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Review Article

Creating A Fresh Plum (Prunus Salicicina Lindell) Consumer Quality Index.

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Abstract

The main uses for plums are for fresh eating, canning, freezing, and jam.Sadly, the amount of plums consumed has either decreased or stayed the same. Customers lament the poor flavor quality but are prepared to spend more for superior products. Therefore, the primary obstacles to consumption are flavor loss and issues with cold storage. Plum varieties are susceptible to "off flavors," flesh discoloration, and gel dissolution. Genotype, qualitative qualities, harvest date, and appropriate postharvest management all influence consumer acceptability and postharvest life. To optimize flavor and postharvest life, a consumer quality index (CQI) based on minimal firmness and soluble solids concentration (SSC) is suggested. Late harvest typically improves quality features. Critical bruising thresholds (CBT), which are based on the minimal hardness assessed at harvest, have been shown in our studies and in industry experience to be a good predictor of when to harvest safely for the best visual and sensory quality.Due to their great tolerance for bruising damage, plums fared well in late harvest; however, in order to preserve flavor and prevent the onset of chilling injury, proper postharvest temperature control and selling within the possible postharvest life are necessary. Therefore, a CQI based on SSC and minimum firmness evaluated during consumption is suggested in order to optimize flavor and postharvest life. In order to preserve quality and boost consumption, this article offers advice on utilizing this CQI in conjunction with appropriate postharvest handling practices, such as accurately determining the harvest date and controlling temperature.

Keywords : *plum consumption; consumer quality index; flesh breakdown; temperature management;critical bruising thresholds; maximum maturity; late harvest; firmness; SSC.*

INTRODUCTION

The plum (Prunus salicina Lindell),a drupe, is a fruit with a single seed encased in a pericarp. The pericarp differentiates into three layers: the exocarp, or outside skin; the mesocarp, or fleshy middle layer; and the endocarp, or hard, woody layer, which surrounds these layers.Carbohydrates (sugar alcohols and the soluble sugars sucrose, glucose, and fructose), organic acids, lipids, proteins, dietary fiber, minerals, and vitamins are abundant in the exocarp (skin) and mesocarp (meat). Plums cultivated in the United States [1] and Europe [2] have been found to contain nutrient contents. Compared to other fruits, plums have higher quantities of bionutrients and antioxidants [3–5]. Each of these fruit components has nutritional, health-promoting, and sensory benefits. The bioactive substances can be divided into phenolic and tetraterpenoids, which are involved in cellular metabolism as well as the fruit's astringent flavor and pigmentation and browning [6–9].Phenolic substances, which are classified as flavonoids and phenolic acids, are secondary metabolites [4,5].Vitamin C, carotenoids, and antioxidants are all derived from these pigments. Caffeic and chlorogenic acids are the main sources of phenolic acids. Comprising anthocyanins, flavones, flavonols, flavanones,flavan-3-ols, and isoflavones, flavonoids are a broad class of structurally related substances. Anthocyanins are a prevalent flavonoid pigment that gives plums their red or black hue.

Eating plums lowers the production of reactive oxygen species (ROSs) in human blood plasma and offers protection against a number of chronic diseases because of their high concentrations of phenolic acids, flavonoids, and anthocyanins. Plum fruit polyphenols, in particular, have chemo-preventive properties against estrogen-independent and -dependent breast cancer cells, with little to no activity on normal cells [6,7], attenuation of oxidative stress and inflammation in in vitro and ex vivo studies, inhibition of

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tumor growth and metastasis of breast cancer in mice [9], prevention of risk factors for metabolic disorders and cardiovascular disease associated with obesity in rats [7], and alteration of intestinal microbiota in rats [5–11]. In addition to its laxative and antihypertensive qualities, plums can be used to treat duodenal ulcers and manage constipation [5,11].

RESULTS

Creating Maximum Maturity Tools and Critical Bruising Thresholds

the maximum maturity index [12,13] as the latest stage at which plums can be harvested without sustaining bruising damage during commercial postharvest handling [14,15] in order to create a safe procedure for determining how late an orchard can be harvested. I used bruise susceptibility measures based on fruit firmness to create maximum maturity indices for plum cultivars [13–17]. Fruit with varying hardness was exposed to three industry-standard bruising energy levels (G), which were evaluated using an IS-100 accelerometer (Techmark, E. Lansing, MI, USA) in order to assess bruising susceptibility. The impact bruising energy G levels found in our earlier packinghouse bruising potential survey [16,18,19] were replicated by the three dropping heights onto a surface with established physical properties.

Characteristics of Fruit Quality and Customer Acceptance

When plums attain maturity, they go through physical and physiological ripening changes [13,19]. As the fruit ripens, its color changes from green to red or dark, its firmness decreases, its sweetness (carbohydrates) increases, and its sourness (organic acids) is perceived. Delaying harvest in most plums enhanced fruit size, deepened red color, and improved flavor, improving quality traits appealing to customers, according to our earlier research utilizing one key cultivar produced at three locations in the early, mid, and late seasons [17, 20–22]. Harvest date and cultivar had an impact on sensory qualities during this assessment, but orchards had no effect. A non-destructive method of figuring out how late harvest can be carried out was crucial, though, as some bruising and decay issues were noted during cold storage and retail handling ([15], Table 1).

While consumers complain about the poor flavor quality, plum consumption has stayed the same or even decreased.I therefore made the decision to look at these impediments to consumption [14,20,22,23]. SSC (soluble solid concentration), TA (titratable acidity), SSC: TA, color, and hardness are the primary factors influencing consumer visual and sensory approval [9,15].Customers may reject certain cultivars of plums due to the phenolic content (astringency) in the skin [8,20]. Plum consumer acceptance reaches its highest potential (80 to 90%) when the fruit is eaten at a firmness of 0.9 to 1.8 kilograms (ready-to-eat, too soft), according to trained panel and consumer acceptance sensory testing [21, 23]. The consumer approval rate drops from around 85% to about 40% when plums are eaten at a greater firmness (less ripe to hard, 1.8 to 3.6 kg) [20].The majority of plums are accepted by consumers based on SSC levels, whereas early-season plums with high TA >0.7% are mostly influenced by TA. Harvest date had a significant impact on SSC and TA levels in “Blackamber” plums, which in turn affected consumer acceptance and market viability (20, Table 2). The ripe titratable acidity (RTA) of plums falling within the most popular commercial ripe soluble solids concentration (RSSC) range (10.0 to 11.9%) was a major factor in consumer approval. Eighteen percent of customers disliked plums in this RSSC range with low RTA (≤0.60%), whereas sixty percent disliked plums with RTA ≥ 1.00%. Regardless of RTA, ~75% of consumers accepted plums with RSSC ≥12.0% (Table 2).Additionally, our sensory analysis revealed that ripening plums treated prior to ingestion reduced TA by 30 to 40% compared to the TA assessed at harvest.In certain instances, plums that would otherwise be unpalatable may become more acceptable due to the ripening process’s drop in TA and increase in the SSC:TA ratio. Ripening procedures have been created and pushed for distribution to retail locations, retail locations, and homes [18, 20, 24].The selection of newly released cultivars, particularly pluots, was based on their great potential for consumer acceptance, low TA, high SSC, and low skin astringency [21, 24].

Obstacles to Plum Intake

Disorders of Cold Storage that Restrict Consumption: When ripe fruit is warmed to ripening temperatures (18 °C to 25 °C) after cold storage, chilling injury symptoms (CI), such as gel disintegration, flesh translucency, flesh bleeding, browning, and/or “off flavor” (Figure 1), typically manifest [25–28]. Harvest maturity and temperature control have a significant impact on the start and intensity, which differ between cultivars [25,27,28]. When kept at 5 °C instead of 0 °C, the majority of plums and pluots are more likely to exhibit these symptoms [28] (Table 3). As a result, cultivar and storage temperature affect market life, which is defined as when 20% of fruit exhibit symptoms [28] (Table 3).For instance, plums of the varieties “Blackamber,” “Fortune,” “Betty Ann,” “Joana Red,” “Flavorich,” “October Sun,” and “Angeleno” that were kept at 0 °C had a market life of more than five weeks, whereas other cultivars that were examined showed signs of chilling injury within three to four weeks, even when kept at 0 °C [28] (Table 3). After being stored at 0°C, all plum cultivars had a significantly longer market life than those stored at 5°C [28] (Table 3). However, other elements including orchard conditions, season, and maturity also have an impact on market-life potential. Pit burning symptoms, which resemble

fleshbrowning illnesses, are brought on by high temperatures throughout the growing season and are linked to heat injury during fruit development. In order to identify this field issue before putting fruit in cold storage, it is crucial to evaluate the state of ripe fruit while estimating market life.

Avoiding Damage from Cold Storage

For the majority of plum cultivars, storage at 0 °C had a higher potential postharvest life than storage at 5 °C [28] (Table 4). Furthermore, postharvest life can be prolonged by late harvest maturity [15,27–29]. Field bins, forced-air cooling, hydrocooling, or room cooling should all be used to eliminate field heat as soon as possible after harvest before packaging. Next, forced-air cooling should be used to bring the packed plums down to almost zero degrees Celsius. To optimize plum postharvest life, a storage temperature of −1.1 °C to 0 °C with 85 to 95% relative humidity is strongly advised.However, high SSC and superior thermostatic control are necessary to prevent freeze damage while storing plums at this low of 1.1 °C [30]. Depending on SSC [30], the plum freezing point ranges from -2 to -1 °C.

In certain situations, fruit firmness can be preserved and alterations in ground color and decay can be postponed with controlled atmosphere (CA) and/or modified atmosphere packaging (MAP). The dependable advantages of low temperature storage, CA, and MAP have limited commercial usage because of inconsistent and even harmful commercial results [31, 32].

Plum Consumer Quality Index (CQI) Absence

Creating an Index of Consumer Quality

Using a color chip guide to evaluate harvest ripeness, the date of harvest is established by changes in the skin background color from green to dark or red [14–17,19]. This maturity measure is unusable in new cultivars since the entire red or black hue develops before harvest maturity, hiding background color changes on the fruit skin. The harvest maturity index based on variations in background color only ensures that, for the most part, plums will ripen off the tree. Nevertheless, neither the maximal postharvest life nor the minimum quality features required to satisfy consumers are guaranteed by this harvest maturity index.Thus, the idea of a consumer quality index (CQI) was required in order to boost plum consumption. Based on sensory research and critical bruising thresholds (CBT), which characterize fruit vulnerability to physical mistreatment, a consumer quality harvest index was created.A minimal SSC of 11 to 12% for specific plum cultivars will satisfy at least 85% of customers, according to “in-store” consumer test results. Additionally, by consistently classifying plum cultivars into tart, plum fragrance, and sweet/plum flavor groups, our plum-trained panel separated cultivars based on the perception of sensory qualities [21]. With the exception of cultivars in the tart group, where acidity was at least 0.7%, SSC was the primary factor influencing consumer approval for each flavor group [21, 23].

DISCUSSION

CBTs

Plums exposed to these energy bruising levels only produced a small number of bruises on fruit weighing less than 1.4 kg at the high energy level 245 G (extremely rare) [12], as shown in Table 6. By employing CBTs, we may harvest later without risking mechanical damage, increasing the potential quality of the fruit. Determine how late and how soft fruit can be gathered and packaged without bruising under particular circumstances by evaluating packing line G-forces and fruit damage susceptibility. Depending on the cultivar and/or orchard circumstances, fruit quality potential can be maximized.According to our earlier research on stone fruit transportation, the firmness of the fruit and the packaging strategy lead to damage during transit (Crisosto’s unpublished data). Transporting tray-packed stone fruit stands is superior to volume-filled ones. On the weakest fruit position, fruit weighing between 2.3 and 3.6 kg had a 2% chance of being damaged.

An IS-100 recording accelerometer was positioned in the middle of the top layer of 12 two-layer tray-packed boxes (45 cm × 36 cm × 16.5 cm box size, 48 fruit) to measure the bruising potential at retail. The results showed that accelerations (G) and velocity changes (m/s) varied during box handling, pallet removal, and repalletization (12, Table 7). The power of impact at this stage ranged from 32 G (7.6 cm drop) to 103 G (31 cm drop). The range of accelerations during shop display and box handling was 19.6 to 34.7 G. As a result, for several plums with firmness equal to or more than 1.4 kg force, retail accelerations were less than the CBT.The majority of the time, SSC was able to surpass the suggested consumer quality index (CQI) by using these CBTs to decide the harvest date. In most orchards, this strategy surpasses the suggested CQI by maximizing the quantity of plums in the orchard (Table 8).

Plum Harvesting and Management

In California, each cultivar’s skin color variations are used to calculate the harvest date [14]. For certain cultivars, maturity is determined using a color chip guide. For some cultivars, firmness—which is determined by pressing the fruit in the palm of the hand (or “spring”)—is also a helpful maturity index [14,33], particularly for those that reach full color several weeks before harvest. For plum cultivars where the skin ground color is obscured by full red or dark color development prior to maturation, it is advised to measure the firmness of the fruit. The suggested CBT and maximum maturity index, which is the point at which fruit can be picked

without sustaining bruising damage during postharvest handling, can be calculated using flesh firmness, which is tested with a penetrometer (eight mm tip). Compared to most peach and nectarine cultivars of similar hardness, plums are less prone to bruising.

Consumer Quality Index (CBT) Implementation in the Field

The tree's ripening of its plums occurs from the top to the bottom as a result of exposure to temperature, light, and canopy structure. Compared to well-exposed fruit at the top of the tree, lower fruit may mature up to 10–14 days later. As a result, several harvests are carried out, usually two to four. The biggest pick is usually the first harvest of plums. Due to the fact that many plum cultivars reach full color, It was crucial to create a technique that would allow a field worker to quickly assess fruit ripeness and forecast consumer grade potential, as these fruits typically soften quite slowly and are harvested several weeks before commercial harvest.To allow workers to work more quickly, this is typically accomplished in full-color cultivars by harvesting only a portion of the tree, usually divided by light exposure: the top third of the tree in the first harvest, the middle third in the second, and so on. Harvested fruits are placed in picking bags with a maximum capacity of 20 kg. Between 400 and 450 kg of fruit are packed into bulk bins by the pickers. Tractor-pulled trailers that can accommodate three or four bins are used to move the bulk bins throughout the orchard. Typically, each harvest crew needs two tractors and bin-trailers. When full,the bins are taken to a centralized shaded area and unloadedfrom the bin-trailers to await loading by forklift onto flatbed trailers for delivery to the packing facility.

CONCLUSION

I suggest boosting plum consumption with a CQI. I used bruising susceptibility assessments based on fruit energy impact firmness to create maximum maturity indices based on CBT for the most significant plum cultivars in order to facilitate the creation of this CQI. These CBTs were expressed as G (acceleration) and computed for varying fruit firmness levels. These limits forecast the amount of physical stress that fruit will withstand at various firmness levels when being packed in a warehouse. Using CBT maximizes fruit quality qualities and consumer acceptance by enabling later picking without causing bruising. It is possible to pick plums later because the majority of cultivars do not sustain physical harm from high energy or bruising impacts.Most of the time, harvesting late enables SSCs above the CQIs to be reached without endangering the crop. In order to maximize the potential for fruit orchard quality, I suggest employing CBTs as a tool to help with harvest decisions without causing bruising during postharvest handling. Fruit drop, environmental conditions, availability of hand labor, market prices, distance to market, possible transportation damage, and temperature control at the reception place are additional considerations that should be taken into account when determining when to harvest.

Two major obstacles to plum consumption will be removed by a regulated late-maturity harvest, which will also allow fruit to acquire sensory qualities and lessen harm from cold storage. When this CQI is established and the temperature is properly controlled, consumers should be guaranteed fruit with a strong flavor.

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