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Effect of sucrose/glucose syrup ratio and citric acid content on physical properties and sensory quality of *Thunbergia laurifolia* Linn. candy products

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Abstract

The objective of this research was to develop the *Thunbergia laurifolia* Linn. candy. The experiment was designed as 3×3 Factorial in Completely Randomized Designs to determine the optimal concentration of sucrose (32, 27, 22%) and glucose syrup (27, 22, 17%) in the production of candy. The candy made from sucrose and glucose syrup of 32% : 27% showed the highest overall liking score (7.09) in sensory tests whereas the lowest hardness (116.142 g). Improvement of the *T. laurifolia* candy taste was investigated by adding citric acid with different concentrations into the product. The addition of 1.4% citric acid had the highest overall acceptability score (7.38). In addition, the *T. laurifolia* candy had a_w of 0.380 and total acidity of 1.381%.

Keywords: *Thunbergia laurifolia* Linn., Candy, Glucose syrup

1. Introduction

The trend of consumers getting more conscious towards their health and balance for nutrition in their diets, it has necessary to explore the newer natural and organic sources of nutrients. Their preference for natural food supplements has been found to be increasing as compared to synthetic food supplements. *Thunbergia laurifolia* Linn. is considered as a "boon" for good health since the ancient times. It is commonly known in Thai as "Rang Chuet", which is a woody climbing plant belonging to the Acanthaceae family. In Thailand, the decoction of the leaves and roots of this plant is traditionally used as an antidote for poisoning caused by insecticides, ethyl alcohol, arsenic, and strychnine [1]. Phytochemical constituents of *T. laurifolia* leaves are phenolic, carotenoid and chlorophyll compounds, besides caffeic acid and apigenin are found to be major constituents in *T. laurifolia* aqueous extract. Several biological activities related to antioxidants have been recently reported for *T. laurifolia*, including hepatoprotective [2], neuroprotective [3], and antimutagenic properties [4]. *T. laurifolia* is traditionally used for anti-inflammation [5], antimicrobial [6,7], antidiabetic [8], antioxidant [9], anticancer activities [10], detoxifying [11-14], and associated diseases such as hepatological and neurological diseases [15]. Oonsivilai et al. (2008) [16] investigated the antioxidant activities and total phenolic content of *T. laurifolia* extracts found that water extraction of phenolic compounds was the most efficient (2433.9 mg GAE/100g) compared to ethanol and acetone extraction. Moreover, water extract possessed the highest antioxidant activities using free radical scavenging at the EC50 values of 0.13 mg GAE/ml and total antioxidant activity using FRAP assay at 0.93 mmol/g.

Candy is a type of confectionery which describes a spectrum of sweet goods and takes on different meanings from one country to the others. Among several definitions, candy is defined as a highly cooked coloured and flavoured sugar mass formed into desired shapes.

Candy is one of favourite foods among people from a wide range of age. Candy typically varies in types, shapes, taste and colors [17]. According to National Standard Agency [18], candy is defined as a type of solid food from sugar or a mixture of sugar with other sweetener as the main ingredients, with or without addition of food additives. Sugar and glucose syrup are the bulking agents in the recipe and are responsible for the sweet taste and shelf life of the product. The most commonly used acid is citric acid as it causes the least degradation in other food ingredients used. Citric acid is used to decrease the pH to 3.2 which will enhance the typical acid fruit flavor. The pH of some hydrocolloid systems is critical in determining the final set [19]. It is often flavoured or coloured, and sometimes contains fruit, nuts, herb, etc. Thus, the idea of herbal candy has been developed. The *T. laurifolia* candy is the new choice for consumer. The effect of sucrose/glucose syrup ratio and citric acid content on physical properties and sensory quality of *T. laurifolia* candy was studied.

2. Materials and Methods

2.1 Preparation of T. laurifolia leaf extract

Fresh samples of *T. laurifolia* leaves were obtained locally from Prachinburi province, Thailand. The leaves were washed before being cut into smaller pieces and then put in boiled water with the ratio of 2:1 for 5 min**.** Supernate and precipitate was separated by filtration through muslin cloth.

2.2 Effect of sucrose/glucose syrup ratio on physical properties and sensory test quality of T. laurifolia candy

The experiment was designed as 3×3 Factorial in Completely Randomized Designs (Factorial in CRD) to determine the optimal ratio of sucrose and glucose syrup. Different ratio of sucrose and glucose syrup used in the production of candy are shown in the Table 1. These formulas were then blended with other ingredients which was 45% water extraction of *T. laurifolia* leaves, 4 % *T. laurifolia* leaves, 1% salt and 1% citric acid to produce candy.

Candy was prepared using a basic formulation with some sucrose and glucose syrup modification in Table 1. For the cooking procedure, sugar and water extraction of *T. laurifolia* leaves were heated and stirred until the sugar dissolved in a brass pan. Glucose syrup was poured into the mixture and heated to approximately 120 ºC. When the temperature of the mixture was raised to 120°C, citric acid, salt and *T. laurifolia* leaves was added and mixed. The mixture was cooled down to 80-90 ºC immediately to stop overheating. The mixture was then poured into suitable molds to form candy.

Table 1 Quantity of sucrose and glucose syrup in *T. laurifolia* candy

Treatment	Sugar**(%)**	Glucose syrup**(%)**
1	32	17
2	32	22
3	32	27
4	27	17
5	27	22
6	27	27
7	22	17
8	22	22
9	22	27

2.3 Effect of citric acid on sensory test quality of T. laurifolia candy

The experiment was designed as CRD to determine the optimal citric acid concentration from five levels concentration (0.6, 0.8, 1.0, 1.2 and 1.4%).

2.4 Determination of T. laurifolia candy hardness

Texture properties of candy products were evaluated using texture analyzer (TA-TX plus model). The experiments conducted with compression force using a P/100 probe and test speed at 1 mm/s. The hardness values of the products were reported.

2.5 Water activity (a_w) measurement

Water activity (a_w) of candy products were determined using a Series3 TE, (AQUA, USA) at 25ºC.

2.6 Determination of Total titrable acidity (TA)

Total titratable acidity of *T. laurifolia* candy was determined as the method described by Woo [20] Citric acid was used as a standard compound.

2.7 Sensory evaluation

Sensory evaluation of the products was performed using 50 untrained panelists using a preference test with 9-point hedonic scale (1=dislike extremely, 9=like extremely) to determine color, order, hardness, taste and overall liking of products.

2.8 Statistical analysis

The data were reported as the means and standard error of triplicate measurements. Statistical analyses were carried out with Duncan's multiple test ($P<0.05$) using SPSS V.16 software (SPSS Institute Inc., Cary, NC).

3. Results and Discussion

3.1 Effect of sucrose/glucose syrup ratio on physical properties and sensory test quality of T. laurifolia candy

Glucose syrup is widely used in production of hard candy as it results in higher plasticity of candy. It also affects durability of color and taste, add clarity and shine. In hard candies, sucrose hydrolysis may cause undesirable changes associated with an increase of their hygroscopicity. Sucrose hydrolysis also decreases the cooling rate during moulding which in turn affects sugars crystallization and the hardness of the product [21]. Hardness of candy is shown in Table 2. Based on statistical analysis with confidence level of 95%, the difference in sugar and glucose syrup ratio influenced the hardness of *T. laurifolia* candy significantly. The highest value of hardness (473.133 g) was obtained by formula 6 (27% of sucrose and 27% of glucose syrup). On the other hand, the lowest value (116.142 g) was resulted by formula 3 (32% of sucrose and 27% of glucose syrup). Although, the hardness was affected by the interaction of the sugar and glucose syrup, it was not affected by the main factors.

Sensory evaluation of the products was performed by 50 untrained panels using a preference test with 9-point hedonic scale (1=dislike extremely, 9= like extremely) to determine color, odor, hardness, taste and overall liking of products. The score of different sensory characteristics of different sucrose/glucose syrup ratio are shown in Table 3. The utilization sugar and glucose syrup ratio influenced the sensory evaluation of *T. laurifolia* candy significantly. The addition of 32% of sucrose and 27% of glucose syrup (formula 3) had the highest score in color, taste and overall liking.

Table 2 Physical properties of *T. laurifolia* candy with different ratio of sugar and glucose syrup

Formula	Ratio of sugar and glucose syrup	Hardness**(g)**
1	32:17	149.244 ± 23.162^{d}
2	32:22	372.834 ± 57.914^{ab}
3	32:27	116.142 ± 10.095^{d}
4	27:17	192.735 ± 64.423^{cd}
5	27:22	132.623 ± 66.269^{d}
6	27:27	473.133 ± 84.535^{a}
7	22:17	436.421 ± 117.478^{a}
8	22:22	305.123 ± 102.050^{bc}
9	22:27	294.255 ± 53.592^{bc}

Note : Different letters showed the significant differences ($p<0.05$

Table 3 Sensory evaluation of *T. laurifolia* candy with different ratio of sugar and glucose syrup

Formula	Ratio of sugar and glucose syrup	Color	Odor^{ns}	Hardness^{ns}	Taste	Overall liking
1	32:17	6.63 ±1.2^{ab}	6.28 ±1.61	6.22 ±1.70	6.16 ±1.56^{abc}	6.37 ±1.50^{ab}
2	32:22	6.97 ±1.17^{a}	6.41 ±1.31	6.44 ±1.39	6.59 ±1.58^{ab}	6.72 ±1.48^{ab}
3	32:27	7.06 ±0.95^{a}	6.44 ±1.50	6.72 ±1.46	6.88 ±1.58^{a}	7.09 ±0.99^{a}
4	27:17	6.53 ±1.27^{abc}	6.13 ±1.68	5.56 ±1.60	5.81 ±1.90^{bc}	5.91 ±1.72^{b}
5	27:22	6.81 ±1.33^{ab}	6.47 ±1.36	6.12 ±1.60	6.84 ±1.32^{a}	7.06 ±1.07^{a}
6	27:27	7.06 ±1.34^{a}	6.84 ±1.56	6.69±1.90	6.50 ±1.65^{ab}	6.66 ±1.82^{ab}
7	22:17	5.88 ±1.62^{c}	5.66 ±1.68	5.78 ±2.01	5.56 ±2.24^{c}	5.90 ±1.80^{b}
8	22:22	6.16 ±1.8^{bc}	6.47 ±1.21	6.13 ±1.96	6.58 ±1.60^{abc}	6.31 ±1.67^{ab}
9	22:27	6.91±1.0^{a}	6.13 ±1.45	6.44 ±1.39	6.28 ±1.46^{a}	6.43 ±1.41^{ab}

Note : Different letters showed the significant differences ($p<0.05$).
ns showed that there was no significant differences ($p\geq0.05$).

3.2 Effect of citric acid on sensory test quality of T. laurifolia candy

Table 4 shows sensory evaluations of candies added with different levels of the citric acid. Four different attributes including color, odor, sourness and overall liking were evaluated by using 9-point hedonic scale. The results showed that the tendency of adding more the citric acid could result in increases in all the attributes. The average score indicating that the color and odor of candy with the different levels of the citric acid were no significant difference ($p\geq0.05$). It was found that the highest score for sourness (7.55) was given for candy with 1.4% citric acid and the lowest score of 4.06 was given for candy with 0.6% citric acid and the highest score for overall liking (7.38) was given for candy with 1.4% citric acid where a score of 3.06 was obtained for candy with 0.6% citric acid. Citric acid was used to enhanced flavor and made hard candies tart [21]. From the result obtained in Table 7, 1.4% citric acid had the highest mean score in terms of overall liking which indicates that it is the most preferred by the panelists. This implies that 1.4% citric acid can be used for *T. laurifolia* candy production.

Table 4 Sensory evaluation of *T. laurifolia* candy with citric acid

Citric acid **(%)**	Color^{ns}	Odor^{ns}	Sourness	Overall liking
0.6	6.97±1.27	6.74±1.12	4.06±1.34^{e}	3.06±1.22 ^{e}
0.8	6.49±1.29	6.93±1.17	4.67±1.24^{d}	4.36±1.27 ^{d}
1.0	6.71±1.07	6.89±1.10	5.49±1.27^{c}	5.53±1.18 ^{c}
1.2	6.66±0.91	6.87±0.82	6.40±0.94^{b}	6.74±1.04 ^{b}
1.4	6.73±1.12	6.80±1.00	7.55±0.89^{a}	7.38±1.02 ^{a}

Note : Different letters showed the significant differences ($p<0.05$).
ns showed that there was no significant differences ($p\geq0.05$).

3.3 Physico-chemical properties of T. laurifolia candy

The data for physico-chemical of *T. laurifolia* candy properties are presented in Table 5. The hardness value of *T. laurifolia* candy was 118.00 g which might be related to the sugar crystallization. The browning reaction of sugar also affected the color of the candy which was dark yellow with the L^* of 38.91, a^* of 11.08 and b^* of 41.59. The a_w of *T. laurifolia* candy was 0.380 which was lower than the a_w limits for growth of microorganisms [22]. This could be prolong the shelf life of product.

Table 5 Physico-chemical properties of *T. laurifolia* candy

Physico-chemical properties	Value
Hardness **(g)**	118.00±5.40
Color Lightness ; *L**	38.91±1.20
Redness ; *a**	11.08±2.90
Yellowness ; *b**	41.59±1.86
a_w	0.380±0.001
Total titrable acidity (%)	1.381±0.043

4. Conclusions

The *T.laurifolia* candy with ratio of sucrose and glucose syrup 32 : 27 had the highest score in color, taste and overall liking. Moreover, this ratio had the lowest hardness value. The addition of 1.4% citric acid had the highest mean score in terms of overall liking.

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