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Production of Pidada (*Sonneratia caseolaris*) Chewy Candy

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Pidada (*Sonneratiacaseolaris*) was a common fruit without toxic, soft pulp in texture, specific flavour and nice taste. This research evaluated the effect of gelatin and sucrose concentration, isomalt replacement to sucrose, boiling temperature and time to quality of pidada chewy candy. Results showed that pidada pulp was blended with gelatin (0.4%), isomalt: sucrose (15%:30%), boiling temperature and time (115/45, ^{o}C/ min) to obtain the best quality of pidada chewy candy. By this investigation, the added value of pidada fruit would be improved effectively.

Keywords: Chewy candy, gelatin, isomalt, pidada, sucrose, temperature, time

INTRODUCTION

Pidada (*Sonneratiacaseolaris*) was commonly distributed in the coastal areas of KienGiang, TraVinh and SocTrang provinces, Vietnam. It's a small tree with oblong or obovate-elliptic coriaceous leaves and large (Samir et al. 2006). Berry globose, pericarp leathery, apex of fruit depressed at base of style (Goutham-Bharathiet al.2012). Its fruit peel had a very strong antioxidant activity (Paputungan et al. 2017). Its fruit pulp had a sour and fragrant taste similar to tamarind fruit due to a huge content of ascorbic acid. Pidada fruit (*Sonneratiacaseolaris*) contained about 15.95% carbohydrate, moisture 77.10%, fat 0.86%, ash 3.85% and protein 2.24% (Patil and Chavan, 2013). Its fruit pulp also contained various bioactive compounds such as saponins, sapogenins, terpenoids, flavonoids, tannins, polyphenols (Samir et al. 2006; Prabhu and Ravishankar, 2013; Harekrishnaet al. 2015; Jariyah et al. 2015b) exhibiting important biological attributes such as astringent, antiseptic, antioxidative, antimicrobial against pathogens (Minqing et al. 2009; Shahbudin et al. 2012; Peddinti and Vanga, 2017; Pagarra et al. 2019). Its pulp had hypoglycemic effect due to dietary fiber, vitamin, flavonoid (Sadhu et al., 2006; Ashok et al. 2010). It possedhepatoprotective, antibacterial, antidiabetic, antioxidant and anticholesterol properties (Bandaranayake, 2002; Charoenteeraboon et al. 2007; Banerjee, 2008; Minqing et al. 2009; Phaechamud et al. 2012; Wetwitayaklung et al. 2013; Jariyah et al., 2014; Jariyah et al., 2015a). The fruit pulp extract was utilized as therapeutant for numerous ailments like cough, anthelmintic, haemorrhage, immunostimulant (Pedro et al. 2012; Wetwitayaklung et al. 2013). The half ripe fruits were utilized to relieve cough, the ripe fruits are used as anthelmintic drug and the fermented fruit juice was useful in arresting haemorrhage (Wetwitayaklung et al. 2013). The pulp of unripe *S. caseolaris* contained the high total phenolic, flavonoid and carotenoid content as compared to ripe fruit (Abu-Bakar et al. 2020). This fruit could be converted into different products such as syrup (Abeywickrama and Jayasooriya, 2010), juice (Nguyen, 2019), cakes and steamed pudding (Jariyah et al. 2014). Objective of our study verified the effect of gelatin and sucrose

concentration, isomalt replacement to sucrose, boiling temperature and time to quality of pidada chewy candy.

MATERIALS AND METHODS

Material

Ripen Pidada fruits were naturally collected in Cu Lao Dung district, SocTrang province, Vietnam. Fruits were washed with clean water remove dirt and foreign matters. These fruits were blanched in hot water at 100^{o}C for 90 seconds, then cooled and crushed. Their pulp was obtained after seiving. Their pulp was initially frozen at a temperature of −20 ± 2°C, and then being defrozen in the thawing machine at a temperature of 28 ± 2 °C.These pulp was ready for experiments. Chemical reagents were all analytical grade.

Researching method

The gelatin was dissolved in water in a gelling agent: a water ratio of 1:2.5 (w/w) to obtain a homogeneous blend and subsequently added to the syrup.

Experiment # 1: Effect of gelatin and sucrose concentration to quality of pidada chewy candy

Pidada pulp was blended with gelatin (0.1-0.5%), sucrose (30-50%). This mixture was boiled 100 ^{o}C for 60 minutes, poured into the molds, cooled and wrapped. The pidada chewy candy was evaluated overall acceptance to determine the appropriate gelatin and sucrose concentration.

Experiment # 2: Effect of isomalt replacement to sucrose to quality of pidada chewy candy

Pidada pulp was blended with gelatin (0.4%), isomalt: sucrose (0%: 45%, 5%:40%, 10%:35%, 15%:30%, 20%:25%, 25%:20%). This mixture was boiled 100 ^{o}C for 60 minutes, poured into the molds, cooled and wrapped. The pidada chewy candy was evaluated overall acceptance to determine the appropriate isomal and sucrose concentration.

Experiment #3: Effect of boiling temperature and time to quality of pidada chewy candy

Pidada pulp was blended with gelatin (0.4%), isomalt: sucrose (15%:30%). This mixture was boiled under different temperature and time (100/ 60, 105/55, 110/50, 115/45, 120/40, 125/35, ^{o}C/ minutes). The paste was poured into the molds, cooled and wrapped. The pidada chewy candy was evaluated overall acceptance to determine the appropriate boiling temperature and time.

Sensory and statistical analysis

Overall acceptance was evaluated by a group of panelists using 9 point-Hedonic scale. The experiments were run in triplicate with different groups of samples. The data were presented as mean±standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

RESULTS AND DISCUSSION

Effect of gelatin and sucrose concentration to quality of pidada chewy candy

Table 1 showed the fffect of gelatin and sucrose concentration to overall acceptance of pidada chewy candy. It's obviously noticed that 0.4% gelatin with 45% sucrose created the highest overall acceptance of the pidada chewy candy. Gelatin originated from the collagen of leather or bones (DeMars and Ziegler, 2001; Djagny et al. 2001; Tau and Gunasekaran, 2016). Sucrose could stabilize the structure of gelatin by reinforcing hydrophobic interactions or hydration of proteins (Choi et al. 2004). In chewy candy preparation, gelatin created a gelling three-dimensional network of junction zones by its helix (Guo et al. 2003). The high molecular mass of gelatin provided more strength of the gel when dissolved in water causing adding gelatin gave more stickiness, toughness, and hardness of the products. The involvement of gelatin in the formulation caused an elastic texture and stable form that led to the high springiness desirable for confection products (Hamann et al. 2006). In higher replacement of sucrose with gellation, the texture of the gelatin gel was weakened because the sugar solids were missing from the regular formulation (Kasapis, 2001 and Kasapis et al. 2003; Tau and Gunasekaran, 2016). Jiamjariyatam (2018) examined the influence of gelatin (9, 12, and 15%) and isomaltulose (20, 30, 40, 50, and 100%) on the physical and sensory quality of gummy jelly. Gummy jelly containing 40% gelatin and 12% isomaltulose gave a maximum significant score in appearance, transparency, sourness, texture and overall acceptance.

Implementation of frozen-thawed pretreatment caused the cell damage leading to an improvement of the pressing efficiency (Rafał et al. 2020). Slow freezing was normally used to treat cellular structure.

Table 1: Effect of gelatin and sucrose concentration to quality of pidada chewy candy

Gelatin (%)	Sucrose (%)				
	30	35	40	45	50
0.1	4.72±0.01^{e}	5.24±0.00^{de}	5.76±0.02^{d}	5.93±0.01^{cd}	6.01±0.00^{c}
0.2	5.21±0.03^{de}	5.71±0.02^{d}	5.89±0.00^{cd}	6.05±0.03^{c}	6.22±0.01^{b}
0.3	5.73±0.00^{d}	5.94±0.01^{cd}	6.12±0.03^{bc}	6.25±0.01^{b}	6.47±0.02^{ab}
0.4	5.95±0.02^{cd}	6.17±0.03^{bc}	6.28±0.01^{b}	6.45±0.02^{ab}	6.61±0.00^{a}
0.5	6.03±0.01^{c}	6.20±0.00^{bc}	6.31±0.02^{b}	6.49±0.03^{ab}	6.65±0.01^{a}

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

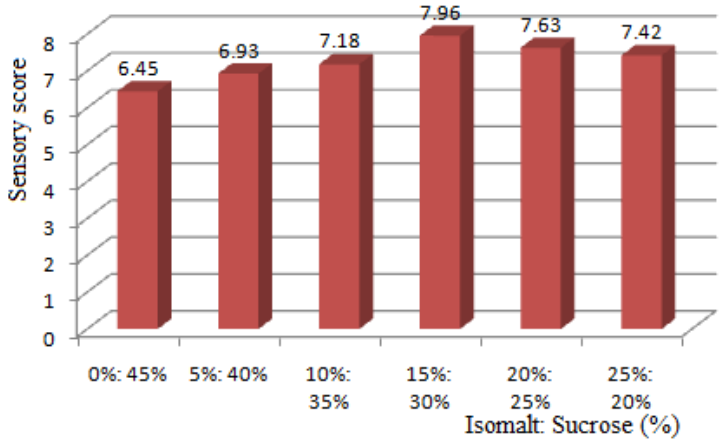

Figure 1:Effect of isomalt and sucrose concentration to quality of pidada chewy candy

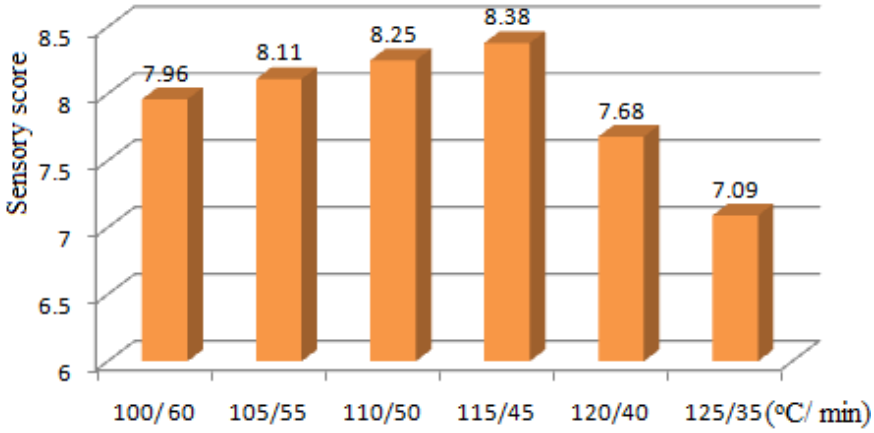

Figure2: Effect of boiling temperature (°C) and time (min) to quality of pidada chewy candy

In slow freezing, water crystallized in vacuoles resulting to the rending of thin cytoplasmic membranes surrounding vacuoles as well as the cell membrane. Ice crystals created in spaces of the cell membrane as a result of cell liquid entering the spaces (Chevalier et al. 2000; Wu et al. 2017). Leakage of cell liquid leaded to tissue weakness and lossed stiffness. Large crystals created in the slow freezing process had sharp edges which demolished cellular constituents owing to the pressure happening while the crystals grew (Buggenhout et al. 2006). By thawing, the cells loosed turgor pressure and became delicate coming to cell liquid leakage. In pressing step, much more damage of weak cells and tissues of Pidadahappended leading to the release of more cell liquid. The change of textural

firmness decreased flow resistance supporting for the juice yield. Rafal et al. (2016) found that the apple pulp pretreated by freezing and thawing had an increase of pressing efficiency. It was showed that total phenolic and total soluble solid content depended on the pulp pretreatment. Obtaining fresh juice rich in bioactive components was hard because most of phenolics located in the skin cells or in cells directly underneath it. These cells were covered by much thicker cell walls which were not easy to break than fruit pulp cells (Beata and Ryszard, 2016). Beata and Ryszard (2016) examined the impact of freezing and enzymatic treatment on the phenolic content in the lingonberry fruit. They found that the highest content of phenolics was recorded in juice obtained from the frozen fruit pulp.

Effect of isomalt replacement to sucrose to quality of pidada chewy candy

Sweeteners played an important role to obtain the desired properties, from appearance to firmness of soft candy (Hadjikinova and Marudova (2016). Isomalt originated from sugar by fermentation of sucrose to isomaltulose and further hydrogenation of the reducing fructose moiety to an equimolar mixture of 1,6-glucopyranosyl-d-sorbitol and 1,1-glucopyranosyl-d-mannitol. Isomalt exhibited about half the sweetness of sucrose. Isomalt was more stable under acidic conditions (Lina et al. 2002). It could be absorbed slowly without any irritation in the stomach, could be digested completely by enzymes in the small intestine. It didn't cause diarrhea if consumed in large quantities and did not create a laxative effect (Hawai et al. 1989). It reduced the risk of obesity, high blood pressure, high blood fat status and diabetes (Mori et al. 2008).

Fiture 1 reflected the effect of isomalt and sucrose concentration to quality of pidada chewy candy. It's clearly seen that at isomalt: sucrose (15%:30%), the pidada chewy candy had the highest sensory score.Meanwhile the lowest sensory score was noticed at isomalt: sucrose (0%:45%). Due to crystallization, the overall acceptance gradually decreased with higher ratio of isomalt. It could be explained by lower solubility of isomalt compared to universal sucrose (Mitchell, 2006; Periche et al. 2014). The crystallization of sugar in chewy candy would provide dissatisfaction among consumers. This implied that isomalt at a fair content would contribute to possitive effect on chewable property of the pidada candy. Hadjikinova and Marudova(2016) demonstrated intermolecular hydrogen bonding between sucrose and isomalt to form new network. Sucrose, isomalt possibly created intersections between gelatin molecules resulting in gels with both covalently cross-linked region and microcrystalline region (Tau and Gunasekaran, 2016). Hence, the isomalt could make gelatin-based gels tougher (Tau and Gunasekaran, 2016).

Effect of boiling temperature and time to quality of pidada chewy candy

The pidada fruit contained two kinds of flavonoids including luteolin and luteolin 7- O-β-glucoside (Varghese et al. 2010; Phaechamud et al. 2012). Isomalt had high heat stability, and that was the reason to select this sweetener in thermal treatment. Isomalt was non-reducing sugar; it did not participate in any browning reaction at high temperature (Wilson, 2007). Boiling temperature and time greatly affected to the overall acceptance of the pidada chewy candy (figure 1). At 115 ^{o}C within 45 minutes of boiling, the highest sensory score of the pidada chewy candy would be obtained. The chewy candy was melting with the increase in temperature enabling entrapped the water to be more mobile and thus resulting in an increase in relaxation times (Kirtil and Oztop, 2015).

CONCLUSION

The ripen pidada fruit had an appealing flavor and taste. This fruit was considered as underutilized fruit as it's not fully investigated for its potential health advantages and not fully commercialized. It included different promising phytochemicals with natural antioxidants to alleviate ailments. This research had successfully investigated the possibility of pidada chewy candy production from ripen fruit by verifying the influence of gelatin and sucrose concentration, isomalt replacement to sucrose, boiling temperature and time.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Nguyen Phuoc Minh arranged the experiments and also wrote the manuscript.

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