed to review sensory attributes and shelf life of mango pulp preserved with some chemical preservatives.

2. Mango Production and Utilization

India, Brazil, and China are the world's top mango producers. Thailand, Egypt, Indonesia, Mexico, Pakistan, the Philippines, and Vietnam are among the countries involved. By far, Asian countries produce the most mangoes on the planet. It accounts for over half of all tropical fruits produced worldwide. Mango is grown commercially in over 80 countries. Asian countries produce the greatest (77%) of the world's output, followed by Americans (13%), and African countries (9%) [31]. Ethiopia's mango industry is yet in its infancy. Mango, on the other hand, is grown throughout the country, particularly in the Rift Valley, western, and southwestern regions. Ethiopia has a total area of 1.13 million Km^2 and is agro-ecologically diversified. Many sections of the country are appropriate for temperate, subtropical, or tropical fruit cultivation. For example, large swathes of the country's southern and south-western regions receive enough rainfall to grow fruits that are adapted to the local climate [12]. Harvesting season ranged from March to July in the west to May to September in the east, depending on where growers are located. During harvesting, most growers prioritized fruit ripening stage, while few considered markets demand. On the other side, growers lacked scientifically confirmed harvesting ripeness standards. As a result, most growers are able to harvest fully ripe fruits [30]. Mangoes are not fully utilized in the producing countries due to their perishable nature and short harvest season [2]. Mango utilization were not well stated.

3. Mango Health Benefits

Phytochemicals found in mango have been shown to have anti-inflammatory properties in a variety of chronic pathological illnesses linked to inflammatory reactions. Inflammatory bowel illnesses, which included ulcerative colitis, are characterized by chronic inflammation of the intestines [18]. Several in vitro studies have demonstrated that mango has the ability to prevent colon cancer. Mangoes are high in dietary fiber, which has been linked to a lower risk of colon, breast, leukemia and prostate cancers, as well as several trial studies suggested that decreased cholesterol buildup in the body [31].

4. Mango Nutritional Importance

Mango fruit is considered as a good source of dietary antioxidants, such as ascorbic acid, carotenoids, and phenolic compounds [21]. As a result, frequent mango eating may be supplied considerable amounts of bio active substances with antioxidant activity as well as other health benefits. Bio active substances have been linked to a reduction in the risk of cardiovascular disease [13], atherosclerosis, and decrease the risk of some types of cancers, among other health benefits [46]. The nutritional makeup of mango pulp is mostly determined by the type or variety of mango, the location and climatic circumstances of its production region, the fruit's stage of maturity [19]. Mango is high in fiber and bioactive substances such as provitamin A carotenoids, vitamin C, and phenolics, which are quickly dissolved during processing and storage [11]. Mango pulp contained four separate types of water- and fat-soluble vitamins, according to the United States Department of Agriculture (USDA) database. Vitamin A and C concentrations are greater than those of vitamins B, E, and K. Green mango's main carbohydrate is starch, which transformed to simple sugars throughout maturity (sucrose, glucose, and fructose). Ripe mango contained modest amounts of cellulose, hemicellulose, and pectin [19]. The vitamin C concentration of mango fruit fluctuated as it ripened; it is higher in less ripened mango fruit than in fully ripe mango fruit [22].

5. Mango Based Value Added Food Products

Processed mango products came in a wide range of flavors, with differences from country to country and area to region. It can be peeled, sliced, and diced mangoes, which introduced to slice, dice, and puree mango products [10]. Mango is a unique fruit in terms of the variety of goods that may be made from it, particularly during the immature to fully ripe phases. Mangoes are used to make a variety of tasty and healthy goods. Mango pulp, jams, jellies, canned slices, dehydrated pulp (mango leather), frozen chunks and slices are currently available in chemically preserved, canned, dried, and frozen forms. Puree/pulp, nectar, juice, juice concentrate, and dried/dehydrated mangoes are the most common processed

mango products [29]. Mango powder can be used for preparing drinks, desserts, baby foods, and confectioneries. In addition, dried green mango powder can be added to curries, chutneys, and soups to impart fruity flavor. On a commercial basis, three significant drinks created from mangoes are mango juice, nectar, and squash. Mango nectar contained 20% pulp, sugar, and acidity. These beverages came in cans [5].

6. Mango Pulp Processing Technologies

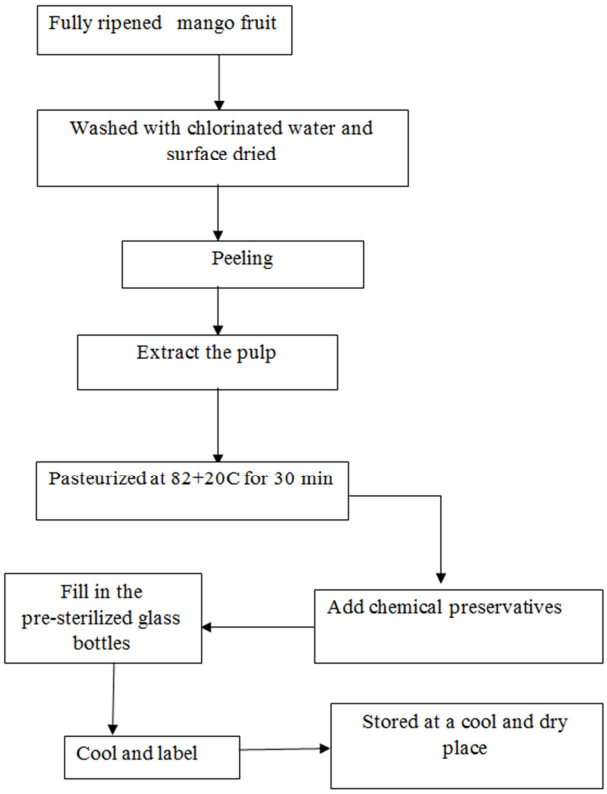

Figure 1. *Flow sheet of mango pulp processing.*

Fruit products are consumed in raw, minimally processed, or processed ready-to-eat or ready-to- drink forms such as whole fresh fruits, fresh cut fruits, and fruits used as components in drinks, juices, and jams. After harvesting, processing of fruits begins, and four processes may be distinguished stabilization or preservation, transformation, manufacture of ingredients, and creation of fabricated meals [13]. Mango is a commercially important tropical fruit. Farmers reported high wastage throughout the production season and relative shortage during the off season due to the perishable nature of the product. To have the product available all year, the fruit must be processed into a form that can be easily kept, preserved, packaged, transported, or consumed in the forms of different products like mango pulp and juice. Mango juice is made by adding an equivalent amount of water and modifying the total soluble solid and acid levels [5]. It can also be drunk fresh. Fruit juices can be dried, combined or blended with other juices to form jams, or evaporated to concentrates [26]. Mango juice also has a high calcium and iron content, calcium aids in the creation of healthy teeth and bones, while iron aids in the elimination of free radicals in the body [4]. Mango pulp is a pectin rich product made from fully matured mango and suitable for conversion to juice, nectar, drinks, jam, and other beverages. It is considered as a source of major and minor nutrients also recognized as nutraceutical on the basis of presence of carotene as an antioxidant. Uniformly ripened mangoes were subjected to washing, peeling, coring, slicing and macerating in an electric blender to get homogeneous pulp. Then pulp was pasteurized in a water bath at a temperature of 82 ± 2°C for 30 min to reduce the microbial load. The acidity was adjusted to 1.0% by addition of citric acid of commercial grade. The process flow chart for preparation of mango pulp is given in Figure 1.

7. Preservatives

Preservatives are natural or synthetic substances that are added to food items, cosmetics and pharmaceuticals in order to extend their durability, maintain their quality and safety by inhibiting, retarding or arresting their fermentation, acidification, microbial contamination and decomposition [44]. It may keep food fresher for longer periods of time and helped us to gain varieties of fruit products year round [45]. Food preservatives can be used to inhibit or prevent spoilage caused by different micro-organisms, enhance consumer acceptability and maintaining quality to make the food more readily affordable, maintain color, consistency, flavor, and texture changes, alkalinity or acidity as well as to delay rancidity. Preservatives should not be irritant, not be toxic, should be stable (physically and chemically) [7] should be compatible with all other ingredients, should be act as good antimicrobial agent, potent in action, have higher shelf life. Generally, Preservatives are classified as: -

1) Natural preservatives included salt, sugar, vinegar, syrup, spices, honey and edible oil [7].
2) Chemical or synthetic preservatives include benzoates, sorbates, nitrites and nitrates of sodium or potassium, sulfites, glutamates and glycerides. Chemical preservative should be used in one food item [45]. People consuming or using items containing more than one preservative are at risk of exposure to multiple chemicals [17].

Table 1. *Codes assigned by commission of European union for some chemical preservatives.*

Number	Codes	Preservatives	Maximum possible limit
1	E200	Sorbic acid	200ppm
2	E202	Potassium sorbate	200ppm
3	E203	Calcium Sorbate	200ppm
4	E210	Benzoic acid	200ppm
5	E220	Sulphur dioxide	200-300ppm
6	E223	Sodium metabisulphite	200-300ppm
7	E224	Potassium metabisulphite	200-300ppm

Source: [7]

Food preservation and processing become vital in order to utilized and maintain its organoleptic properties like taste, flavor, and appearance. It is a great source to utilize the mango products by the processing of different product formation as mango breakfast cereal, mango dried chutney [5].

8. Effects of Chemical Preservative on Shelf Life and Sensory Properties of Mango Pulp

The Institute of Food Technologists defines sensory evaluation as "a scientific discipline utilized to elicit, measure, evaluate, and interpret human reactions to meet sensory features as experienced by sight, smell, taste, touch, and hearing" (IFT). Sensory evaluation can be used to compare similarities and differences in a variety of fruit/products; evaluate a variety of existing fruit and products; and analyze food samples for improvements. Assess reactions to a fruit/product, such as acceptable vs. unacceptable [5]. Sensory study of fruit pulps and products is a useful method for determining the relationship between physicochemical qualities and human perception [6].

It is evident that addition of chemical preservatives greatly influences these attributes with a little loss in pulp quality [1]. According to duraani study addition of potassium sorbate and sodium benzoate, either alone or in combination, obliterate the pulp's natural yellow color. This could be due to the interaction of these preservatives with carotenoids in mango pulp [6]. While potassium metabisulphite bleaches the natural color of mango pulp and alters its flavor, it extends its shelf life [8]. This sensory assessment study revealed that addition of potassium sorbate and potassium metabisulphite at a concentration of 0.05 percent each, as well as potassium sorbate and ascorbic acid at a concentration of 0.1 percent each, maintains the overall acceptability of mango pulp to some extent.

Mango pulp preserved with potassium metabisulphite exhibited in controlled microbial growth and maintained sensory characteristics [42]. Addition of potassium metabisulphite as preservative in mango pulp ensure physcio-chemical stability, increases shelf-life to twelve months at ambient temperature, minimized degradation in colour, flavour, taste and overall quality [36]. According to research finding by Sakhale *et al*., safe and maximum sensory attributes upto three months was reported for mango pulp preserved by sodium benzoate, potassium meta-bisulphite (KMS), potassium sorbet each at 0.2% and stored room temperature [47]. Other related study revealed that pear pulp preserved by adding potassium meta-bisulphite alone (1200 mg/kg) or in combination with Sodium benzoate (600 mg/kg each) could be kept up to one year at ambient temperature without a significant loss of sensory properties of the fruit pulp [38]. Green mango pulp treated with different concentration of potassium metabisulphite were found to be acceptable in both nutritional value and sensory acceptability upto 120 days under freezing storage condition [40]. This showed that the use of chemical preservatives combined with cold storage, is effective in enhancing sensory attributes and shelf life of fresh fruits and fruit products.

9. Conclusion

Use of different preservatives at optimum level in mango pulp greatly contributed in maintaining quality and extension of fruits post harvest life. Chemical preservatives such as Potassium sorbate, sodium benzoate and potassium metabisulphite are among the most important preservatives used in the preservation of mango pulp. These preservatives have significant role in arresting microbial growth, improving shelf stability, enhancing sensory properties of mango pulp to 1 year.

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