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EFFECT OF VELVET TAMARIND JUICE-TO-SUGAR RATIO ON THE QUALITY OF HALAL JELLY

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ABSTRACT

The development of Halal velvet tamarind (VT) jelly products is important for Muslim consumer confidence. This study analyzes the proximate composition of VT fruit and develop VT fruit jelly. Based on proximate analysis, the VT pulp contains 11.23 ± 0.86% moisture, 1.53 ± 0.23% ash, 1.67 ± 0.19% protein, 1.12 ± 0.15 fat, 79.48 ± 0.82 carbohydrates, 8.24 ± 0.02% total soluble solids, and has a pH level of 2.89 ± 0.04. The ratio of VT juice and sugar is varied as 4:1, 3.5:1.5, 3:2, 2.5:2.5, and 2:3. There is a significant difference ($p \leq 0.05$) between jellies with varying VT juice-to-sugar ratio in terms of the brightness (L*), red value (a*), and yellow value (b*) of the finished product. The ratio shows that both L* and b* values increase with higher amounts of sugar in the mixture, leading to an overall dark color. Meanwhile, a* increases with higher amounts of sugar, rendering a reddish color on the jelly. The water activity and pH of the jelly are 0.88 ± 0.01 and 3.01 ± 0.01, respectively. Our results show that a ratio of 3:2 has the highest overall likeness score at 7.96 ± 0.92 (like moderately). Therefore, the quality of the halal chewy products was found to be acceptable by the sensory evaluation panel members.

1.Introduction

Velvet tamarind (VT) is an important fruit in the 3 southern border provinces (SBPs) of Thailand (Chedoloh & Chemalee, 2019). Most often found as red fruits, VT fruits are harvested from the trees that grow in southern Thailand. The people in Yala, Patani, and Narathiwat provinces know these trees as Lukyee and Kerayee. They have average height of about 30 m, densely leafy crown, and smooth greyish barks (Chedoloh, 2018). Their leaves are hairy and their flowers are usually whitish. Meanwhile, the fruits are almost circular and flattened. Its pulp is edible and sweet, has a delicate aroma and high levels of ascorbic acid and fiber (Obasi *et al*., 2013), and is a good source of minerals and antioxidants (Afolabi *et al*., 2018). The fruit is offered as a candy-like snack in the 3 SBPs, often dried, sugar-coated and spiced with chili (Chedoloh, 2018). The dried fruit has a powdery texture and is orange in color with a tangy flavor. However, each product has distinctive characteristics and flavors depending on the producers owing to unique processes and ingredients utilized during production. Despite these differences, the end-product is still traditional and entrepreneurs lack development strategies for new products, which limit the choices for consumers. To widen the range of choices and enhance the market competition of households and housewife groups in the 3 SBPs, creating new products

derived from VT is necessary. An alternative product to candied VT fruit, which is now gaining popularity, is jelly. The demand for jelly is driven by consumers ranging from children up to the working age group because jelly is classified either as a dessert or a snack.

The main components of jelly are fruit juices, sugar, acids, and gel-causing agents (Curi *et al*., 2017). In jelly production, sugar contributes to the product's structure, given that gels with high methoxyl pectins are formed only if sucrose is present at a concentration greater than 55% (Acosta *et al*., 2008). Consumers like to eat 14.7% of dried jelly. Of the consumers, 96% are interested if there are jelly products with health benefits available in the market. Apart from the health benefits, producers must study the use of ingredients approved by Islam. The producers also need to address the customers' safety concerns and demand for consistent quality products by raising the quality of production. In addition, VT-derived souvenirs from the 3 SBPs should include Halal products to support the Association of Southeast Asian Nations (ASEAN) market in the future.

The aim of this study is to develop jelly products from VT, with texture and sensory properties similar to the standard products, by replacing sucrose partially or totally with an appropriate substitute combination of VT fruit juice and sugar.

2. Materials and methods

2.1. Procurement of Raw Material and Chemical

VT fruits (*Dialium indum* L.) dried in May 2016 was collected from the Amani Luk Yee Factory, located in the Muang District of Yala province. The glucose, sugar, syrup, salt, copper pan, stainless steel tray, silicone mold, and refrigerator, which were used for jelly production, were obtained from the Yala market, Thailand. The fish gelatin was from the Halamic Company International (Thailand). The strength of the gelatin was 247 g Bloom while its pH, moisture content, and protein were 5.6, 11.1%, and more than 86.5%, respectively. All the chemicals and reagents used in this study were analytical grade and supplied by Sigma Chemical Co.

2.2. Chemical Analysis of Velvet Tamarind Dried Fruit

The method described in AOAC (2000) was used to estimate the moisture content in the dried VT fruits with the temperature maintained at 100-105 °C for 24 hours. It was also used to determine the protein, ash, crude fat, and ascorbic acid content of the samples. The color of each VT samples was evaluated using the three parameters in the color space defined by the International Commission on Illumination (CIE), which are L* (lightness/darkness value), a* (green/red value), and b*(blue/yellow value). These parameters, collectively known as CIE-Lab, were measured using a reflectance calorimeter. The dried fruits' pH was measured by a pH meter. Finally, the total soluble solids (TSS) were determined by a refractometer.

2.3. Effect of Juice-to-Sugar Ratio on Quality of Halal Jelly

Jelly production from the VT fruits started with a mixture of VT pulp and water with a ratio of 1:3. The VT pulp and water mixture was blended for 3 minutes using a blending machine and was filtered with a cheesecloth that is folded 2 times to extract the juice. Sugar was added to the juice with a VT fruit juice-to-sugar ratio (VJS) of 4:1, 3.5:1.5, 3:2, 2.5:2.5 and 2:3 (Table 1). In addition, gelatin (20%), warm water (18%), glucose syrup (31.50%), and salt (0.5%) were also added to the different formulations while keeping the total volume across all formulations constant. The ingredients were placed in a brass pan and the mixture was stirred for 15 minutes until the ingredients were combined well. After stirring, the final mixture was poured into silicone molds with depth that is about 1 cm, and with sides that are approximately 1.5 cm long. The silicone molds were then placed in a large plastic bag to prevent contamination and were refrigerated at a temperature of 4-5 °C until the VT jelly sets, which takes about 8 hours. Finally, the jellies

were taken out of the molds and were placed in PP plastic bags.

Table 1. List of all ingredients in jellies with different VT fruit juice-to-sugar ratio

Ingredients	VT fruit juice-to-sugar ratio				
	4:1	**3.5:1.5**	**3:2**	**2.5:2.5**	**2:3**
VT fruit juice (%)	40.00	35.00	30.00	25.00	20.00
Sugar (%)	10.00	15.00	20.00	25.00	30.00
Gelatin (%)	20.00	20.00	20.00	20.00	20.00
Water (%)	18.00	18.00	18.00	18.00	18.00
Glucose Syrup (%)	31.50	31.50	31.50	31.50	31.50
Salt (%)	0.50	0.50	0.50	0.50	0.50

2.4. Physical and Chemical Properties

The VT jelly was analyzed for its physical and chemical properties. Specifically, the physical property investigated was the color of the jelly. The same parameters as those used for the dried VT fruit (CIE-Lab) were used to describe the color. On the other hand, the chemical properties analyzed were pH, the amount of vitamin C (mg/100 g), and the TSS. All methods were analyzed gravimetrically following the AOAC method (2000).

2.5. Sensory Evaluation

Sensory testing was performed in Yala Rajabhat University Sensory Lab. Fifty (50) non-trained panelists were selected to equally represent genders with ages between 18 to 45 years old. The panelists were asked questions about the color, flavor, taste, adhesion of meat, chewiness, the difficulty of swallowing, sweetness, saltiness, sourness, and overall liking. All questions were ranked using a 9-point hedonic scale, with 1 corresponding to dislike extremely and 9 to like extremely (Meilgaard *et al*., 1990).

2.6. Texture Analysis of Fresh and Dried VT Fruits

Texture analysis of the VT fruit was performed using a Brookfield's CT*3* texture analyzer. Data for the breaking force were collected in Newton (N). A texture analyzer program outputs the hardness and texture curves from three types of fresh and dried VT fruits. Five separate scans were performed for each sample.

2.7. Statistical Analysis

The statistical analysis followed a completely randomized design for physical and chemical properties evaluation (by conducting 3 trials) and a randomized complete block design for the sensory tests. A linear mixed model was implemented using the SPSS software to analyze different treatments (e.g. type and source of VT). Duncan's new multiple range test was used to compare means of treatments for statistical significance ($p \leq 0.05$).

3.Results and discussions

3.1. Initial Raw Material Analysis

Various chemical properties in the raw materials were analyzed first. Table 2 lists the values of pH, water activity (a_w), moisture, TSS, fiber, carbohydrate, fat, protein ash, and vitamin C contents of dried VT. The results suggest that dried VT is a good source of nutrients and antioxidants. The 23 mg/100g vitamin C content is in good agreement with the 33.33 mg/100 g vitamin C previously reported by Niyi *et al*. (2015). The dried VT pulp has high acidity with a pH of 2.89. It also has a moisture content and a_w value of 11.23 ± 0.86 g/100 g and 0.46 ± 0.01, respectively. Osanaiye *et al*. (2013) who did a comparative study of the chemical composition of Africa's *Dialium guineense* samples reported a moisture content of 10.53%. The low moisture and a_w help to extend the shelf life of the raw materials. The VT pulp was low in fat and protein, at 1.67 ± 0.19 and 1.12 ± 0.15 g/100 g, respectively, and contains 4.82 ± 0.75% dietary fiber, which can help in the excretion as well.

Table 2. Analysis of physical and chemical properties of VT fruit

Properties	VT fruit
Color L*	25.12±1.32
a*	12.37±0.25
b*	8.64±0.05
pH	2.89±0.04
a_w	0.46±0.01
Moisture (g/100g)	11.23±0.86
TSS (°Brix)	8.24±0.02
Fiber (g/100g)	4.82±0.75
Carbohydrate	79.48±0.82
Fat (g/100g)	1.12±0.15
Protein (g/100g)	1.67±0.19
Ash (g/100g)	1.53±0.23
Vitamin C (mg/100g)	23.70±0.12

3.2. Effect of VT Juice-to-Sugar Ratio on Physical and Chemical Properties of the Jelly

3.2.1 Physical Properties

VJS in the jelly affects the color attributes (L*, a*, and b*) significantly ($p \leq 0.05$). The parameters L*, a*, and b* were selected as responses to the experimental design and formulation variables (Garrido *et al*., 2015). As summarized in Table 3, L* increases with VJS. Consequently, Fig. 1 shows that the jelly with VJS = 4:1 is darker compared to the jelly with VJS = 2:3. The experimental values of L*, a*, and b* ranges from 21.85 to 29.49, 4.53 to 2.93 (reddish), and 6.94 to 8.57 (yellowish), respectively, as listed in Table 3. These values reflect the yellow-brown color of our jellies.

Table 3. Physical property analysis of VT jelly

Physical properties	VT fruit juice-to-sugar ratio				
	4:1	**3.5:1.5**	**3:2**	**2.5:2.5**	**2:3**
L*	21.85±0.01^{e}	24.46±0.01^{d}	24.48±0.01^{c}	27.80±0.01^{b}	29.49±0.01^{a}
a*	4.53±0.03^{a}	3.93±0.02^{b}	3.44±0.01^{c}	3.26±0.01^{d}	2.93±0.01^{e}
b*	6.94±0.01^{e}	7.37±0.01^{c}	7.05±0.02^{d}	7.61±0.01^{b}	8.57±0.01^{a}

Different characters in the landscape have significant differences ($p \leq 0.05$).

4:1 3.5:1.5 3:2 2.5:2.5 2:3

Figure 1. Representative velvet tamarind jellies with decreasing juice-to-sugar ratio from left to right

3.2.2 Chemical Properties

Table 4 summarizes the proximate composition (%) of the VT jellies. There is a significant change ($p < 0.05$) in the properties as VJS is varied. The moisture content of the jellies ranges from 29.60 g/100g for VJS = 2:3 to 40.83

g/100g for VJS = 4:1. The moisture content decreases as VJS increases, that is, there is a higher amount of sugar in the jelly. Likewise, a_w decreases as the amount of sugar in the jelly increases. Fat, protein fiber, and ash contents in the VT jelly are very low possibly due to the low fat content in VT fruits as previously reported by Adetuyi and Ibrahim (2014). The carbohydrate content of each jelly was significantly different ($p < 0.05$) from each other and ranges from 59.70 g/100g to 66.62 g/100g. The increase in the carbohydrate content could be because VT is rich in glucose and fructose (Obasi *et al*., 2013). Lastly, the pH affected the texture of the jelly. The addition of sugar in jelly processing decreases the pH of the final product. Standard alkalinity of jelly products is between 2.8 and 3.5, while the optimum acidity/alkalinity is between 3.08 and 3.20 according to the Thai Industrial Standards Institute (2004) No. 263-2521 (TIS. 263-2521). The addition of VT juice can contribute to an increased taste, improved gelling, and stabilized natural color of the resulting product. H+ ions that causes the sour taste in the jelly, are derived from an organic acid molecules, which are found mainly in lemon. The ionized molecule releases its proton as H+. Large quantities of H+ ions result to acidic solutions and lower pH (Nazir and Adrian, 2016).

Table 4. Chemical property analysis of VT jelly product

Chemical properties	VT fruit juice-to-sugar ratio				
	4:1	**3.5:1.5**	**3:2**	**2.5:2.5**	**2:3**
Moisture (g/100g)	40.83±0.32^{a}	36.24±2.90^{b}	33.26±1.21^{c}	31.25±1.48^{c}	29.60±1.20^{d}
a_w	0.92±0.01^{a}	0.90±0.01^{b}	0.89±0.01^{c}	0.88±0.01^{c}	0.83±0.01^{d}
Fiber (g/100g)	1.65±0.04^{b}	1.78±0.05^{a}	1.83±0.06^{a}	1.43±0.1^{d}	1.54±0.02^{c}
Ash (g/100g)	0.65±0.04^{b}	0.78±0.05^{a}	0.83±0.06^{a}	0.43±0.01^{d}	0.54±0.02^{c}
Protein (g/100g)	1.10±0.01^{a}	1.08±0.01^{b}	1.02±0.01^{c}	1.09±0.001^{ab}	1.03±0.02^{c}
Fat (g/100g) ^{ns}	0.65±0.01	0.66±0.01	0.67±0.01	0.65±0.01	0.66±0.01
Carbohydrate (g/100g)	59.70±2.98^{b}	54.85±0.34^{c}	59.38±1.16^{b}	65.13±2.49^{a}	66.62±0.59^{a}
pH	3.08±0.01^{c}	3.00±0.01^{d}	3.01±0.01^{d}	3.25±0.02^{a}	3.20±0.02^{b}

Different characters in the landscape have significant differences ($p \leq 0.05$)
^{ns} is Non- significant differences ($p > 0.05$).

3.2.3 Chemical Properties

Table 5 summarizes the sensory evaluation results for different VJS investigated in this study. The results show that VJS has a significant effect on the sensory acceptance in consumers such as the taste, sweetness, sourness, and overall liking ($p \leq 0.05$). On the other hand, there is no significant difference ($p > 0.05$) in the color, flavor, chewiness, and saltiness. The sensory test results reveal that consumers gave their highest overall likeness score of 7.96 (like moderately) to VJS = 3:2 (by weight) among all other VJS investigated in this study.

3.2.4 Effect of Ratio on Texture Analysis

Table 6 depicts the effects of VJS on the jelly texture. The hardness, cohesiveness, gumminess, springiness, and chewiness of the jellies increase significantly with decreasing VJS. As other conditions known to affect the formation of jelly, such as cooking time, temperature, and concentration of sugar (Royer *et al*., (2006)), were fixed in this study, only the amount of sugar added in the jelly influences the textural properties of the gels, except for the adhesiveness (Lee *et al*., 2010).

Table 5. Sensory evaluation results of VT jelly products

Attributes	VT fruit juice-to-sugar ratio				
	4:1	**3.5:1.5**	**3:2**	**2.5:2.5**	**2:3**
Color ^{ns}	7.34±0.89	7.29±1.03	7.74±0.92	7.24±0.68	7.55±0.82
Flavor^{ns}	7.44±0.94	7.51±0.91	7.67±0.90	7.31±0.83	7.27±0.84
Taste	7.00±1.25^{d}	7.38±0.76^{bcd}	7.90±0.78^{a}	7.48±0.76^{abc}	7.80±0.87^{ab}
Chewiness^{ns}	7.03±1.23	7.25±0.85	7.38±0.88	7.03±1.19	6.89±1.22
Sweetness	7.31±0.71^{bc}	7.67±0.65^{ab}	7.38±0.49^{bc}	7.41±0.50^{bc}	7.80±1.01^{a}
Saltiness ^{ns}	7.17±1.07	7.26±1.31	7.48±0.96	7.32±0.90	7.16±1.03
Sourness	7.03±1.09^{b}	7.16±1.10^{b}	7.77±0.66^{a}	7.41±0.67^{ab}	7.16±0.77^{b}
Overall liking	7.30±1.29^{b}	7.51±1.02^{ab}	7.96±0.92^{a}	7.48±0.85^{ab}	7.67±0.70^{ab}

Different characters in the landscape have significant differences ($p \leq 0.05$).
^{ns} is Non- significant differences ($p > 0.05$)

Table 6. The results physical properties of each VT jelly products

Physical properties	VT fruit juice-to-sugar ratio				
	4:1	**3.5:1.5**	**3:2**	**2.5:2.5**	**2:3**
Hardness (N)	37.43±1.30^{c}	49.18±0.74^{b}	38.41±0.94^{c}	98.61±3.83^{a}	95.89±3.37^{a}
Cohesiveness	0.89±0.02^{b}	0.91±0.02^{ab}	0.89±0.03^{ab}	0.93±0.02^{a}	0.93±0.01^{a}
Gumminess (N)	33.40±0.94^{c}	44.95±1.00^{b}	34.59±1.05^{c}	91.25±3.62^{a}	88.95±3.55^{a}
Springiness	0.97±0.02^{ab}	0.94±0.01^{c}	0.96±0.01^{b}	0.98±0.01^{a}	0.94±0.03^{c}
Chewiness (N)	32.69±1.54^{d}	42.47±0.95^{c}	33.22±1.04^{d}	89.42±4.31^{a}	83.87±3.68^{b}

Different characters in the landscape have significant differences ($p \leq 0.05$)

4. Conclusions

VT jelly with VT fruit juice-to-sugar ratio of 3:2 gave the highest overall likeness score of 7.96 as evaluated by a sensory panel in terms of color and smell. The ingredients of the jelly were 30% VT fruit juice, 20% sugar, 20% gelatin, 18% water, 31.5% glucose syrup, and 0.5% salt. Our results show that the jellies could be used as ingredients for Halal production and development of new products to provide alternatives for consumers in the future.

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