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Original Article

Effect of pectin and maltodextrin and drying temperature on qualities of tamarind leather

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ABSTRACT: Tamarind leather is snack or dessert that produced from tamarind based products in dried sheet form. The tamarind leather ingredients were 25% tamarind paste, 25% sugar, 0.75% pectin and maltodextrin, 1% salt and 48.25% water. The study was aimed to determine the effects of pectin and maltodextrin on qualities of tamarind leather. The various percentage ratio of pectin to maltodextrin at 3:0, 2:1, 1:1, 1:2 and 0:3 were investigated to improve appearance of product. The amount of both pectin and maltodextrin did not effect on total soluble solids and moisture content of dried tamarind leather that presented 11.8-15%. The highest transparent acceptability score was found at the ratio 2:1 when compared with control at ratio 3:0. Furthermore, drying temperature was conducted at 60, 70 and 80 ^{o}C. The moisture content and a_w of tamarind leather revealed equilibrium condition after 8 hr of drying time at all temperature. There was no significant different ($p \leq 0.05$) of drying temperature on sensory evaluation of tamarind leather. The range of moisture content and a_w were 15.98-16.50% and 0.541-0.577, respectively. The drying temperature at 60 ^{o}C was appropriated and selected to study microbiological properties during storage at room temperature and 4^{o}C. Yeast and mold was found >3x10^4 CFU/g when product was stored at room temperature for 5 days but yeast and mold were not found during storage at 4 ^{o}C.

Keywords: tamarind leather, fruit leather, pectin, maltodextrin

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INTRODUCTION

Nowadays, the consumer trend is to consume more natural snack foods made from natural fruits [1]. Fruit leather is a traditional fruit product that is commonly produced in many parts of the world such as in North America, South America, Africa, Asia [2,3]. Fruit leather is generally nutritious and is a healthy option because of rich in vitamins, antioxidants and fiber from fruit [4,5,6]. Fruit leathers are dehydrated sheet-like structures characterized with a chewy texture characteristic [7,8] and consumed as fruit bars or snacks. Sometimes, it has been used as ingredients in biscuits, breakfast cereal, and bakery products [2]. Fruit leather preservation depends on the moisture content which should range within 15-25% [9] by drying process to remove water in order to inhibit enzyme and bacterial activity for prolonging product shelf life [10]. There are various types of drying processes that can be used to produce fruit leathers, including sun drying, oven drying, cabinet drying, and vacuum drying. Drying operations should be handled by considering many aspects such as economy, quality of product, consumer and preference. The efficiency of the process can be enhanced by optimizing drying conditions [3].

There are generally three ingredients that used to produce fruit leathers; fruit puree, sweeteners and food additives [11]. Fruit puree can be from various fruits, such as apple, apricots, berries, grapes, jackfruit, kiwifruits, oranges, papayas, peaches, pears, tomato, pineapple, plum, durian and other fruits [1, 4, 12]. Sugar such as sucrose, glucose and fructose is the most commonly used as sweeteners during the processing of fruit leathers [9]. Sometimes, corn syrup or glucose syrup and honey can be also applied [11]. Various food additives may be added for several purposes during the processing of fruit leathers such as to increase total solids, to modify flavor, texture and hygroscopicity of fruit leathers [1] and to enhance shelf life of products. Acids such as acetic and citric acid are used to control pH and total acidity. Hydrocolloids have been widely used as gelling or thickening agents to improve texture of fruit leathers [11, 13]. Artificial and natural colors and flavors may be also added. The addition of sodium bisulfite has effectively reduced the enzymatic browning reaction [14]. Other ingredients such as lecithin, maltodextrin, vegetable oil, starch have been also used in addition to fruit leather [15]. Therefore, the objectives of this study were to obtain the appropriate content of pectin and maltodextrin for tamarind leather production and to study effect of drying temperature on qualities of tamarind leather.

MATERIALS AND METHODS

Material and sample preparation

De-pitted ripe tamarinds were purchased from a local market in Papayom District, Phatthalung, Thailand. The samples were stored in refrigerator until used. Tamarind was mashed with water at ratio 1:1 in a stainless bowl and it became paste after handed mashing. Then tamarind paste was filtered by using cotton cloth to remove pulps. Tamarind mixture was prepared by mixing tamarind paste, water, sugar, pectin, maltodextrin and salt following the various formulas shown in Table 1. The formulas were varied ratio of pectin to maltodextrin of 3:0, 2:1, 1:1, 1:2 and 0:3. All ingredients were thoroughly mixed and heated at 50-60 °C for 10 min and blended for 2 min in the blender to form smooth and homogenous mixture. The prepared tamarind mixture formulations (300 g) were poured and spread into an aluminium tray (30 cm × 30 cm × 3 cm). Subsequently, drying was performed by using tray drier or hot air drier at 60 °C until water activity (a_w) of tamarind leather reached 0.6. The process of tamarind leather was concluded in Fig. 1. The moisture content, a_w and lightness (L*) of each finished tamarind leather were investigated.

Table 1 Ingredients of tamarind leather based on various ratio of pectin to maltodextrin

Ingredient (% by wt)	ratio of pectin to maltodextrin 3:0	2:1	1:1	1:2	0:3
Tamarind paste	25	25	25	25	25
Sugar	25	25	25	25	25
Pectin	0.75	0.5	0.375	0.25	0
Maltodextrin	0	0.25	0.375	0.5	0.75
Salt	1	1	1	1	1
Water	48.25	48.25	48.25	48.25	48.25

Hot air drying experiments

The aluminium trays which contained tamarind mixture were placed in the middle of carbinet of the hot air drier. The drying was performed at varying of drying temperature at 60, 70 and 80 °C for 12 hr. The tamarind leather samples were taken every 2 hr to determine moisture content and a_w.

Physical and microbial analysis

Total soluble solids and pH of initial tamarind mixture were measured with hand refractometer and pH meter, respectively. The moisture content of tamarind mixture and tamarind leather were determined by drying samples of approximately 1 g at 105 °C till reached constant weight in hot air oven (Memmert, Germany). The a_w of tamarind mixture and tamarind leather were measured with AquaLab water activity instrument. The lightness (L*) of tamarind mixture and tamarind leather were determined by HunterLAB instrument.

Dried tamarind leather (10 g) was dispersed in 90 ml 0.1% peptone solution and appropriate decimal dilutions were prepared using 0.85% NaCl under the aseptic conditions. Yeast and molds were enumerated by spread plate technique on pre-poured, solidified potato dextrose agar (PDA) plates. The inoculated plate was incubated at room temperature for 5 days before the number of colonies was counted. The yeast and mold count was calculated in units of CFU/g [16].

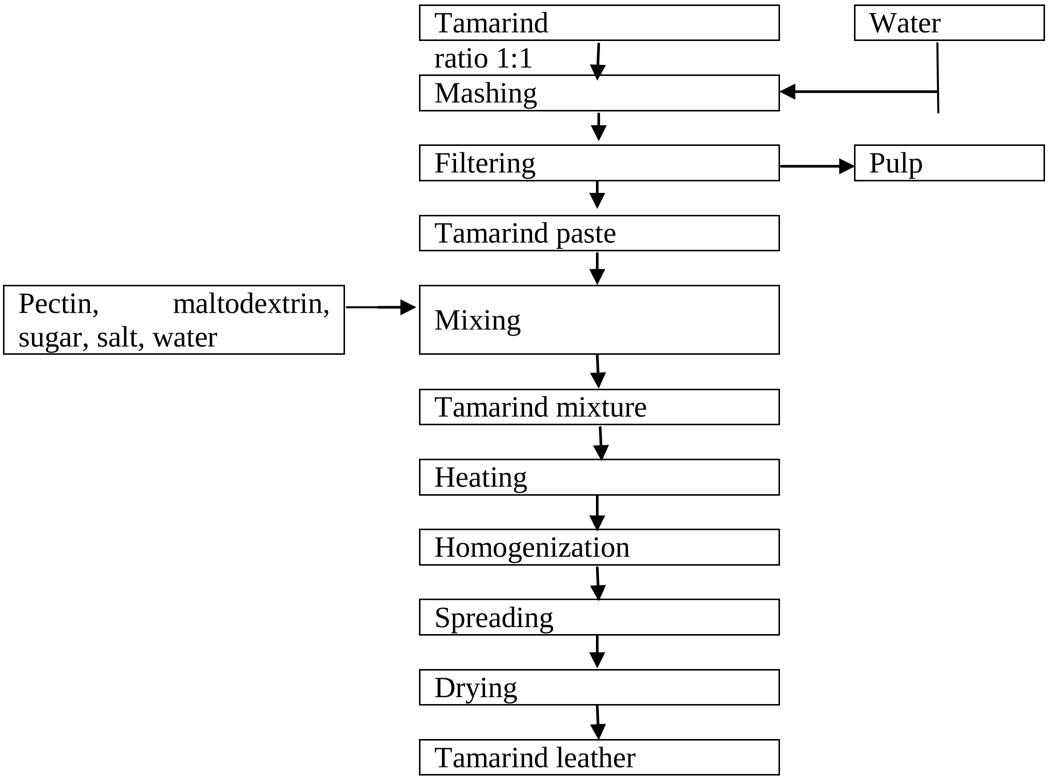

Fig. 1 Flow chart diagram of tamarind leather production

Sensory analysis

A 9-point hedonic scale was used as measuring tool for evaluating an appropriate amount of pectin and maltodextrin. The tamarind leathers were evaluated for color, transparency and texture using 30 untrained panelists. Each panelist received a series of five samples of tamarind leathers (ratio of pectin to maltodextrin of 3:0, 2:1, 1:1, 1:2 and 0:3) and each sample was coded with three random digit numbers. For each sample, panelists rated the degree of preference of tamarind leather using a 9-point hedonic scale assigned numerical values, ranging from “dislike extremely” as “1” to “like extremely” as “9”.

A difference from control test was performed to compare tamarind leather that made from different drying temperature at 60, 70 and 80 °C. The 60 °C–dried tamarind leather was used as control sample. The overall differences were rated as: no difference, very small difference, moderate difference, large difference and very large difference.

Statistical analysis

The differences among the mean values were determined by Duncan’s multiple range tests with 95% confident interval.

RESULTS AND DISCUSSION

Variation of pectin and maltodextrin for tamarind leather production

The pH was 3.00 in tamarind mixture before drying that acidic condition may be useful for gelation of pectin [17] during leather formation. Moreover, acidic condition may confer longer keeping quality of tamarind leather [2]. The total soluble solids were controlled at 35 °Brix in tamarind mixture. The pectin and maltodextrin content did not effect on total soluble solids tamarind mixture. The moisture content of tamarind mixture ranged 64.5-66.1% (Table 2) and decreased after drying at 60 °C for 12 hr to 11.8-15.0%. The results showed that without adding pectin reduced significantly moisture content of tamarind leather (Table 3). The ratio of pectin to maltodextrin had no effects on a_w of tamarind mixture and tamarind leather. Tamarind leather had intermediate a_w level that was observed of 0.60-0.64. Moreover, the ratio of pectin to maltodextrin had no effects on the lightness of tamarind mixture and tamarind leather (Table 2 and 3). Lightness of tamarind leather decreased when compared to tamarind mixture before drying. Heat treatment during leather preparation may cause by non-enzymatic browning reactions. The color of tamarind leather was dark brown.

Table 2 Properties of tamarind mixture before drying when using various ratio of pectin to maltodextrin

Properties	ratio of pectin to maltodextrin				
	3:0	2:1	1:1	1:2	0:3
Lightness (L*) ^{ns}	31.77±4.51	31.42±6.03	31.89±2.68	33.95±3.97	33.56±4.59
Total soluble solid (°Brix) ^{ns}	35.0	35.0	35.0	35.0	35.0
pH	3.00	3.00	3.00	3.00	3.00
a_w ^{ns}	0.969	0.979	0.974	0.971	0.981
Moisture content (% wt basis) ^{ns}	64.5±0.3	64.8±0.10	65.1±0.6	66.1±1.5	64.9±0.9

Table 3 Properties of tamarind leather after drying at 60 °C for 12 hr when using various ratio of pectin to maltodextrin

Properties	ratio of pectin to maltodextrin				
	3:0	2:1	1:1	1:2	0:3
Lightness (L*) ^{ns}	29.09±1.63	31.16±1.31	30.70±1.64	32.20±0.88	30.89±3.05
a_w ^{ns}	0.61±0.01	0.63±0.03	0.62±0.03	0.64±0.04	0.60±0.06
Moisture content (% wt basis)	14.7±3.8^{a}	15.0±3.4^{a}	14.7±5.6^{a}	13.8±3.4^{a}	11.8±2.12^{b}

Sensory evaluation by a 9-point hedonic scale was performed to test preference for color, transparency and texture of tamarind leather when using various ratio of pectin to maltodextrin. The results showed that all preferences of panelists decreased with increasing maltodextrin content or decreasing in pectin content. The absence of pectin obtained the lowest score for all preferences. The highest average scores for all preferences were given to tamarind leather followed by ratio of pectin to maltodextrin 2:1 (Fig. 2). Therefore, ratio of pectin to maltodextrin at 2:1 was chosen for drying investigation. The appropriate ingredients of tamarind mixture before drying were 25% tamarind paste, 25% sugar, 0.5% pectin, 0.25% maltodextrin, 1% salt and 48.25% water.

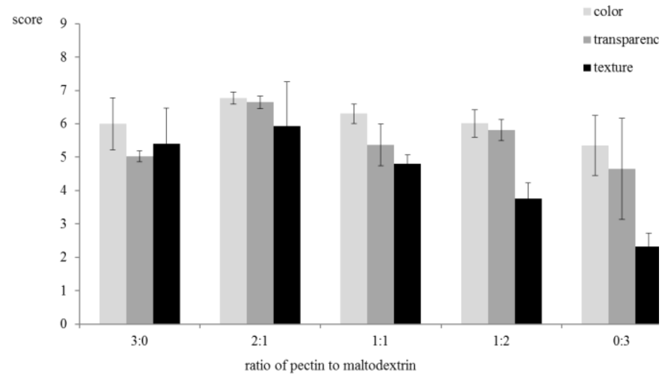

Fig. 2 Sensory evaluation by a 9-point hedonic scale test of color, transparency and texture of tamarind leather when using various ratio of pectin to maltodextrin. The preference scores were presented as mean±SD.

In this study, tamarind fruit leather was prepared with tamarind base and added sugar, pectin, maltodextrin, and salt. Fruit leather can be made from many fruit base and various ingredients to improve physical, chemical and sensory qualities. There were numerous previous studies to optimize appropriate quantities of ingredients to produce fruit leather. Vatthanakul, et al. (2010) demonstrated desired properties of fruit leather from customer requirements by using the House of Quality analysis were more fruit flavored and had a lower hardness, chewiness and sweetness [5]. Subsequently, gold kiwifruit leather was produced by establishing the optimum glucose syrup and pectin to fruit ratio for control the product's textural characteristics. The results showed that tensile strength increased with increasing pectin and glucose syrup content. Moreover, pectin and glucose syrup content affected significantly moisture content of gold kiwifruit leather. The optimum pectin and glucose syrup content were 2 g and 15 g per 100 g of gold kiwifruit puree [5]. Fransiska et al., (2015) used carrageenan as binder in mango fruit leather. The results showed that the panelists preferred mango leather contained puree mango, carrageenan, sorbitol of 90%, 0.2% and 9.8%, respectively [18]. Patil et al., (2017) observed effect of pectin and carboxyl methyl cellulose on textural and sensory quality of date-mango leather. The sensory level ranked the best product at 1% level of pectin and carboxyl methyl cellulose with respect to color, flavor, texture and overall acceptability. The results revealed that hardness and gumminess increased with addition of hydrocolloids [13].

Hot air drying experiments

The initial moisture content and a_w of tamarind mixture containing pectin and maltodextrin of 2:1 were 64.8% and 0.98, respectively (Fig. 3). The dehydration behavior of tamarind leather was observed by using hot air drier at varying of drying temperature at 60, 70 and 80 °C for 12 hr. The result revealed that the moisture content and a_w decreased with increasing in drying time. The moisture content and a_w were reduced rapidly within 4 hr and they were slowly reduced after 4 hr of drying time. Variation of drying temperature showed that a_w was reached of 0.6 when drying time for 6 hr at drying temperature of 70 and 80 °C whereas for 8 hr at drying temperature of 60 °C (Fig. 3A). Therefore, drying time was increased with decreasing in drying temperature. However, all drying temperature was demonstrated constant moisture content to reach moisture content below 20% after 8 hr of drying time (Fig. 3B). Sensory evaluation by a difference from control test of overall difference using drying temperature at 60 °C as control and using 30 untrained panelists was performed (Table 4). There was no significant different of drying temperature on sensory evaluation of tamarind leather. The drying temperature at 60 °C was appropriated and selected due to the light brown color of tamarind leather was presented.

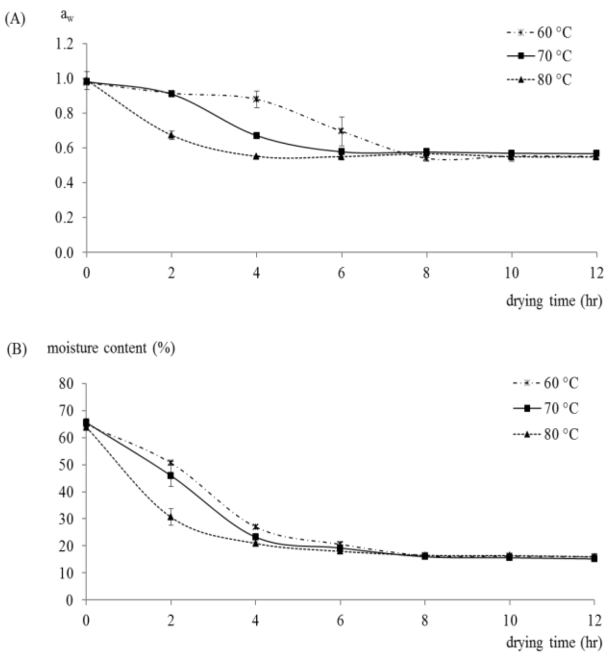

Fig. 3 Effect of drying temperature (60, 70 and 80 °C) by hot air drying for 12 hr on a_w (A) and moisture content (B) of tamarind leather using ratio of pectin to maltodextrin at 2:1

Table 4 Sensory evaluation by a difference from control test of overall difference using 60 °C–dried tamarind leather as control and using 30 untrained panelists

Drying temperature	Rates of difference				
	no	very small	mode-rate	large	very large
70 °C	22	7	1	0	0
80 °C	11	7	4	8	0

Huang and Hsieh (2005) prepared pear fruit leather by drying a mixture of pear juice concentrate, pectin, corn syrup, and water at 70 °C for 8 hr. The result revealed that pectin was the most important ingredient that significantly affected textural properties of the fruit leather [4]. The additives sucrose, pectin and maltodextrin had significant effects on the drying rate, drying rate constant, and effect moisture diffusivity. The effect of addition of pectin was most significant on moisture diffusivity both in pineapple and mango leather [1]. Yilmaz et al. (2017) studied the effects of open air, vacuum and cabinet drying methods at 50, 60 and 70 °C with different sample thickness of pomegranate fruit leather. The results showed that the fastest drying on pomegranate fruit leather completed in vacuum drier at 70 °C for 25, 40 and 60 min for the samples at 1, 2 and 3 mm thickness, respectively. Moreover, vacuum dried pomegranate fruit leather had the highest bioactive content [3].

Microbial count during storage

The drying temperature at 60 °C was appropriated and selected to study microbiological properties during storage at room temperature and 4 °C. In general, $a_w < 0.85$ will prevent growth of pathogenic microorganisms. A_w of tamarind leather was lower than 0.6 which ranged from 0.541 to 0.577. Yeast and mold was found $>3x10^4$ CFU/g when product was stored at room temperature for 5 days. Total bacteria were not found during storage for 15 days at room temperature and 4 °C, however some fungi and yeasts can grow (Table 5). Therefore, tamarind leather should be stored under refrigerator to prolong shelf life and inhibit microorganisms leading to safety to consume.

Storage time (days)	Yeast and mold (CFU/g)	
	room temperature	4 °C
0	ND	ND
5	$> 3 \times 10^4$	ND
10	$> 3 \times 10^4$	ND
15	$> 3 \times 10^4$	ND

Torres et al. (2015) reported apple leather had low levels of aerobic mesophilic microorganisms (less than 1000 CFU/g) and less than 10 CFU/g for yeast and mold after 6 months storage at 20 °C. There was no presence of *Salmonella* sp., *Staphylococcus aureus*, *Enterobacterium* and *Escherichai coli* because apple leather had low pH, intermediate water activity (0.56-0.69) and low moisture content (ca. 18%) although without preservatives [15]. Basha (2018) reported that guava leather showed organoleptic properties as well as good storage stability at ambient and refrigerated conditions up to 3 months [19].

CONCLUSION

In this study, the producing tamarind leather has been investigated. Based on sensory evaluation by a 9-point hedonic, the panelists preferred pectin to maltodextrin at ratio 2:1. The drying temperature of tamarind leather at 60 ^{o}C was appropriated to obtain the range of moisture content and a_w of 15.98-16.50% and 0.541-0.577, respectively. The further study needs to optimize drying conditions besides hot air drying to enhance the efficiency of the process and shelf life of tamarind leather.

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