

Quality Characteristics of Compound Chocolate Enriched with Dried Indian Cherry Fruit Pulp

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Abstract: The effect of the addition of dried Indian cherry (*Cordia dichotoma*) fruit pulp on the colour, texture and sensory attributes of compound chocolate was evaluated. The obtained results revealed that the dried Indian cherry fruit pulps contained 12.60% moisture, 68.28% carbohydrate, 4.07% crude protein, 6.19% crude fiber, 4.27% fat and 2.32% ash. The addition of dried Indian cherry fruit pulp increased the firmness of the resultant products. On the other hand, the three CIE values L^* , a^* and b^* reflected a good colour for the resultant chocolate. Moreover, There were no significant differences ($p < 0.05$) for colour, odour, flavour, sweetness, texture, melting quality and global quality for all studied chocolate samples, only astringency had a significant differences ($p < 0.05$). It could be concluded that the addition of dried Indian cherry fruit pulp (up to 40%) to compound chocolate manufacturing produced a new flavored chocolate with a good sensory attributes.

Keywords: *Cordia dichotoma*, compound chocolate, firmness, colour, sensory properties

INTRODUCTION

Indian cherry (*Cordia dichotoma* Forst, Synonym: Lisura or Lasora) is a small to moderate size plant of family Boraginaceae. Fruits are 1.3-2.5 cm long globose or ovoid glossy, yellowish brown, pinkish or nearly black when ripe, usually single seed surrounded by a transparent, sticky, sweet edible pulp (Vidyasagar *et al.*, 2010). *Cordia dichotoma* is one of the traditional medicinally important deciduous plants available all over India and other warmer regions (Pawar *et al.*, 2018). The fruits turn dark on ripening and the pulp gets viscid and produces a sticky, jelly-like mass called *Cordia dichotoma* gum (Pawar and Jadhav, 2015).

The whole plant of *Cordia dichotoma* is edible and is used as food. Immature fruits are pickled and are also used as vegetable (Jamkhande *et al.*, 2013). Also, it was found that the using of *Cordia myxa* fruit extract or its powder as stabilizer for ice cream production produced a better quality with low cost product (Al-Hamdani, 2017). The flowers of *Cordia dichotoma* and curd milk mixture used to protect human body against the negative effects of sun waves (Pawar *et al.*, 2018). The full ripe fruits were used for preparing a *Cordia dichotoma* juice with high acceptability (Toliba, 2012). Also the fruits of Indian cherry (*Cordia dichotoma*) were dried for nutrition and food purposes after processing with different pretreatments (Toliba, 2018).

The plant parts of *Cordia dichotoma* such as leaves, fruit, bark and seed have many health benefits and it have been recorded for keeping anti-diabetic, antiulcer, anti-inflammatory, immune modulator, general hypolipidemic effect and analgesic activity. (Jamkhande *et al.*, 2013; El-Newary *et al.*, 2016; 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 (Patil *et al.*, 2010).

Cordia dichotoma fruits contained 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 (Valvi and Rathod, 2011; Toliba, 2012). The extracts of *Cordia dichotoma* possessed antibacterial and antioxidant activities (Rajashekar *et al.*, 2014).

Chocolate is one of the most famous craved foods in the world markets. It has a particular attractive taste and might be useful for human health. The demand of this food appears to be mainly due to its potential to arouse sensory pleasure and positive emotions. Chocolate is perceived as a comfort food and has been reported to be craved and consumed during depressive moods. (Serafini *et al.*, 2003; Macht and Dettmer, 2006; El-kalyoubi *et al.*, 2011). The product may have many forms and consistency and may be stuffed or covered (Leite *et al.*, 2013). Differences in the sensory characters of chocolate can be attributed to the use of different cocoa types, variations in ingredient proportions, use of milk crumb instead of milk powder, blending techniques and processing methods (El-kalyoubi *et al.*, 2011). Researchers are still investigating the best formulation, a method of extraction, physical properties, rheological behavior and sensory perception of the compound chocolate (Hussain *et al.*, 2018).

Compound chocolates provide confectioners with an alternative to chocolate that is both economical and convenient. Compound chocolates can be used either to enrobe centers (biscuits, fruits, nuts, ice cream, etc.) or be formed into shells for subsequent filling (Talbot, 2009). They have a good product structure as the vegetable fats used are solid at ambient temperatures and above, but still melt at mouth temperature which usually around 37°C (Rosales *et al.*, 2017).

No information is available on the use of Indian cherry fruits in the compound chocolate enrichment. Hence, this study was to evaluate the influence of dried Indian cherry fruit pulp enrichment on the quality

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characteristics (colour, texture and sensory properties) of compound chocolate.

MATERIALS AND METHODS

Materials

Ripe Indian cherry (*Cordia dichotoma* Forst) fruits were collected from a private Farm in Kafri-Sakre, Sharkia Governorate, Egypt during summer 2017. The fruits were carefully washed using tap water at air-conditioned room temperature $22\pm 2^\circ\text{C}$. Ready to use compound cooking chocolate was purchased from a local supermarket in Zagazig city, Egypt. As described on the compound chocolate package it consists of sugar, cocoa butter substitute, cocoa powder, soya lecithin (E322), salt and vanillin. All chemicals were purchased from El-Gomhorya Company Branch, Zagazig City, Egypt.

Methods

Dehydration of Indian cherry fruit pulp:

The edible pulp of Indian cherry fruits was manually separated by removing the non-edible parts (stone and sticky pulp) and carefully washed to remove the traces of the sticky pulp. The fruit pulp was soaked

in 2% citric + 2% ascorbic acid solution (to prevent the browning colours) for 5 min at room temperature ($22\pm 2^\circ\text{C}$). The fruit pulp was directly dried as described by Toliba (2018) using a hot-air oven at 65°C for 7.5 hrs. The dried product was packaged in a polyethylene packages till used

Chocolate manufacturing:

Kitchen compound chocolate produced from a famous company was melted in a water-bath at 50°C for 30 min and then mixed with dried Indian cherry fruit powder (the grinding of dried fruit pulp was performed using a grinder, Moulinex, France) with the ratios 20, 30 and 40%. The liquid mixture was molded by poured to solidify in a silicon chocolate former star shape. Separately whole halves of dried Indian cherry fruit pulps were directly dipped as it is, in the melted chocolate. All chocolate treatments were placed in the refrigerator at $4\pm 2^\circ\text{C}$ for 15 min for hardening. The formed compound chocolate samples were removed from the former and all chocolate samples were packed in a polyethylene packages and restored at the refrigerator till used. The control of compound chocolate was free from Indian cherry fruits and produced by the same technique. Figure (1) showed the photo of prepared chocolates.

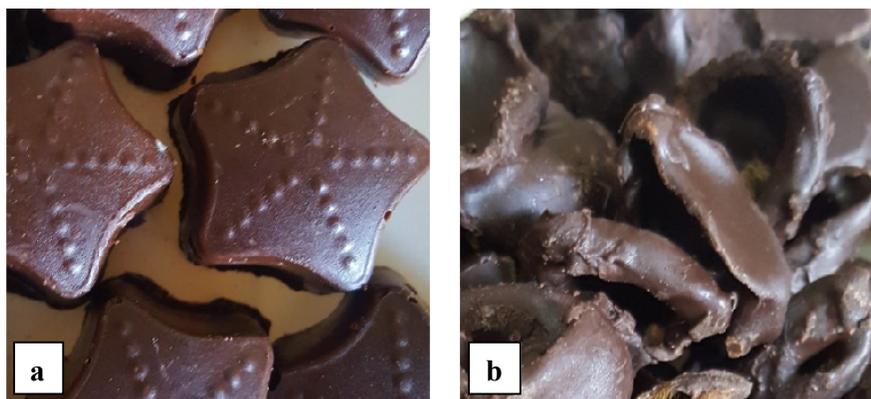


Figure (1): Photos of compound chocolate containing dried Indian cherry fruit pulps: (a) grounded fruits and (b) whole fruit pieces dipped in chocolate

Proximate composition determination:

The dried Indian cherry fruit pulp were analyzed for moisture, carbohydrate, protein, crude fibers, fat, ash contents as described by Ranganna (2003).

Colour analysis determination:

Hunter Lab colour analyzer (Hunter Lab Color Flex EZ, USA) calibrated with white and black ceramic reference standard was used to determine the color attributes (lightness L^* , redness a^* and yellowness b^*) of compound chocolate samples as summarized by Hussain *et al.* (2018).

Texture analysis determination:

Texture analysis of compound chocolate samples was measured using a texture analyzer (TA-XT plus, stable micro systems, UK), connected to a computer

with the software as described by Ashkezary *et al.* (2018). Test settings were as follows: test mode: compression, pre-test speed: 1 mm/sec, test-speed: 3 mm/s, post-test speed: 10 mm/s, distance 23.0 mm, strain 10.0 %, trigger type: button, trigger force: 5.0 g, probe: HDP/SR. Firmness was taken as the maximum peak force in Newton. Results for hardness are expressed as the mean value of three replicates conducted on each sample.

Sensory evaluation:

The sensory evaluation of the five chocolate samples 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 Leite *et al.* (2013). A nine-point structured hedonic scale (1= disliked extremely and 9 = liked extremely) was used in

the acceptance test to evaluate the colour, odour, flavour, sweetness, texture, melting quality, astringency and global quality of the samples and the means were taken. The chocolate samples served at room temperature ($22\pm 2^\circ\text{C}$).

Statistical analysis:

Data collected on different parameters were analyzed statistically by using MSTAT-C programme (Anonymous, 1986) for analysis of variance and means were compared using Fisher's protected least significant differences (LSD) test at 5% probability level (Steel *et al.*, 1997). Standard deviation (SD) was calculated. Means having the same letters are not significantly different.

RESULTS AND DISCUSSION

Proximate composition of dried Indian cherry fruit pulp:

Table (1) presented the results of proximate composition of dried Indian cherry fruit pulp. Moisture content was 78.97 ± 2.04 for fresh Indian cherry fruit pulp. The dried fruit pulp contained 12.60 ± 1.02 Moisture, 68.28 ± 1.25 carbohydrate, 4.07 ± 0.47 crude protein, 6.19 ± 1.64 crude fiber, 4.27 ± 0.72 fat and 2.32 ± 0.83 ash. These results are in agreement with those reported by Valvi and Rathod (2011) and Toliba (2012). Figure (2) showed the photos of fresh and dried Indian cherry fruit pulps.

Table (1): Proximate composition (%) of dried Indian cherry fruit pulp (Mean \pm SD)

Component (%)	Moisture	Carbohydrate	Crude protein	Crude fiber	Fat	Ash
Dried Indian cherry fruit pulp	12.60 ± 1.02	68.28 ± 1.25	4.07 ± 0.47	6.19 ± 1.64	4.27 ± 0.72	2.32 ± 0.83



Figure (2): Photos of fresh (a), dried whole pieces (b) and dried powder (c) of Indian Cherry (*Cordia dichotoma*) fruit pulps

Compound chocolate manufacturing:

Colour attributes:

The foods colour may be affected by different optical phenomena like scattering and the morphology of food surface. Therefore, a full understanding of the influence of surface topography on measured color is important (Hussain *et al.*, 2018). CIE $L^* a^* b^*$ system was used for colour measurements of compound chocolate samples and the results are presented in Table (2). Generally, the three CIE values reflected a good chocolate colour for resultant chocolate as compared with earlier studies such as those reported by Popov-Raljic and Lalicic-Petronijevic (2009) and Hussain *et al.* (2018). However, L^* value ranged between 23.62 ± 1.54 to 26.78 ± 1.03 , a^* value 5.50 ± 0.69 to 6.96 ± 1.06 and b^* value 4.37 ± 0.45 to 4.94 ± 1.37 .

Texture:

Texture of food is a combination of the physical structure of the material and its mechanical and surface

properties (Andrae-Nightingale *et al.*, 2009). Generally, the result of the stable micro systems test is an average of the forces required to compress, shear, puncture or extrude the sample of variable geometry. The maximum force and area under the curve are usually recorded for all of these types of test and taken as an indication of bulk firmness. The area under the curve is usually termed the 'work of shear, compression or penetration' - a larger value indicating a firmer sample (Novaković and Tomašević, 2017).

Texture results of compound chocolate containing dried Indian cherry fruit pulp was presented in Table (3) and Figure (3). As expected, firmness increased by increasing the levels of Indian cherry fruit pulp in the compound chocolate samples. The compound chocolate free from Indian cherry fruit pulp was the softest and the dried Indian cherry fruit pulp coated with compound chocolate was the hardest (Table 3). Generally, firmness of all compound chocolate samples ranged from 2.46 to 63.47 N while, the work of shear ranged from 598.63 to 20781.88 g. sec.

Table (2): Colour attributes (Mean \pm SD) of compound chocolate containing different levels of dried Indian cherry fruit pulp (whole pieces or grounded fruit)

Sample	Colour value		
	L^* , Lightness	a^* , Redness	b^* , Yellowness
Compound chocolate (control)	25.85 ± 0.88	6.39 \pm 0.82	4.46 ± 1.46
20	26.78 ± 1.03	6.96 ± 1.06	4.37 ± 0.45
Compound chocolate containing dried Indian cherry fruit pulp powder with the ratio (%) of			
30	24.32 ± 2.06	6.12 ± 0.97	4.60 ± 0.63
40	23.62 ± 1.54	5.50 ± 0.69	4.94 ± 1.37
Whole pieces of dried Indian cherry fruits pulp coated with compound chocolate	26.47 ± 1.72	6.49 ± 1.56	4.51 ± 1.08

Fat content, particle size distribution, moisture content, emulsifiers, conching time, and temperature affect rheological properties of chocolate product (Gonçalves and Lannes, 2010). Ashkezary *et al.* (2018) investigated the possibility of producing reduced fat dark compound chocolate and found that hardness of compound chocolate samples ranged from 32.09 to

53.25 N. As the Indian cherry fruit pulp increased in the studied chocolate samples, the chocolate components decreased particularly the fat component (because the Indian cherry fruits are poor in fats, Table 1) which mostly responsible for the softness of chocolate. This may be led to the increase of firmness by increasing the fruit component (Table 3).

Table (3): Texture analysis of compound chocolate containing different levels of dried Indian cherry fruit pulp (whole pieces or grounded fruit)

Sample	Firmness (N)	Work of shear g. sec
Compound chocolate (control)	2.46	598.63
20	7.88	3695.44
Compound chocolate containing dried Indian cherry fruit pulp powder with the ratio (%) of		
30	15.99	5457.84
40	55.18	20781.88
Whole pieces of dried Indian cherry fruits pulp coated with compound chocolate	63.47	18261.53

Sensory properties:

Sensory evaluation is a powerful scientific tool that can be used to identify variations in sensory properties and measure product's acceptability (Singh-Ackbarali and Maharaj, 2014). Sensory properties of compound chocolate containing different levels of dried Indian cherry fruit pulp (whole pieces or fruits powder) are presented in Table (4). The panelists recognized a new and clean taste for compound chocolate containing Indian cherry fruit pulp. All tested chocolate samples

were strongly accepted from all panelists. According to the data, there were no significant differences ($p < 0.05$) for colour, odour, flavour, sweetness, texture, melting quality and global quality for all studied chocolate samples, only astringency had a significant differences ($p < 0.05$). It could be referred that the addition of Indian cherry dried fruit pulp to chocolate manufacturing gave a new flavoured chocolate with no negative effect on the sensory attributes.

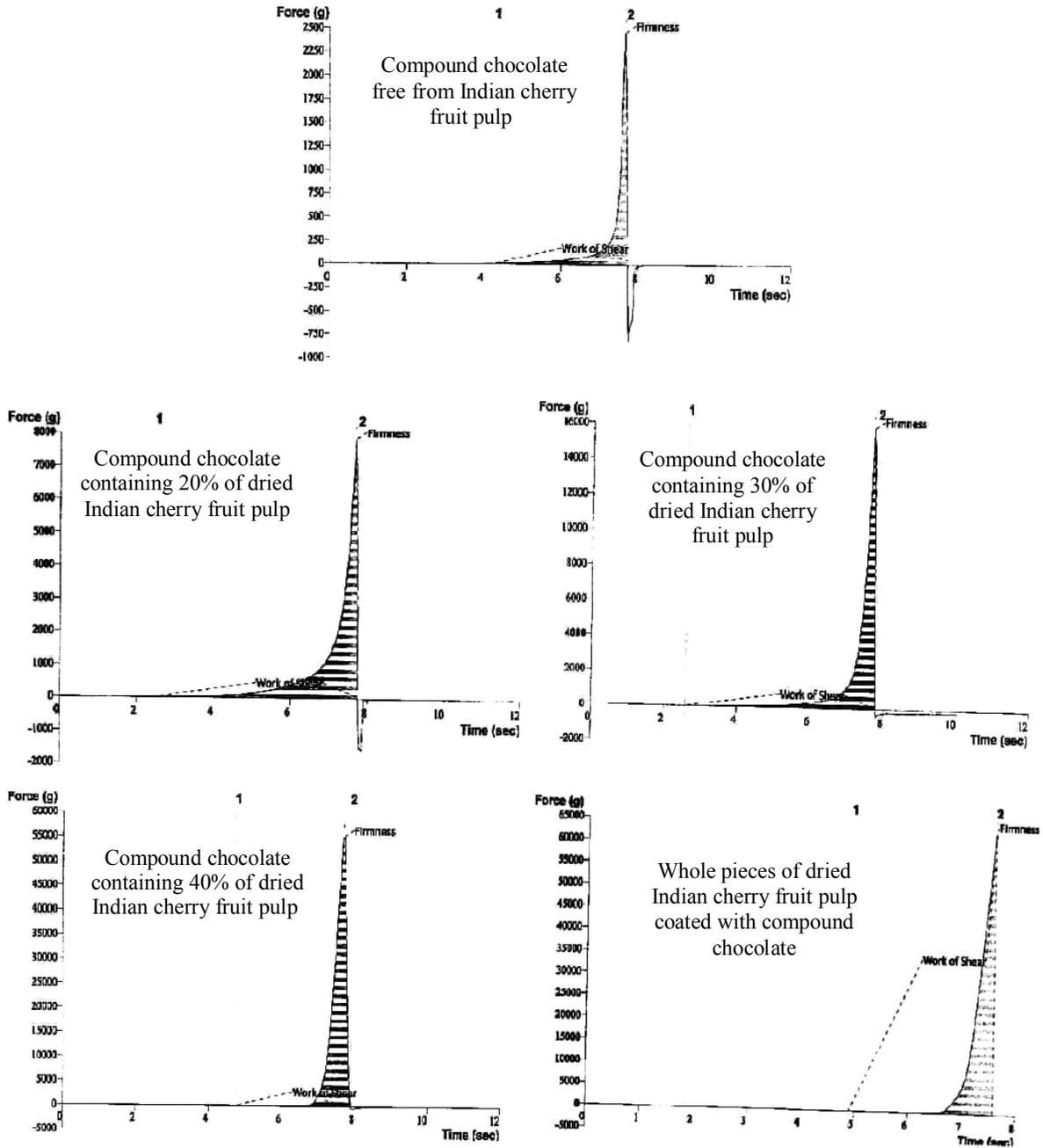


Figure (3): Texture analyzer TA.XT Plus curves of compound chocolate containing different levels of dried Indian cherry fruit pulp (whole pieces or grounded fruit).

Table (4): Sensory properties (Mean \pm SD) of compound chocolate containing different levels of dried Indian cherry fruit pulp (whole pieces or grounded fruit)

Sample	Sensory properties								
	Colour	Odour	Flavour	Sweetness	Texture	Melting quality	Astringency	Global quality	
Compound chocolate (control)	8.34 ± 0.67	8.05 ± 1.01	7.27 ± 1.01	8.34 ± 1.01	6.82 ± 1.17	7.82 ± 0.75	8.18 ^a ± 0.75	8.07 ± 0.48	
Compound chocolate containing dried Indian cherry fruit pulp powder with the ratio (%) of	20	8.05 ± 1.06	8.09 ± 0.86	7.32 ± 1.10	8.45 ± 0.82	7.36 ± 0.50	7.36 ± 0.92	7.55 ^{ab} ± 0.82	7.91 ± 0.54
	30	8.27 ± 0.52	8.02 ± 1.05	7.59 ± 0.92	8.55 ± 0.52	7.45 ± 0.93	7.36 ± 1.12	7.55 ^{ab} ± 1.13	8.27 ± 0.90
	40	8.18 ± 0.90	8.14 ± 1.05	7.68 ± 0.98	8.64 ± 0.67	7.55 ± 1.13	7.52 ± 1.10	7.18 ^b ± 0.60	8.45 ± 0.69
Dried Indian cherry fruit pulp coated with compound chocolate	8.05 ± 0.85	8.09 ± 0.94	7.95 ± 0.75	8.64 ± 0.92	7.55 ± 0.52	7.05 ± 1.15	7.45 ^{ab} ± 0.69	8.36 ± 0.67	
F-test	N. S.	*	N. S.						
L. S. D.	-	-	-	-	-	-	0.70	-	

N.S., *: not significant, significant at level 0.05, respectively.
L.S.D. Least Significant Difference

CONCLUSION

It could be concluded that the enrichment of compound chocolate with dried Indian cherry fruit pulp produced a new flavoured compound chocolate product with good colour, hardness and sensory properties.

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خصائص الجودة للشيكولاتة المركبة المدعمة بلب ثمار الكريز الهندي المجفف

عباس عمر ظليبة

قسم علوم الأغذية – كلية الزراعة – جامعة الزقازيق – مصر

تم دراسة تأثير إضافة لب ثمار الكريز الهندي المجفف على درجة الصلابة، واللون، والخواص الحسية للشيكولاتة المركبة. حيث أوضحت النتائج أن لب ثمار الكريز الهندي المجفف يحتوي على 12.60% رطوبة و 68.28% كربوهيدرات و 4.07% بروتين خام و 6.19% ألياف خام و 4.27% دهن و 2.32% أملاح معدنية. إضافة لب ثمار الكريز الهندي المجفف إلى الشيكولاتة المركبة قد زاد من صلابة المنتج. وعلى الجانب الآخر تبين من قيم الألوان الثلاثة L^* , a^* and b^* أن لون الشيكولاتة الناتجة كان جيدا في كل العينات. بالإضافة إلى ذلك لم يثبت وجود فرق معنوي ($p < 0.05$) في كل من اللون، والرائحة، والنكهة، ودرجة الحلاوة، والقوام، والقابلية للانصهار، والقابلية العامة في كل عينات الشيكولاتة محل الدراسة، وكان الفرق معنويا فقط في الطعم القابض. هذا ويمكن استنتاج أن إضافة لب ثمار الكريز الهندي المجفف لصناعة الشيكولاتة المركبة نتج عنه منتج شيكولاتة ذو طعم وخواص حسية جيدة.