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Impact of Drying Pretreatments on the Quality Characteristics of Indian Cherry Fruit Pulp

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ABSTRACT

The present research has been conducted to study the effect of different dehydration pre-treatments on the proximate chemical composition, drying curve, dehydration and rehydration characteristics, colour and sensory properties of Indian cherry (*Cordia dichotoma)* fruit pulp. The obtained results revealed that the fresh Indian cherry fruit pulp contained 78.97±2.04% moisture, 16.43±0.94% carbohydrate, 0.98±0.11% crude protein, 1.49±.62% crude fiber, 1.03±0.27% fat and 0.56±0.02% ash. For dried samples, slight variations were observed between the proximate chemical compositions of all samples which have different treatments. The Pre-treatments performed in this search are an important parameter that affects drying time. Where, Samples dipped in a citric + ascorbic or ascorbic acids solutions prior to drying had a shorter drying time (7.5 hrs) compared to citric acid as well as blanching (8 hrs) and finally control samples (8.5 hrs). The maximum dehydration ratio was 4.70 for dried samples treated with citric + ascorbic acids. Also, rehydrated fruit pulp treated with citric + ascorbic acids had the highest rehydration ratio recording 3.51 followed by those treated with ascorbic acid (3.32), citric acid (3.31), blanching (3.26) and finally control sample (3.10). Rehydrated products contained clearly lower moisture content than fresh samples, it ranged between 65.34±1.98% for control sample to 69.87±1.01% for sample treated with citric + ascorbic acids. The Indian cherry fruit pulp colour treated with citric + ascorbic acids had the lightest colour as measured by the HunterLab color analyzer and as appears from the photos of studied samples, while control samples had the darkest colour comparing with all dried products. It could be referred that the dipping of Indian cherry fruit pulp in a 2% citric + 2% ascorbic acid solution before dehydration greatly increase the sensory attributes of the resulted dried products.

Keywords: Indian cherry, pretreatment dehydration, chemical and sensory properties

INTRODUCTION

Indian cherry *(Cordia dichotoma* Forst, Synonym: Lisura or Lasora) is a small to moderate size plant of family Boragenaceae. *Cordia dichotoma* is one of the traditional medicinally important deciduous plants available all over India and other wormer regions. The fruit of *Cordia dichotoma* is a green-yellow shining globose or ovoid drupe seated in a saucer-like enlarged calyx. It turns dark on ripening and the pulp gets viscid and produces a sticky, jelly-like mass called *Cordia dichotoma* gum (Basu *et al.,* 1984). The whole plant of *Cordia dichotoma* is edible and is used as food. Plant parts such as leaves, fruit, bark and seed have been reported for possessing anti-diabetic, antiulcer, anti-inflammatory, immune modulator and analgesic activity. (Agnihotri *et al*., 1987; Jamkhande *et al*., 2013 and Pawar *et al*., 2018). *Cordia dichotoma* fruit is a delicious fruit particularly admired by children. The fruit is slimy, juicy and helps in the curing of mouth ulcers, strengthening of teeth and gums. It is also used as an ingredient in preparations to relieve urinary tract infection (Rapisarda *et al.,* 1992 and Patil *et al.,* 2010). *Cordia dichotoma* fruits contain 74.87-82.46 % moisture, 1.98-2.8% protein, 1.6-2.0% fat, 13.0-17.0% carbohydrate and 2.0-2.91% ash. *Cordia dichotoma* fruits is a rich source of vitamin C, calcium, phosphorus, potassium, magnesium and iron (Duhan *et al*., 1992; Valvi and Rathod, 2011 and Toliba, 2012).

Dehydration of fruits is an important means of preservation. The main attribute of this method is the decrease in the water activity in the product by decreasing its water content, inhibiting the development of microorganisms, and decreasing spoilage reactions, thus prolonging the shelf life of the product (Doymaz, 2014 and Pisalkar *et al*., 2014). Out of various methods available to extend the shelf life of perishable crops, dehydration is one of the easy and less expensive processes, and it is a complex process involving transient heat and mass transfer and various factors should be taken into account. Hot air is one of the most common methods for food dehydration (Prakash *et al*., 2004 and Al-Amin *et al.,* 2015). Pre-treatment affects the nutritional, sensorial and functional properties of the dried food without changing its integrity. It also improves the texture as well as stability of the pigment during dehydration and the storage of dehydrated product (Raoult-Wack, 1994; Rastogi *et al*., 2002 and Al-Amin *et al.,* 2015). Many reports have been carried out regarding the process for rehydration and cooking of fruits and vegetables (Krokida and Marinos-Kouris, 2003; Singh *et al*., 2007 and Al-Amin *et al.,* 2015). In addition to, colour is a vital fruit quality characteristic which occurs in the interaction among light, observed object and observer (Yam and Papadakis 2004 and Nowicka *et al*., 2015). Colour changes are mostly related to browning interactions that occur during dehydration of fruits and vegetables. Several studies about pretreatments of fruit in order to minimize negative effects carrying out during dehydration and reconstitution (Guerrero-Beltran *et al*. 2005; Doymaz, 2006). The browning of fruits and vegetables during drying appears due to both enzymatic and non-enzymatic reactions (Vadivambal and Jayas 2007).

However, less information is available on the dehydration and rehydration characteristics of Indian cherry fruit pulp. That is why, the present study has been conducted for studying the effect of different drying pre-treatments on the proximate chemical composition, drying curve, dehydration and rehydration characteristics, colour and sensory properties of Indian cherry (*Cordia dichotoma)* fruit pulp.

MATERIALS AND METHODS

Materials:

Ripe Indian cherry *(Cordia dichotoma* Forst) fruits were collected from a private farm in Kafr-Saqre, Sharqia Governorate, Egypt during summer 2017. The fruits were carefully washed using tap water at ambient temperature 22±2°C.

All chemicals as analytical grade were purchased from Elgomhorya Company Branch, Zagazig City, Egypt.

Methods:

Dehydration experiment of Indian cherry fruit pulp:

Indian cherry fruit pulp was manually separated by removing the nonedible parts (stone and sticky pulp). The fruit pulps were divided into five parts and coded T1, T2, T3, T4 and T5, respectively. The first, third, fourth and fifth parts were separately soaked in distilled water, 2% citric acid solution, 2% ascorbic acid solution and 2% citric + 2% ascorbic acids solution for 5 min at room temperature 22±2ºC, respectively. In addition to, the second part was blanched at 85ºC for 5 min and rabidly cooled under tap water (22±2ºC). After pretreatments the fruit pulps were directly dried as described by Choudhary (2004) using a hot air cabinet dryer. The temperature thermostat of the cabinet dryer was adjusted at 65 ºC for all drying times (7.5, 8 and 8.5 hrs). The fruit pulps were distributed in a single layer (Fig. 1) on the trays. The trays load was 3.8 kg/m^2. The dried fruit pulp was coded DFP.

Figure 1. Photos of Indian cherry whole fruits (1), sticky pulp and stones (2) and fruit pulp as loaded on the trays for dehydration (3).

Proximate composition:

The fresh and dried Indian cherry fruit pulp were analyzed for moisture, carbohydrate, protein, crude fibers, fat, ash contents as per the methods summarized by Ranganna (2003).

Drying curve determination of Indian cherry fruit pulp:

Drying curve of Indian cherry fruit pulp was performed as described by Polatoglu and Bese (2017). Drying curve expressed as a relationship between moisture ratio (MR) and drying time whereas:

$$MR = M_t - M_e / M_o - M_e$$

where M_o, M_e **and** M_t **reflect initial moisture content (g H_2O/g dry matter), equilibrium moisture content (g H_2O/ g dry matter) and moisture content at any time (g H_2O/g dry matter), respectively.**

Dehydration, rehydration ratio and co-efficient of reconstitution determination:

Rehydration is a process of refreshing the dried material in water however, rehydration prowess was conducted the optimum conditions which described by Al-Amin *et al.* (2015). Both control and treated samples of *Cordia dicotoma* fruit pulp were reconstituted as follows: each sample was pre-soaked in water for 45 min and then 2g of pre-soaked sample was boiled with 150 ml water for 30 min. After boiling, the liquid portion was drained off and excess water was removed by filter paper. The rehydrated materials were removed from the filter paper and weights were recorded separately and the following parameters were calculated.

Dehydration ratio= Weight of prepared material before drying / Weight of dehydrated material.

Rehydration ratio = Weight of rehydrated sample / Weight of dehydrated sample.

Co-efficient of reconstitution= Rehydration ratio / Dehydration ratio.

Colour analysis:

Hunter Lab color analyzer (Hunter Lab Color Flex EZ, USA) calibrated with white and black ceramic reference standard was used to compare the color attributes (lightness L*, redness a* and yellowness b*) between the dried Indian cherry fruit pulps as described by Hussain *et al.* (2018). The L* value represents lightness of colour from 0 (black) to 100 (white), a* value represents the degree of redness (+) or greenness (-) and b* value represents yellowness (+) or blueness (-). All tests were conducted in triplicates and the means and standard deviations were calculated.

Sensory evaluation:

The sensory evaluation test of the four dried Indian cherry fruit pulps were conducted with ten consumers of varied ages and gender, who were students, professors and employees of Food Science Department, Faculty of Agriculture, Zagazig University as described by Dever *et al*. (1996). A nine-point structured hedonic scale (1= disliked extremely and 9= liked extremely) was used in the acceptance test to evaluate the colour, taste, flavour, texture, appearance and overall acceptability of the dried fruit samples and the means were calculated with the standard deviations.

Statistical Analysis:

The obtained data were statistically analyzed according to Steel *et al.* (1997). Least significant differences were used for the comparison between means at 0.05 level. Means having the same letters are not significantly different.

RESULTS AND DISCUSSION

Proximate chemical composition of fresh and dried Indian cherry fruit pulp:

Proximate composition of fresh and dried Indian cherry fruit pulp are presented in Table 1. The fresh fruit pulp contained 78.97±2.04% moisture, 16.43±0.94% carbohydrate, 0.98±0.11 crude protein, 1.49±.62% crude fiber, 1.03±0.27% fat and 0.56±0.02% ash. These results are in agreement with those reported by Duhan *et al*. (1992), Valvi and Rathod (2011) and Toliba (2012). For dried samples, slight variations were observed between the proximate chemical compositions of all samples which have different treatments. Where, the moisture content ranged between 12.54±0.31 to 12.85±0.36%, Carbohydrate 66.34±0.89 to 68.28±1.25%, Crude protein 3.87±0.88 to 4.07±0.47%, Crude fiber 6.19±0.64 to 6.31±0.84%, fat 4.20±0.22 to 4.27±0.12% and Ash 2.19±0.29 to 2.34±0.24%

Table 1. Proximate chemical composition of fresh and dried *Cordia dicotoma* fruit pulp

Products		Component (%)					
		Moisture	Carbohydrate	Crude protein	Crude fiber	Fat	Ash
Fresh Indian cherry fruit pulp		78.97±2.04	16.43±0.94	0.98±0.11	1.49±0.62	1.03±0.27	0.56±0.02
Dried Indian cherry fruit pulp	T1	12.85±0.36	67.98±1.09	3.98±0.65	6.31±0.84	4.20±0.22	2.22±0.27
	T2	12.71±0.84	67.45±0.45	3.87±0.88	6.27±0.65	4.26±0.45	2.34±0.24
	T3	12.54±0.31	66.53±0.79	3.91±0.55	6.23±0.13	4.26±0.65	2.31±0.25
	T4	12.59±0.30	66.34±0.89	4.02±0.78	6.21±0.47	4.27±0.56	2.19±0.29
	T5	12.60±1.02	68.28±1.25	4.07±0.47	6.19±0.64	4.27±0.12	2.32±0.33

T1, T2, T3, T4 and T5 were fruit pulps treated with water (control), blanching, citric, ascorbic, and citric + ascorbic acids, respectively.

Drying process of Indian cherry fruit pulp:

Dehydration experiment was performed to evaluate the effects of pre-treatments on dehydration and rehydration properties of Indian cherry fruit pulp as well as the colour attributes of the dried products using a hot air cabinet dryer at 65ºC.

Drying curves of Indian cherry fruit pulp treated with citric acid, ascorbic acid, citric + ascorbic acids or blanching as well as control sample were expressed as a relationship between the moisture ratio and the drying time (Figure 2).

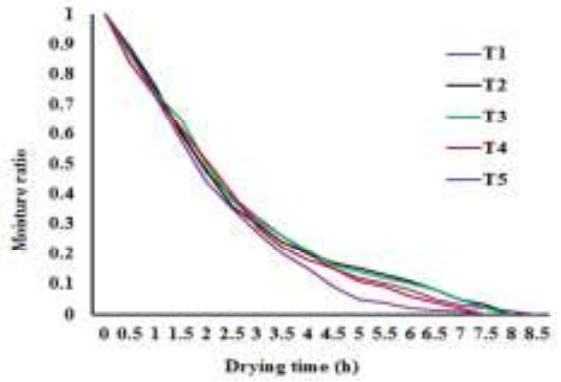

Figure 2. Drying curves of Indian cherry fruit pulps treated with water as control (T1), blanching (T2), citric (T3), ascorbic (T4) or citric + ascorbic acids (T5).

It is clear that moisture ratio decrease continuously with the drying time for all treatments. The falling-rate period was mostly observed in all fruit samples. On the other hand, the pre-treatments performed in this search are an important parameter that affects drying time (Figure 2).

Where, T5 and T4 samples prior to drying had a shorter drying time (7.5 hrs) compared to T3 as well as T2 (8 hrs) and finally T1 (8.5 hrs). These data are in a harmony with those reported by many researchers for many fruits and vegetable (Madamba *et al*., 1996; Choudhary, 2004; Akoy, 2014; Doymaz, 2014 and Polatoglu and Bese, 2017).

Rehydration characteristics of the dried Indian cherry fruit pulps were studied after soaking dried samples in water for 45 min followed by boiling for 30 min. However, the rehydration characteristics of Indian cherry fruit pulps treated with blanching, citric, ascorbic or citric + ascorbic acids as well as control sample are presented in Table 2. It was noticed that there is difference between the rehydration characteristics of dried samples with different pre-treatments. The maximum dehydration ratio was 4.70 for T5. Also, T5 had the highest rehydration ratio recording 3.51 followed by T4 (3.32), T3 (3.31), T2 (3.26) and finally T1 (3.10). Co-efficient of reconstitution is considered one of the important indicators reflecting the reconstitution of rehydrated products. Generally, T5 had the highest co-efficient of reconstitution being 0.75 while the lowest was for T1 being 0.69. On the other hand, as mentioned above the moisture content of the fresh Indian cherry fruit pulp was 78.97%, rehydrated products contained clearly lower moisture content comparing with fresh fruit pulp. It was 65.34±1.98% for T1 and 69.87±1.01% for T5. Same results were obtained by Al-Amin *et al.* (2015) for carrots and that recoded by Polatoglu and Bese (2017) for cornelian cherry fruits.

Table 2. Rehydration characteristics of Indian cherry fruit pulps.

Treatment	Dehydration ratio	Rehydration ratio	Co-efficient of reconstitution	Moisture content of rehydrated product
T1	4.45	3.10	0.69	65.34±1.98
T2	4.51	3.26	0.72	66.98±0.86
T3	4.57	3.31	0.72	67.03±1.38
T4	4.54	3.32	0.73	67.87±0.99
T5	4.70	3.51	0.75	69.87±1.01

T1, T2, T3, T4 and T5 were fruit pulps treated with water (control), blanching, citric, ascorbic, and citric + ascorbic acids, respectively.

Colour values of dried Indian cherry fruit pulps:

Color is one of the most important features determining a product quality. It is a parameter determining the first impression, and thus, it shapes the purchase desire of the consumers (Wojdyło *et al*. 2014, Nowicka *et al*., 2015). Colour attributes (lightness, L*; redness, a* and yellowness, b*) of dried Indian cherry fruit pulps treated with different pre-treatments and control ware determined and the obtained results are shown in Table 3.

It could be mentioned that the all treatments have a clear effect on the colour of the final product. The T5 had the lightest colour as measured by the HunterLab color analyzer and as shown in the photos presented in Figure 3, while T1 had the darkest colour comparing with all dried products. However, L value ranged between 15.71±2.34 to 22.76±1.45, a value 3.03±0.43 to 5.57±1.86 and b value 8.27±0.73 to 11.80±0.56 for all treated as well as control samples. Similar trends in colour changes were noticed by Nowicka *et al*. (2015) who studied the color parameters of dried sour cherries as affected by osmo dehydration pre-treatment process. The improvement of colour for T5 may

be due to the synergistic effect of citric and ascorbic acids as anti-browning.

Table 3. Colour values of dried Indian cherry fruit pulps

Treatment	Colour value		
	L*	a*	b*
T1	15.71±2.34	5.57±1.86	8.27±0.73
T2	17.65±0.95	4.82±1.23	8.95±1.10
T3	19.29±1.76	3.85±1.69	9.69±1.11
T4	20.86±1.95	3.55±0.75	11.27±1.23
T5	22.76±1.45	3.03±0.43	11.80±0.56

T1, T2, T3, T4 and T5 were fruit pulps treated with water (control), blanching, citric, ascorbic, and citric + ascorbic acids, respectively.

Sensory properties of dried Indian cherry fruit pulps:

Sensory analysis is a powerful scientific tool that can be used to identify variations in sensory properties and measure product's acceptability. Sensory properties of dried Indian cherry fruit pulp resulted from different pretreatments are presented in Table 4. It could be noticed that, T5 was more acceptable than T4, T3, T2 and T1 for all studied sensory properties. Where, the colour score ranged between 5.05±0.75 to 7.95±0.78, taste 4.81±0.78 to 7.54±0.68, flavour 6.04±0.90 to 7.86±0.66, texture 4.31±0.95 to 7.50±0.50, appearance 4.06±0.97 to 7.72±0.78 and overall acceptability 4.30±0.79 to 7.40±0.76. It could be referred that the dipping of Indian cherry fruit pulp in a 2% citric + 2% ascorbic acid solution before dehydration greatly increase the sensory attributes of the resulted products. Generally the drying pretreatments affects the sensory properties of the final products (Abd Elrashid and Nasar, 2000 and Al-Amin *et al*., 2015).

Figure 3. Photos of dried Indian cherry fruit pulps pre-treated with water as control (T1), blanching (T2), citric (T3), ascorbic (T4) and citric + ascorbic acids (T5).

Table 4. Sensory properties of dried Indian cherry fruit pulps

Treatment	Sensory properties					
	Colour	Taste	Flavor	Texture	Appearance	Overall acceptability
T1	5.05^{e}±0.75	4.81^{d}±0.78	6.04^{c}±0.90	4.31^{d}±0.95	4.06^{d}±0.97	4.30^{d}±0.79
T2	5.89^{d}±0.73	5.77^{c}±1.00	6.36b^{c}±0.50	5.27^{c}±0.56	4.63^{d}±0.45	5.05^{c}±0.68
T3	6.55^{c}±0.72	6.63^{b}±0.67	6.84^{b}±0.92	6.77^{b}±0.60	5.63^{c}±0.50	5.91^{b}±0.66
T4	7.18^{b}±0.68	7.27^{ab}±0.51	7.68^{a}±0.97	6.81^{b}±0.75	6.77^{b}±0.68	7.04^{a}±0.65
T5	7.95^{a}±0.78	7.54^{a}±0.68	7.86^{a}±0.66	7.50^{a}±0.50	7.72^{a}±0.78	7.40^{a}±0.76
L.S.D.	0.63	0.64	0.69	0.59	0.57	0.61

L.S.D. Least Significant Difference

T1, T2, T3, T4 and T5 were fruit pulps treated with water (control), blanching, citric, ascorbic, and citric + ascorbic acids, respectively.

CONCLUSION

From this study it could be concluded that, the pre-treatments of Indian cherry fruit pulp conducted before hot air drying at 65ºC affects the proximate chemical composition, colour, dehydration and dehydration ratios and drying time of dried products. So, it could be recommended to soak Indian cherry fruit pulp in a 2% citric + 2% ascorbic acids solution for 5 min before dehydration process to improve the characteristics of the final product. Finally, more studies needed for formation a module for Indian cherry fruits drying.

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أثر معاملات ماقبل التجفيف على خصائص الجودة للب ثمار الكريز الهندى

عباس عمر طليبة

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تم إجراء هذا البحث لدراسة تأثير معاملات ما قبل التجفيف على التركيب الكيماوى التقريبى واللون وخصائص التجفيف والاسترجاع للب ثمار الكريز الهندى (*Cordia dichotoma*) . حيث اتضح من النتائج المتحصل عليها أن لب ثمار الكريز الهندى يحتوى على 2.04±78.97 % رطوبة و 0.94±16.43 % كربوهيدرات و 0.11±0.98 % بروتين خام و 0.62±1.49% ألياف خام و 0.27±1.03 % دهن و 0.02±0.56 % أملاح معدنية. أما بالنسبة لعينات الثمار المجففة فإنه وجد إختلافات طفيفة فى التركيب الكيماوى بين كل العينات المختلفة فى معاملاتها. وتعتبر المعاملات الأولية التى أجريت فى البحث عامل هام فى التأثير على وقت التجفيف.حيث وجد أن العينات التى وضعت فى محلول حمضى الستريك + الاسكوربيك أو حمض الاسكوربيك فقط تم جفافها فى وقت أقصر(٧.٥ ساعة) مقارنة بحمض الستريك والمعاملة بالسلق (٨ ساعات) وفى النهاية عينة الكنترول (٨.٥ ساعة). كما وجد أن أعلى نسبة تجفيف كانت ٤.٧٠ وذلك للعينة المجففة المعاملة بحمضى الستريك+ الاسكوربيك. وأيضا سجلت العينة المعاملة بحمضي الستريك + الاسكوربيك أعلى نسبة استرجاع حيث كانت ٣.٥١ متبوعة بتلك المعاملة بحمض الاسكوربيك (٣.٣٢)، ثم المعاملة بحمض الستريك (٣.٣١) ثم المعاملة بالسلق (٣.٢٦) وفى النهاية عينة الكنترول(٣.١٠). وبالاضافة الى ذلك فقد وجد ن العينات المسترجعة تحتوى على محتوى رطوبى منخفض بدرجة واضحة مقارنة بالثمار الطازجة، حيث تراوحت بين 1.98±65.34 % فى عينة الكنترول الى 1.01±69.87 % فى العينة المعاملة بحمضى الستريك + الاسكوربيك. هذا وكان لون لب ثمار الكريز الهندى المعامل بحمضى الستريك والاسكوربيك هو الأفتح كما تبين من نظام هانتر لقياس اللون وكذلك الصور الفوتوغرافية المأخوذة للعينات محل الدراسة، بينما عينة الكنترول سجلت أكثر العينات دكانة فى اللون وذلك مقارنة بكل العينات المجففة. هذا ويمكن الاشارة الى ان غمر لب ثمار الكريز الهندى فى محلول ٢%حمض ستريك + ٢% حمض اسكوربيك قد حسن بشكل كبير من الخواص الحسية للمنتج المجفف المتحصل علية.

الكلمات المساعدة: الكريز الهندى - معاملات ماقبل التجفيف – الخواص الكيميائية والحسية