PROCESSING AND QUALITY EVALUATION OF SOME SUGAR-FREE CHOCOLATE PRODUCTS

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(Manuscript received 2 October 2004)

Abstract

The present study was designed to produce sugar-free chocolate for diabetic patients. Milk and dark chocolate, plain or enrobed with diabetic candied fruit (pumpkin) were formulated using skimmed milk powder, polydextrose (P.D.), and mixture of sorbitol and P.D. as bulking agent. Diabetic chocolate sweetened with natural and artificial sweeteners such as stevia or aspartame (APM).

There is a variation of the chemical composition and caloric value of prepared chocolates due to the type of sugar substitutes. The chemical composition of chocolates was slightly affected due to storage for 6 months at refrigerator on 5ºC temperature.

Organoleptic evaluation showed that overall acceptability of all diabetic chocolate treatments can be arranged in the following descending order according to the scores; sucrose > skimmed milk powder > mixture of sorbitol + P.D. > P.D.

INTRODUCTION

Yet, chocolate still retains its attraction primarily because of the desirable flavor and the aesthetic pleasure derived from its consumption. With the growing controversy over sucrose – related health problems and the increasing uncertainly over the safety of artificial sweeteners, many of the so-called " rare food sugars" are now finding increasing food applications in the chocolate and sugar confectionery industry, particularly in designed products e.g. non cryogenic and diabetic products. Greater awareness is therefore being generated of the wider spectrum of bulk carbohydrate sweeteners at the disposal of the manufacturer, (wiggall 1981).

Alternative (non caloric) sweetener are in demand to control calorie intake, prevent tooth decay, and facilitate the formulation of food products for people who suffer from diabetes, (Grenby, 1991). Aspartame is a methyl ester of two amino acids, phenylalanine and aspartic acid; products, which contain it, must be labeled to notify individuals with phenylketonuria that it is present in the product. Aspartame is 150 times sweeter than sucrose, heaving no aftertaste. The FAO/WHO (1983) confirmed

the ADI of aspartame at 40 mg/kg of body weight (FAO /WHO 1984). Stevia herb (Stevia rabaudiane bertoni) extract used for commercial food is sweet about 100 times as sucrose (Kienle, 1995), Xili *et al.* (1992) suggested that the acceptable daily intake of stevioside for humans was 7.9 mg/kg body weight per day. Sorbitol is considerably less sweet than sucrose, about 0.5 times that of sucrose. When consumed in large quantities (25 to 50 grams) it can have a laxative effect, apparently because of its slow intestinal absorption (Newsome, 1986).

Polydextrose made from dextrose, sorbitol, and citric acid, contributes 1Kcal /g. some sensitive individuals may feel a laxative effect when consuming large amounts of polydextrose, studies indicated a mean laxative threshold of 90 g/day. Regulations require a single serving of food containing more than 15 g of polydextrose to be labeled Giese, (1993).

Functional ingredients have been tried as replacements of sugar in chocolate, which constitutes 40 -50 % of the final products weight, Bollinger and Keme (1989), prepared sugar- free chocolate with substitution of sorbitol, mannitol, maltitol, lactitol, xylitol, palatinik, palatinose or polydextrose for replacement the sugar used in the normal products.

Ogunmoyela and Birch, (1984 a) evaluated the profile of sensory differences in dark chocolates prepared using different carbohydrate (sucrose, maltose hydrate, B-D-fructose, L-sorbose and sorbitol). The same authors (1984 b) studied storage changes in the previous samples at two added levels of lecithin as surfactant.

Gaafer, (1999) produced milk chocolates for diabetic patients by using aspartame, acesulfame –k, sorbitol, mannitol and stevioside as a sweeteners and maltodextrine as a filler, the products were evaluated during storage period for 6 months.

No sugar added has several interpretations, but for our purposes it will mean no sugars or sugar containing ingredients are added during processing or packaging.

The present study was carried out mainly to formulate some plain chocolates or enrobed with diet candied fruit in center for diabetic patients by substituting sucrose with aspartame, stevia or sorbitol according to their relative sweetness power to sucrose and skimmed milk powder or polydextrose were used as bulking agents and to follow the changes in quality and composition during processing and storage at refrigerator for 6 months were also under investigation.

MATERIALS AND METHODS

Materials:

Cocoa powder, cocoa butter substitute were purchased from local market " imported from Malezia ". Sucrose powder, pure vanillin crystals (vanilla), butter oil and skimmed milk powder, spray –dried ware purchased from super market. Aspartame, (nutrasweet) a product of G.D. Searle & Co. LTD, U.S.A. Polydextrose, brought from Pfizer CO. U.S.A. Dried leaves stevia (Rebaudina Bertoni,), brought from Nutrition Institute, Ministry of Health. Sorbitol crystals, cocoa butter, and Soya lecithin were obtained from Alex. CO. for manufacturing sweets and chocolate (Corona). Matured pumpkin *(cucurbita pepo)* was obtained from El – Abor market, Cairo, Egypt.

Technological Methods:

Candied fruit processing: Matured pumpkin was used to prepare candied fruit using the procedure as described by El-Sherefa (2004). Pumpkin was washed, cleaned, peeled, cut into pieces (1x1x0.5 cm), blanched in boiling water for 3 min, and soaked overnight in a 30°Brix sucrose solution at the ratio of 1: 1.5 (fruit: syrup) contained 1000 P.P.M. of sodium metabisulfite, 0.5 % salt, and was adjusted for pH with citric acid from 3.5 to 4.0 The fruit was soaked for 24h. Sucrose was then added to the syrup to adjust concentrations to a level of 40, 50, and again 50°Brix. The fruit was soaked in each sucrose concentration for 1 day and finally dried in a hot air oven at 50 °C for 20 h., then cooled at room temperature.

Dietetic candied fruit prepared by substitute sucrose with mixture of sorbitol and stevia according to their relative sweetness, asprtame, stevia, and sorbitol are sweet about 150, 100, and 0.5 times as sucrose, respectively.

Chocolate processing: Sweet plain, dark and milk chocolate (with sucrose) were manufactured in laboratory using the traditional procedure as described by Beckett (1988).

Plain dark chocolate: the formulation of control sample and samples prepared with different sugar substitutes are in Table (1).

Plain milk chocolate: The formulation of control sample and milk chocolate with different sugar substitutes are in Table (2).

Table 1. Formulation of dark chocolate prepared with different sugar substitutes.

Ingredients%	Control sample with sucrose	Sugar substitutes			
		Polydextrose With		Sorbitol + P.D. with	
		APM	Stevia	APM	Stevia
Sucrose	48.00	—	—	—	—
Cocoa powder	28.44	25.52	25.52	27.44	27.44
Cocoa butter and substitute	23.00	30.00	30.00	28.68	28.52
Lecithin	00.50	00.50	00.50	00.50	00.50
Aspartame (APM)	—	00.32	—	00.32	—
Stevia	—	—	00.48	—	00.48
Polydextrose (P.D.)	—	43.60	43.44	20.00	20.00
Sorbitol	—	—	—	23.00	23.00
Salt	00.06	00.06	00.06	00.06	00.06

Table 2. Formulation of plain milk chocolate prepared with different sugar substitutes.

Ingredients%	Control sample with sugar	Sugar substitutes					
		Milk powder With		Polydextrose With		Sorbitol +P.D. With	
		APM	Stevia	APM	Stevia	APM	Stevia
Sucrose	40.50	—	—	—	—	—	—
Cocoa powder	10.00	10.80	10.67	10.80	10.80	10.00	10.00
Skim milk powder	20.07	56.50	56.50	26.50	26.37	20.00	20.00
Cocoa butter and substitutes	20.50	22.50	22.50	22.50	22.50	20.50	20.50
Butter oil	8.40	9.40	9.40	9.40	9.40	9.40	9.40
Lecithin	00.50	00.50	00.50	00.50	00.50	00.50	00.50
Asprtame (APM)	—	0.27	—	0.27	—	0.15	—
Stevia	—	—	0.40	—	0.40	—	0.20
Polydextrose (P.D.)	—	—	—	30.00	30.0	19.71	19.68
Sorbitol	—	—	—	—	—	19.71	19.69
Vanillin	0.03	0.03	0.03	0.03	0.03	0.03	0.03

The sugar (or sugar substitutes), butter oil, cocoa butter, and substitute were mixed to homogeneous mass then cocoa powder and skimmed milk powder were then added, ingredients were mixed continuously for 16 hr. at 50 °C using water bath.

Lecithin and vanilla (or sweeteners in case of diet chocolate) were added before the end of mixing time. The chocolate sample were tempered and molded into form –sized (5g) without or with (1g) pieces of candied fruit in center, rolled up then wrapped in aluminum foil and stored at refrigerator on 5°C±1°C.

Methods of analysis:

Chemical analysis: Moisture, ash, fiber, protein and fat were determined according to the method described by A.O.A.C. (1984); available carbohydrate (starch + sugars) was determined by difference. Approximate energy value was presented as kilocalorie per 100g. of product calculated on the base of : 1g of total sugars, starch or protein equals 4.0 kilo calorie and 1g of fat equals 9 kilo calorie as mentioned by Lawrence (1965).

Organoleptic tests and statistical analysis:

Organoleptic tests were carried out according to Amerine *et al.* (1965). Ten panelists were asked to evaluate samples for their characteristics (color, texture, sweetness, appearance and overall acceptability), the score used for each quality in the sheet was 10.

Statistical analyses of data obtained from sensory evaluation were carried out according to the methods described by Snedecor and Cochron (1967). Significant differences among means were distinguished according to the Duncan, multiple test range (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical properties:

Table (3) shows the chemical composition of plain dark chocolate and chocolate enrobed with candied fruit sweetened with different sweeteners and stored at refrigerator for 6 months, moisture content is low in the products, this could be due to the fatty nature of chocolates, from Table (3) it could be noticed that there were a variable trend in moisture content in different chocolate samples processed by different treatments. From the same table it could be stated that the moisture in candied fruit and hygroscopic for polydextrose may be caused the difference in moisture content of chocolate samples, whereas moisture content in different chocolate after processing ranged from 1.7 to 3.23 % in plain dark chocolate and ranged from 5.25 to 6.27 % in dark chocolate enrobed with candied fruit. From the same table it could be seen that there was a fluctuated trend increasing in moisture

content during storage. The Egyptian standards NO.1667 (1988), and 465 (1990) stated that moisture in sweet plain chocolate should not more than 3 %.

Data in the same Table showed the percentage of total protein in different treatments of chocolate, plain dark chocolate is higher than that in chocolate with candied fruit after processing and ranged from 6.46 to 7.3 % whereas, it ranged from 5.5 to 6.53 % in chocolate with candied fruit.

As shown from Table (3) fat content ranged from 25.24 to 32.21 % in plain dark chocolate and about 20.1 to 25.51 % in chocolate with candied fruit. Also ash content of chocolate sample indicated that no special pattern for ash in different treatments and a fluctuated trend in ash was also observed in different treatments. Also, data in the same Table showed the fiber content in different chocolate after processing ranged from 1.03 to 1.23 % in plain dark chocolate and ranged from 1.98 to 2.31 % in dark chocolate with candied fruit. Concerning carbohydrates, chocolate with candied fruit showed the highest values being from 69.20 to 64.52 % while plain dark chocolate ranged from 64.52 to 58.49%.

Table 3. Effect of storage on some chemical properties for plain dark chocolate and chocolate enrobed with candied fruit sweetened with different sweeteners (on dry weight basis).

Chemical composition	Storage (month)	Sucrose		Sugar substitutes							
				Polydextrose with				Sorbitol + P.D. with			
				APM		Stevia		APM		Stevia	
		P	E	P	E	P	E	P	E	P	E
Moisture%	0	1.70	5.25	3.23	6.27	3.07	6.13	2.19	5.78	2.31	5.83
	3	1.77	5.28	3.62	6.49	3.40	6.50	2.31	5.87	2.62	5.95
	6	1.83	5.31	4.13	6.78	3.85	6.85	2.56	5.97	2.97	6.10
Protein%	0	7.30	6.53	6.46	5.58	6.52	5.50	6.86	6.01	6.91	6.11
	3	7.28	6.50	6.40	5.50	6.46	5.38	6.81	5.93	6.82	6.02
	6	7.26	6.46	6.33	5.36	6.34	5.25	6.76	5.88	6.74	5.92
Fat%	0	25.24	20.10	32.05	25.51	32.21	25.51	31.06	24.87	31.23	24.90
	3	25.18	20.03	31.86	25.12	32.10	25.16	30.92	24.51	31.16	24.63
	6	25.15	20.00	31.71	24.85	32.02	24.93	30.85	24.10	31.10	24.13
Ash%	0	1.71	2.16	1.63	2.09	1.65	2.15	1.59	2.11	1.58	2.16
	3	1.70	2.13	1.60	2.06	1.61	2.13	1.55	2.06	1.53	2.12
	6	1.66	2.13	1.52	2.02	1.55	2.09	1.52	2.01	1.51	2.08
Fiber%	0	1.23	2.01	1.03	1.98	1.13	2.13	1.13	2.05	1.16	2.31
	3	1.20	1.86	1.01	1.96	1.07	2.08	1.08	2.05	1.10	2.26
	6	1.16	1.85	1.00	1.92	1.02	2.01	1.03	1.96	1.08	2.20
Carbohydrate%	0	64.52	69.20	58.83	64.84	58.49	64.71	59.36	64.96	59.12	64.52
	3	64.64	69.48	59.13	65.36	58.76	65.25	59.64	65.45	59.39	64.97
	6	64.77	69.56	59.44	65.85	59.07	65.72	59.84	66.05	59.57	65.67
Energy (K.calory/100g)	0	514.44	483.82	427.21	389.41	426.54	388.57	483.22	451.61	483.99	450.52
	3	514.30	484.19	426.46	387.66	427.38	387.10	481.28	450.01	484.08	449.53
	6	514.47	484.08	427.42	386.39	426.18	386.39	482.85	448.52	483.94	447.43

P: plain chocolate
E: chocolate enrobed with candied fruit
APM: aspartame
P.D.: polydextrose

Results in Table (3) show the total calories per 100 gm of all chocolate samples is different according to the sweetener type, kind of bulking agent and recipes of chocolate type. Sucrose treatment has about 514.44 and 483.82 calories per 100 gm in plain chocolate and chocolate with candied fruit, respectively, Chocolate treatment with candied fruit were low calories than those plain chocolate "may be treatment caused by presence of candied fruit and high quantity of moisture". In plain chocolate samples caloric value were ranged from 489.99 to 426.18 calories/100gm, whereas, in chocolate with candied fruit samples were ranged from 451.61 to 388.57 calories/100gm.

Table (3) also, shows the revealed slight changes in all chemical composition due to storage condition. Protein, fat, and fiber were slight decrees as storage time increased referring to the increase of moisture content with the increase of storage period. These results are in agreement with Gaafer (1999).

Plain milk chocolate and chocolate enrobed with candied fruit were analyzed for; moisture, protein, fat, ash, fiber, and total carbohydrate. The obtained results are shown in Table (4) on dry weight basis.

From the results presented in Table (4) it could be noticed that moisture content in different chocolate after processing ranged from 2.15 to 5.53% in plain milk chocolate and ranged from 5.53 to 8.26% in milk chocolate enrobed with candied fruit. These variation in moisture content in different samples may be due to moisture content in candied fruit, skimmed milk powder and hygroscopic properties for polydextrose. During storage for 6 months it could be noticed that there was slight increase in moisture content in all samples.

Data in the same table, indicated the percentage of total protein in different treatments of chocolate, crude protein showed its maximum value ranged from 18.59 to 22.73% in treatments used milk powder as a bulking agent, whereas, protein content ranged from 10 to 11.62% and from 8.65 to 9.62% in plain milk chocolate and milk chocolate enrobed with candied fruit respectively, used sucrose, polydextrose or sorbitol + poly dextrose as bulking agent. Lipid content showed a slight variation between treatments in plain milk chocolate, it ranged from 29.3 to 32.76%. Also in milk chocolate enrobed with candied fruit lipid content ranged from 23.26 to 25.93%, the maximum and the lowest value were found in plain milk chocolate with sucrose.

Table (4) also show ash content ranged from 2.32 to 5.13% in plain milk chocolate and it ranged from 2.56 to 5.06% in milk chocolate with candied fruit. The

maximum value was found in samples with skimmed milk powder as bulking agent sweetened with aspartame or stevia, while the lowest resulted were in samples with sucrose, polydextrose and sorbitol + polydextrose as bulking agent.

Concerning fiber, milk chocolate with candied fruit showed the highest values being 1.46% and slight variation found between treatments in the same sample. While the lowest value found in plain milk chocolate samples, it was ranged from 0.43 to 0.52%.

The obtained data in Table (4) showed that the lowest and the highest total carbohydrate 38.92 and 57.88% respectively in plain milk chocolate whereas, in milk chocolate with candied fruit ranged from 49.37 to 64.17%. Generally, the obtained data showed that total carbohydrate was high in chocolate with candied fruit samples than in plain chocolate, this is because chocolate with candied fruit contain high quantity of carbohydrate in the prepared mixture.

Table (4) shows the total calories per 100gm of milk chocolate samples differ according to the sugar substitutes type and kind of chocolate (plain or with candied fruit) which is higher in plain milk chocolate with skimmed milk powder as sugar substitute (541.19), and lowest in milk chocolate with candied fruit sweetened with aspartame and polydextrose as sugar substitute (419.58).

Table 4. Effect of storage on some chemical properties for plain milk chocolate and chocolate enrobed with candied fruit sweetened with different sweeteners (on dry weight basis).

Chemical composition	Storage (months)	Sucrose		Sugar substitutes											
				Milk powder with				Polydextrose with				Sorbitol +P.D. (1:1) with			
				APM		STEVIA		APM		STEVIA		APM		STEVIA	
		P	E	P	E	P	E	P	E	P	E	P	E	P	E
Moisture%	0	2.15	5.53	5.46	8.26	5.53	8.13	5.14	8.07	5.23	8.19	4.16	7.35	4.30	7.21
	3	2.18	5.50	5.51	8.28	5.57	8.15	5.46	8.12	5.50	8.26	4.20	7.41	4.35	7.26
	6	2.21	5.50	5.59	3.30	5.62	8.16	5.60	8.18	5.91	8.32	4.31	7.49	4.42	7.33
Protein%	0	10.00	8.65	22.62	18.63	22.73	18.59	11.55	9.51	11.62	9.45	11.66	9.62	11.53	9.49
	3	9.97	8.62	22.60	18.61	22.70	18.57	11.51	9.50	11.60	9.43	11.60	9.60	11.50	9.46
	6	9.95	8.62	22.56	18.60	22.67	18.56	11.41	9.43	11.50	9.40	11.52	9.57	11.41	9.42
Fat%	0	29.30	23.26	32.59	25.81	32.70	25.87	32.76	25.93	32.52	25.69	32.65	25.79	32.60	25.81
	3	29.30	23.25	32.57	25.80	32.68	25.87	32.70	25.90	32.50	25.69	32.60	25.77	32.56	25. 78
	6	29.27	23.23	32.55	25.77	32.65	25.85	32.60	25.82	362.41	25.62	32.52	25.72	32.51	25.75
Ash%	0	2.32	2.56	4.97	4.72	5.13	4.82	2.80	5.06	2.57	2.93	2.79	3.01	2.72	2.95
	3	2.31	2.55	4.95	4.71	5.11	4.80	2.76	5.01	2.70	2.90	2.76	3.01	2.70	2.91
	6	2.31	2.55	4.95	4.70	5.09	4.78	2.70	5.00	2.61	2.87	2.73	2.97	2.64	2.90
Fiber%	0	0.50	1.36	0.47	1.41	0.52	1.35	0.45	1.42	0.48	1.46	0.43	1.40	0.45	1.39
	3	0.49	1.33	0.47	1.40	0.52	1.35	0.43	1.40	0.45	1.45	0.41	1.38	0.41	1.37
	6	0.46	1.31	0.45	1.37	0.50	1.32	0.40	1.36	0.43	1.45	0.40	1.35	0.40	1.35
Carbohydrate%	0	57.88	64.17	39.35	49.43	38.92	49.37	52.44	58.08	52.63	60.47	52.47	60.18	52.70	60.36
	3	57.93	64.25	39.41	49.48	38.99	49.41	52.60	58.19	52.75	60.53	52.63	60.24	52.83	60.48
	6	58.51	64.29	39.49	49.56	38.59	49.49	52.89	58.39	53.05	60.66	52.83	60.39	53.04	60.58
Energy K.calorie/100gm	0	535.22	500.62	541.19	504.53	540.90	504.67	466.65	419.58	465.53	426.73	495.08	456.02	495.03	456.49
	3	535.30	500.73	541.17	504.56	540.88	504.75	466.59	419.71	465.75	426.90	495.03	456.00	495.16	456.58
	6	535.62	500.71	541.15	504.57	538.89	504.85	466.45	419.51	465.74	426.67	494.79	456.03	495.19	456.55

P: plain chocolate
E: chocolate enrobed with candied frui
APM: aspartame
P.D.: polydextrose

Generally, the type and amounts of bulking agents and sweeteners added varied according to its relative sweetness, which may reflect the variation on the chemical composition of prepared chocolates.

The data in Table (4) shows reveal slight changes in all chemical composition due to storage for 6 months at refrigerator.

Chemical composition for both plain dark and milk chocolate sweetened with sucrose is agreement with Egyptian standard NO.465 (1990).

Organoleptic evaluation:

As in all foods, organoleptic tests are generally the final guide to the quality from the consumer's point of view. Data in Table (5) show the average score of organoleptic parameters for plain dark chocolate. The data showed that all treatments produced chocolate color with non-significant change in color compared with control at zero time and during storage period. Data also showed that there is no significant difference between the average scores of texture at zero time for any treatment except treatments with polydextrose as sugar substitute. It could be concluded that there are no significant differences between the average of sweetness at zero time for any sweetener except treatments sweetened with stevia. This may be due to the after taste of stevia, whereas, during storage, there are significant differences between the average of APM treatment at zero time and after 6 month of storage. This may be due to the degradation of APM during storage. Concerning general appearance, the score showed no significant differences between any treatments after processing except treatment with polydextrose. Overall acceptability can be arranged in the following descending order according to the score; sucrose > sorbitol + P.D. with APM > sorbitol + P.D. with stevia >polydextrose with APM > poly dextrose with stevia.

All dark chocolate enrobed with candied fruit were organoleptically evaluated for color, texture, sweetness, and appearance as showed in Table (6). The average scores of color appear that there is no significant difference between the average scores of color at zero time and after 6 month for any treatment. Also there are no significant between average scores of color between any two sweeteners for the same storage period. Analysis of variance indicated that there is no significant difference between the average of texture at zero time except treatment with polydextrose sweetened with APM. Also there is no significant difference between any treatment at zero time and after 6-month storage period. It could be seen that the average scores of sweetness, analysis of variance indicated that there is no significant differences between the average scores of sweetness at zero time and after 6 months

of storage for all samples. Also the data indicated that there was significant difference between averages of sweetness in sample sweetened with stevia and all samples for the same storage period. Also, there was no significant difference between the average of appearance at zero time or during storage period.

From Table (7) it could be noticed that there is no significant difference between the means of color at zero time except treatment with polydextrose, while no significant difference between the means at zero time and after 6 months storage period within the same sweeteners. The same observations were also found in texture scores. There is a significant difference between the means scores sweetness for stevia and any other sweetener at zero time, whereas no significant difference between the means at the same sweetener during storage period. The results revealed the over-all acceptability of different plain milk chocolate manufactured with three different sugar substitutes as affected by storage period.

Table 5. Mean score of organoleptic parameters for plain dark chocolate sweetened with different sweeteners during storage periods.

Organoleptic parameters	Storage (months)	Sucrose	Sugar substitutes			
			Polydextrose with		Sorbitol +P.D. with	
			APM	Stevia	APM	Stevia
Color	0	9.3 A	9.2 A	9.1 A	9.2 A	9.2 A
	3	9.3 A	9.1 A	9.0 A	9.0 A	9.1 A
	6	9.2 A	9.1 A	9.0 A	9.0 A	9.0 A
Texture	0	9.2 AB	8.5 F	8.6 EF	9.0 BCD	9.0 BCD
	3	9.3 A	8.4 F	8.5 F	8.9 CD	8.8 DE
	6	9.1ABC	8.4 F	8.4 F	8.8 DE	8.8 DE
Sweetness	0	9.4 A	9.3 AB	8.7 D	9.3 AB	8.6DE
	3	9.4 A	9.2 BC	8.6 DE	9.2 BC	8.6 DE
	6	9.3 AB	9.1 C	8.6 DF	9.1 C	8.5 EF
Appearance	0	9.3 A	8.7 DE	8.6 DE	9.0 BC	9.1 ABC
	3	9.2 AB	8.7 DE	8.5 E	8.8 CD	9.0 BC
	6	9.2 AB	8.5 E	8.5 E	8.8 CD	8.9 CD
Overall acceptability	0	9.3 A	8.93 BCDE	8.75 DEF	9.13 ABC	8.98 BCD
	3	9.3 A	8.85 CDEF	8.65 EF	8.98 BCD	8.88 CDEF
	6	9.2 AB	8.78 DEF	8.62 F	8.93 BCDE	8.80 DEF

APM: aspartame
P.D.: poly dextrose

-Raw wise: mean not followed by the same latter (s) are significantly different ($P < 0.05$)

-Column wise: mean between any two-storage period at the same organoleptic parameter not followed by the same latter (s) is significantly different ($P< 0.05$).

Table 6. Mean score of organoleptic parameters for dark chocolate enrobed with candied fruit sweetened with different sweeteners during storage periods.

Organoleptic parameters	Storage (months)	Sucrose	Sugar substitutes			
			Polydextrose with		Sorbitol +P.D. with	
			APM	Stevia	APM	Stevia
Color	0	9.5 A	9.3 AB	9.3 AB	9.2 AB	9.2 AB
	3	9.3 AB	9.3 AB	9.2 AB	9.2 AB	9.1 B
	6	9.3 AB	9.2 AB	9.2 AB	9.1 B	9.1 B
Texture	0	9.5 A	7.5 B	8.9 A	9.3 A	9.3 A
	3	9.5 A	7.3 B	8.9 A	9.3 A	9.2 A
	6	9.4 A	7.0 B	8.8 A	9.2 A	9.1 A
Sweetness	0	9.4 A	9.3 A	8.0 B	9.4 A	8.2 B
	3	9.4 A	9.2 A	8.0 B	9.3 A	8.0 B
	6	9.3 A	9.1 A	7.8 B	9.3 A	8.0 B
Appearance	0	9.4 A	9.2 A	9.3 A	9.2 A	9.3 A
	3	9.4 A	9.1 A	9.1 A	9.2 A	9.3 A
	6	9.3 A	9.1 A	9.1 A	9.1 A	9.2 A
Overall acceptability	0	9.45 A	8.83 DEF	8.88 DE	9.26 AB	9.00 CD
	3	9.40 AB	8.73 EF	8.80 DEF	9.25 ABC	8.90 DE
	6	9.33 AB	8.60 F	8.73 EF	9.18 BC	8.85 DEF

APM: aspartame

P.D.: poly dextrose

-Raw wise: mean not followed by the same latter (s) are significantly different ($P < 0.05$)

-Column wise: mean between any two-storage period at the same organoleptic parameter not followed by the same latter (s) is significantly different ($P< 0.05$).

Table 7. Mean score of organoleptic parameters for plain milk chocolate sweetened with different Sweeteners during storage periods

Organoleptic Parameters	Storage (months)	Sucrose	Sugar substitutes					
			Dry milk with		Polydextrose with		Sorbitol +P.D. with	
			APM	Stevia	APM	Stevia	APM	Stevia
Color	0	9.0 AB	9.1 AB	9.2 A	8.6 CD	8.5 D	9.0AB	9.0 AB
	3	9.0 AB	9.0 AB	9.1 AB	8.5 D	8.4 D	8.9 AB	9.0 AB
	6	9.0 AB	9.0 AB	9.1 AB	8.5 D	8.4 D	8.8 BC	8.9 AB
Texture	0	9.1 ABC	9.3 AB	9.4 A	8.5 DE	8.4 E	9.1 ABC	9.1 ABC
	3	9.0 BC	9.4 A	9.4 A	8.2 E	8.3 E	9.0 BC	9.0BC
	6	8.8 CD	9.3 AB	9.3 AB	8.2 E	8.2 E	8.9 C	8.8 CD
Sweetness	0	9.3 A	9.3 AB	8.7 C	9.2 AB	8.6 C	9.2 AB	9.1 AB
	3	9.3 A	9.2 AB	8.7 C	9.0 B	8.6 C	9.1 AB	9.0 B
	6	9.1 AB	9.2 AB	8.6 C	9.0 B	8.5 C	9.1 AB	9.0 B
Appearance	0	9.2 AB	9.3 A	9.2 AB	8.5 F	8.6 EF	9.0BCD	8.9 CD
	3	9.0 BCD	9.2 AB	9.2 AB	8.4 F	8.4 F	8.8 DE	8.9 CD
	6	9.0 BCD	9.1 ABC	9.1 ABC	8.4 F	8.4 F	8.9 CD	8.8 DE
Overall acceptability	0	9.15 ABC	9.25 A	9.13 ABC	8.70 DE	8.53 EF	9.05 ABC	9.03 ABC
	3	9.08 ABC	9.20 AB	9.10 ABC	8.53 EF	8.43 EF	8.98 ABCD	8.98 ABCD
	6	8.98 ABCD	9.15 ABC	9.03 ABC	8.53 EF	8.38 F	8.93 BCD	8.88 CD

APM: aspartame.
P.D.: polydextrose.
-Raw wise: mean not followed by the same latter (s) are significantly different ($P < 0.05$)

-Column wise: mean between any two-storage period at the same organoleptic parameters not followed by the same latter (s) are significantly different ($P< 0.05$).

In conclusion, the obtained results revealed that the three sugar substitutes used did not affect the over all acceptability after processing except treatment with polydextrose sweetened with APM or stevia. During storage period for 6 months it notice that no significant differences was found.

According to the spreading scores of different sugar – free milk chocolate enrobed with candied fruit, results in Table (8) revealed that a significant differences was found between color of chocolate with polydextrose as sugar substitutes, sweetened with APM or stevia and all treatments after processing. Also, there are no significant differences between treatment at zero time and during storage period. The same observations were also found in texture scores. The same results, also indicated that there is no significant differences between treatments with AMP as sweetener comparing with control at any time of storage period, the same observation was also found in treatment with stevia and sorbitol +P.D., as a sugar substitutes. Data in the same table also show that is significant difference between mean scores of sweetness sucrose and stevia with in both chocolate with dry milk or with polydextrose, this may be due to the after taste of stevia.

Concerning general appearance, the data are presented in Table (8) showed that there are no significant differences between any treatments except chocolate with polydextrose as bulking agent. During storage period there is no significant differences between any two-storage periods with in the same treatment. Overall acceptability can be arranged in the following descending order according to the score: sucrose >skimmed milk powder with APM > skimmed milk with stevia > sorbitol + P.D. with APM > sorbitol +P.D. with stevia > P.D. with APM > P.D. with stevia. Insignificant differences were noticed in the over all acceptability of plain milk chocolate.

From these results, it could be concluded that the chosen sugar substitutes i.e. skimmed milk powder, polydextrose, and sorbitol + P.D. are the best for sugar – free chocolate. Also, validity of this type of chocolate was 6 months at refrigerator temperature.

Table 8. Mean score of organoleptic parameters for milk chocolate enrobed with candied fruit sweetenedwith different sweeteners during storage periods.

Organoleptic parameters	Storage (months)	Sucrose	Sugar substitutes					
			Dry milk with		Polydextrose with		Sorbitol +P.D. with	
			APM	Stevia	APM	Stevia	APM	Stevia
Color	0	9.1 A	9.0 A	9.1 A	8.2 C	8.3 BC	8.9 A	8.8 A
	3	9.0 A	9.0 A	8.9 A	8.0 C	8.1 C	8.8 A	8.8 A
	6	8.9 A	8.9 A	8.9 A	8.0 C	8.0 C	8.7 AB	8.7 AB
Texture	0	9.4 A	9.3 A	9.4 A	8.1 B	8.0 B	9.2 A	9.3 A
	3	9.4 A	9.4 A	9.2 A	8.1 B	8.1 B	9.1 A	9.1 A
	6	9.3 A	9.3 A	9.2 A	8.0 B	8.1 B	9.2 A	9.1 A
Sweetness	0	9.4 A	9.4 A	8.5 C	9.2 AB	8.3 C	9.2 AB	9.3 AB
	3	9.3 AB	9.2 AB	8.5 C	9.0 B	8.2 C	9.1 AB	9.0 B
	6	9.3 AB	9.0 B	8.4 C	9.0 B	8.3 C	9.1 AB	9.0 B
Appearance	0	9.5 A	9.5 A	9.4 A	8.5 B	8.5 B	9.3 A	9.3 A
	3	9.5 A	9.4 A	9.4 A	8.4 B	8.3 B	9.4 A	9.4 A
	6	9.4 A	9.2 A	9.3 A	8.3 B	8.3 B	9.4 A	9.3 A
Overall acceptability	0	9.35 A	9.30 AB	9.10 ABCD	8.50 E	8.28 EF	9.15 ABCD	9.18 ABCD
	3	9.30 AB	9.25 ABC	9.00 CD	8.38 EF	8.18 F	9.10 ABCD	9.08 ABCD
	6	9.23 ABCD	9.10 ABC	8.95 D	8.33 EF	8.18 F	9.10 ABCD	9.03 ABCD

APM: aspartame.
P.D.: polydextrose.
- Raw wise: mean not followed by the same latter (s) are significantly different ($P < 0.05$).
-Column wise: mean between any two-storage period at the same organoleptic parameters not followed by the same latter (s) are significantly different ($P< 0.05$).

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إنتاج وتـقييم جودة بعض منتجات الشيكولاته الخالية من السكر

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- أجريت هذه الدراسة لإنتاج شيكولاته خالية من السكر خاصة بمرضى السكر. تم تصنيع كلا من شيكولاته سادة و شيكولاته باللبن وشيكولاته ساده محشوة وشيكولاته باللبن محشوة بفاكهة مسكرة دايت (قرع العسل) واستخدم في ذلك لبن جاف منزوع الدسم وبولي ديكستروز وخليط من السوربيتول والبولي ديكستروز كمواد مالئه واستخدام محليات صناعية وطبيعية (الاسبرتام أو الاستيفيا) كمحليات للشيكولاتة.
- وجد تفاوت في التركيب الكيماوي والقيمة الحرارية للشيكولاته المنتجة وهذا بسبب نوع بدائل السكر المستخدمة. وتأثر التركيب الكيماوي تأثر طفيف نتيجة التخزين لمدة ٦ شهور في الثلاجة على درجة حرارة ٥ درجة مئوي.
- كذلك يتضح من الاختبارات الحسية انه يمكن ترتيب منتجات شيكولاتة مرضى السكر على حسب درجة القبول تنازلياً بناء على نوع المادة المالئة كالتالي : السكروز ثم لبن منزوع الدسم ثم خليط السوربيتول والبولى ديكستروز ثم البولي ديكستروز.