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Characteristics of children Marshmallow Candy Colored by Natural Anthocyanin Extract from Jamun (*Syzygium cumini*) during cold Storage

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ABSTRACT

It is difficult to produce children's marshmallow candy colored with anthocyanin enriched extract (AEE) from jamun (*Syzygium cumini*) without first researching the product's quality. Different levels of anthocyanin enriched extract (AEE) additionally mixed into the standard marshmallow candy (at 3, 5 and 7g into 100g recipe compared with marshmallow sample coloring by synthetic color (Carmine) at 0.10 g/100g. Characterize of (AEE) were analysis. Water activity, color properties and organoleptic characteristics of the products during storage for 90 days were evaluated. Present study reports (AEE) at 0.6, 0.8 and 1mg/ml was found to exhibit a higher significant DPPH radical scavenging activity ($P \leq 0.05$) than that of BHT at concentration 200 and 300 ppm. there were no significant difference ($p<0.05$) in (AEE) at pH 5 and incubation period 0, 30, 60, 90 and 120 min at 50°C was 2.65, 3.06, 3.03, 3.18 and 3.16 mg/100 ml. Water activity of marshmallow candy tended to decrease with the addition of (AEE). It caused by the ability of (AEE) to prevent moisture absorption and retention. There were no significant difference in (appearance, odor, taste, texture and overall acceptability) between the control sample and marshmallow samples colored with 3% (AEE). Jamun is a dark purplish fruit and its color undoubtedly contributed to the color of marshmallow by decreasing the L* and b* values and increasing a* value so that Jamun extract can be successfully used to improve properties of children marshmallow candy.

***Keywords*:** Candy products, jambolan, stability, water activity and Organoleptic characteristics

INTRODUCTION

Color is an important quality attribute in the food industry, and it influences consumer's choice and preferences (Pathare *et al.*, 2013). It considered one of the most impressive and delightful attributes of foodstuffs, which directly influences preference, selection and eating desires of the consumers (Shim *et al.*, 2011). Synthetic food colors are substances of chemicals that do not synthesis in nature and made by human. These colors are water-soluble which used in foods without any further processing (Bachalla, 2016).

Biocolourants are prepared from renewable sources and majority is of plant origin. The main food biocolourants are anthocyanidins, carotenoids, flavanoids, chlorophyll, crocin and betalain that extracted from several horticultural plants. In addition to food coloring, biocolourants also act as antimicrobials, antioxidants and thereby prevent several diseases and disorders in human beings. Although, biocolourants have several potential benefits, tedious extraction procedures, low color value, higher cost than synthetic dyes, instability during processing etc. hinder their popularity (Rymbai *et al.*, 2011), so that there has been an increased interest in the development of food colorants from natural sources as alternatives to synthetic dyes because of both legislative action and consumer concern (Giusti and Wrolstad, 1996). Anthocyanins as natural colorants used to color a number of non-beverage foods including gelatin desserts, fruit fillings and certain confectionaries (Chattopadhyay *et al.*, 2008).

Jamun (*Syzygium cumini*), mainly known as 'Jaam' in Bengali, black plum in English and 'Indian berry', belongs to the family Myrtaceae. It found in tropical and subtropical countries. Because of its high nutritional value and excellent processing qualities, it is now gaining popularity in sub-tropics and arid region of the country (Bukya and Madane, 2018). World production of Jamun estimated to 13.5 million tones, out of which 15.4% contributed by India, Maharashtra state is the largest Jamun producer (Anonymous, 2005).

Jamun fruit is having higher amount of antioxidants when compared to the other seasonal fruits like banana, papaya, guava and sapota (Ghosh *et al.*, 2017).The higher antioxidant activity in the fruit is attributed to the presence of antioxidant vitamins, tannins and anthocyanins (Koley *et al.*, 2011). Antibacterial activity of water extract of jamun by HPLC shows antibacterial activity at various levels against *Escherichia coli, Bacillus cereus and Staphylococcus aureus* because it contains a large amount of phenolic compounds, tannins and flavonoids so that we can use it in folk medicines (Borhade, 2012).

Functional foods consumed in the normal diet and contain biologically active compounds with potential to improve health or to reduce the risk of disease (Butnariul and Sarac, 2019). The functionality of food depends on some of its bioactive compounds (Asghari *et al.*, 2020). The sugar-based products characterized by high nutritional value, pleasant taste and aroma, attractive appearance, so that the demand for this product group is continuously increasing (Ghendov-mosanu, 2018). Marshmallow candy is becoming

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more popular, especially among children, due to the variety of its forms, appearances and flavors (Magomedo *et al*., 2014).

The aim of this research work was to characterize the pigments obtained from jamun (*Syzygium cumin*) and using these pigments as alternative natural red colorant in marshmallow candy. Water activity, color properties and organoleptic characteristics of the products during storage for 90 days were evaluated.

MATERIALS AND METHODS

Materials

Fully ripe Jamun Fruit: (Syzygium cumini) obtained from the Farm of Horticulture Research Institute at El-Qanatir El-khayriyah city, Qalyubiyah Governorate, Egypt, during September 2019.

Glucose syrup (30-32DE) purchased from National Co. for Maize Products, 10th of Ramadan City, Egypt.

Sugar: Commercial grade granulated sugar cane (sucrose) was obtained from the local market, a product of Egyptian Sugar and Integrated Industries Company, Hawmdia City, Egypt.

Other ingredients: Orange flavor (BC 101), gelatin powder, sodium chloride (food grade) and corn starch were obtained from local market, Tanta City, El-Gharbia Governorate, Egypt.

Chemicals: Synthetic antioxidants namely butylated hydroxyl toluene (BHT) and synthetic red colorants namely carmine (Alum Lake of carminic acid C.I. 75470), Potassium Ferric cyanide, Ferric Chloride, Trichloroacetic acid, Ethanol and 2, 2-Diphenyl-1-Picryl-Hydrazyl (DPPH) all were obtained from sigma-Aldrich Chime, Steinheim, Germany.

Methods

Extraction of Anthocyanin enriched Extract (AEE) from Jamun (*Syzygium cumini)*:

Fresh jamun fruit cleaned and washed. The seeds removed from edible part. Pulp and skin were mashed into particles by an electric mixer (Barun, Combimax 700, Germany). An aqueous extraction was prepared from jamun pulp. The obtained crude extracts were collected and centrifuged at 6000 rpm for 30 min (Hermle Z206A, Germany), and evaporated at 40°C to a small volume (Rotary evaporator, Stuart, UK) . The extract was freeze-dried (Snijders, Netherlands), at an absolute chamber pressure of 0.04 Pa, freeze-drying began at - 40°C (shelf temperature). The collected powder processed until it examined in a hermetically sealed glass container.

Preparation of marshmallow candy

Marshmallow samples were prepared using the recipe shown in Table 1. The gelatin was soaked with warm water (45°C). The sugar, glucose syrup, sodium chloride and the remaining water heated. The brix (°B) value of the mixture adjusted to 68-75°B by adding a portion of water. The control sample was coloring by synthetic color (Carmine) at 0.01 g/100g. Different levels of the (AEE) were additionally mixed into the standard marshmallow candy (additional levels at 3, 5 and 7g into the 100g recipe of the marshmallow candy), The mixture was then poured into cylindrical shaped to the required thickness, cooled overnight and cut to desired shape (3cm). Stored in sealed polypropylene plastic bags at 5±1°C and analyzed after 0, 30, 60 and 90 days.

Table 1. Quantity of ingredients used in the formulae of marshmallow candy

Ingredients	Weight (g/100g)
Gelatin	10.30
Water to soak gelatin	12.74
Sugar	45.09
Water	28.81
Glucose syrup (30-32 DE)	1.93
Sodium chloride (food grade)	0.13
Orange flavor	1
Total	100

DE= Dextrose Equivalent

Analytical Methods:

Antioxidant Activity of Anthocyanin Enriched Extract from Jamun (*Syzygium cumini*):

The free radical scavenging activity measured according to the DPPH method as reported by Brand-Williams *et al*., (1995). The FRAP (Ferric reducing antioxidant power) assay was conducted following the method described by Yen and Chen, (1995).

Stability of anthocyanin enriched extract from Jamun (*Syzygium cumini*):

The stability was determined according to the methods of Stintzing and Carle, (2004).

Water activity of marshmallow candy samples:

Water activity (a_w) measured using a Lab Swift-a_w (Novasina, Switzerland) hygrometer (Piga *et al*., 2005).

Color parameter of marshmallow candy samples:

Color measured by a colorimeter (Minolta CR 400, Minolta Camera, Co, Osaka, Japan) and recorded in the L*, *a**, *b** color system (Hunt, 1991).

Organoleptic characteristics of marshmallow candy samples:

Organoleptic characteristics was carried out (Watts *et al.*, 1989) by panelists from Food Science and Technology Department, Faculty of Home Economic, Al-Azhar University, Tanta, Egypt.

Statistical Analysis

The results were analyzed statistically to establish mean values, standard deviation (±SD). The data were statistically evaluated according to the 5 percent level of probability procedure by the least significant differences (L.S.D) (Snedecor and Cochran, 1980) using Costat program Version of (6.451).

RESULTS AND DISCUSSION

Antioxidant activity of anthocyanin enriched extract from jamun (*Syzygium cumini):*

The free radical–scavenging capacity of anthocyanin enriched extract at different concentrations was measured by DPPH assay and ferric reducing antioxidant power (FRAP) is given in Table 2. Data showed the ability of (AEE) to scavenge DPPH radicals demonstrated as the percentage of DPPH inhibition. At the concentration of (1, 0.8, 0.6 and 0.4 mg/ml) (AEE) caused the highest scavenging of the DPPH radical (97.9, 93.9, 76.07 and 51.03%), respectively. While the lowest inhibition values of DPPH radical were (36.72 and 25.06%) at concentration (0.2 and 0.1mg/ml), respectively. Anthocyanin enriched extract at 0.6, 0.8 and 1mg/ml was found to exhibit a higher significant DPPH radical scavenging activity ($P \leq 0.05$) than that of BHT which caused scavenging

of the DPPH radical (59.14 and 82.45), respectively at concentration 200 and 300 ppm. The IC_{50} value of the extract studied was found to be 3.60 mg/ml and was equivalent to the synthesis antioxidant BHT (IC_{50} = 139.5 ppm). This result was accordance with (Menaka and Venkatasubramanian, 2018) found that the antioxidant activity of Lyophilized Jamun Pulp (22.54%) Inhibition and was better than Jamun Pulp (18.5%).

Table 2. Antioxidant activity of Anthocyanin Enriched Extract (AEE) from Jamun (*Syzygium cumini)* compared with butylated hydroxytoluene (BHT)

Concentrations	Antioxidant activity	
	DPPH (%)	FRAP (Absorbance at 700 nm)
0.1 mg/ml	25.06	0.166
0.2 mg/ml	36.72	0.254
0.4 mg/ml	51.03	0.402
0.6 mg/ml	76.07	0.553
0.8 mg/ml	93.9	0.700
1 mg/ml	97.9	0.855
(AEE) IC_{50} (mg/ml)	3.60	--
BHT (100ppm)	36.28	0.306
BHT (200ppm)	59.14	0.789
BHT (300ppm)	82.45	0.988
(BHT) IC_{50}	139.60	--

DPPH==2, 2-diphenyl-1-picrylhydrazyl radical. FRAP= ferric reducing antioxidant power. IC_{50}= (Half maximal inhibitory concentration)

Data in the same table showed that in ferric reducing antioxidant power (FRAP), the yellow shade of the test arrangement changes to green or blue shading relying upon the reducing power of antioxidant samples. A higher absorbance indicates a greater reducing power of the ferric. An increase in FRAP was observed in the anthocyanin enriched extract with increasing concentration. In general, the natural antioxidant extract (AEE) would be preferred over synthetic antioxidant (BHT) to minimize the adverse health effects. Anthocyanin, as well as other phenolic compounds could acts as antioxidants by donating hydrogen to highly reactive radicals thereby preventing further formation of oxidation products (Fu-kumoto and Mazza, 2000).

Stability of Anthocyanin Enriched Extract (AEE) from Jamun (*Syzygium cumini)*:

The stability of Anthocyanin Enriched Extract (AEE) dissolved in buffer solution at various pH values of buffer ranging from 2.5 to 8.0 and water at pH 6.65. The results in Table 3 presented that, there is no significant difference ($p<0.05$) in (AEE) at pH 5 and incubation period 0, 30, 60, 90 and 120 min at 50°C was 2.65, 3.06, 3.03, 3.18 and 3.16 mg/100 ml. Meanwhile, anthocyanin enriched extract was more stable at pH 2.5, 3 and 8, which was 21.92, 8.90 and 10.87 mg/100 ml, respectively. However, by diminishing the pH underneath 3 or expanding the pH over 8, (AEE) content was significantly decreased.

The statistical analysis in Table 4. show non a significant difference ($p<0.05$) in (AEE) content by the raising of time from 0: 120 min on buffer solutions of anthocyanin pigment at different pH and temperatures resulted led to no significantly decreased from 7.85 to 7.89 mg / 100 ml, respectively. However, there was not a vast difference in retention between the 50 and 70 °C treatments, this could indicate imply that most of the pigments were degraded at 90 °C and no further degradation could occur as reported by (Saira and Kamran, 2017). Our results were according to Troise and Fogliano, (2013) noticed that the stability of anthocyanin and all pigments found in foods decreased with increases in temperature.

Table 3. Effect of temperature, time and pH level on stability of Anthocyanin Enriched Extract (AEE) (mg /100 ml) from Jamun (*Syzygium cumini)*

Temperature (ºC)	Time (min)	pH							
		2.5	3	4	5	6	7	8	Water
50	0	23.07^{a}	8.51 ^{mnop}	3.54 ^{yzABCD}	2.65 ^{D}	2.94 ^{BCD}	4.48 ^{vwxyz}	14.69^{e}	2.90 ^{CD}
	30	22.82^{a}	8.98 ^{jklmno}	3.72 ^{xyzABCD}	3.06 ^{ABCD}	3.31 ^{zABCD}	5.12 ^{tuvw}	10.31^{fghi}	3.10 ^{ABCD}
	60	22.77^{ab}	9.95^{fghijk}	3.70 ^{xyzABCD}	3.03 ^{ABCD}	3.60 ^{yzABCD}	4.25 ^{wxyzA}	8.98 ^{jklmno}	3.25 ^{zABCD}
	90	22.71^{ab}	9.07 ^{hijklmno}	3.91 ^{wxyzABCD}	3.18 ^{ABCD}	3.56 ^{yzABCD}	5.71 ^{stuv}	8.87 ^{jklmno}	3.49 ^{zABCD}
	120	22.62^{ab}	9.12 ^{hijklmn}	4.00 ^{wxyzABC}	3.16 ^{ABCD}	3.73 ^{xyzABCD}	5.85 ^{stu}	8.79 ^{jklmno}	3.29 ^{zABCD}
70	0	23.07^{a}	8.51 ^{mnop}	3.54 ^{yzABCD}	2.65 ^{D}	2.94 ^{BCD}	4.48 ^{vwxyz}	14.69^{e}	2.90 ^{CD}
	30	22.62^{ab}	9.51 ^{ghijklm}	3.86 ^{wxyzABCD}	3.20 ^{zABCD}	3.98 ^{wxyzABC}	6.60 ^{qrs}	9.25 ^{hijklmn}	3.26 ^{zABCD}
	60	22.57^{av}	8.92 ^{jklmno}	3.99 ^{wxyzABC}	3.32 ^{zABCD}	4.31 ^{wxyzA}	7.28 ^{pqr}	10.01^{fghij}	3.57 ^{yzABCD}
	90	22.51^{ab}	9.16 ^{hijklmn}	4.11 ^{wxyzABC}	3.52 ^{zABCD}	4.82 ^{uvwxy}	7.80 ^{opq}	9.87^{fghijkl}	3.37 ^{zABCD}
	120	22.21^{ab}	9.04 ^{ijklmno}	4.14 ^{wxyzABC}	3.62 ^{xyzABCD}	4.83 ^{uvwxy}	7.81 ^{opq}	9.95^{fghijk}	3.39 ^{zABCD}
90	0	23.07^{a}	8.51 ^{mnop}	3.54 ^{yzABCD}	2.56 ^{D}	2.94 ^{BCD}	4.48 ^{vwxyz}	14.69^{e}	2.90 ^{CD}
	30	21.48^{bc}	8.73 ^{jklmno}	4.03 ^{wxyzABC}	3.56 ^{yzABCD}	4.92 ^{tuvwx}	8.07 ^{nop}	10.61^{fg}	3.30 ^{zABCD}
	60	20.65^{c}	8.66 ^{klmno}	4.08 ^{wxyzABC}	4.08 ^{wxyzABC}	5.71 ^{stuv}	8.25 ^{mnop}	10.34^{fgh}	3.49 ^{zABCD}
	90	18.80^{d}	8.51 ^{mnop}	4.23 ^{wxyzAB}	4.19 ^{wxyzABC}	6.02 ^{rstu}	8.58 ^{lmno}	10.96^{f}	3.58 ^{yzABCD}
	120	17.80^{d}	8.39 ^{mnop}	4.26 ^{wxyzA}	4.26 ^{wxyzA}	6.15 ^{rst}	8.39 ^{mnop}	11.06^{f}	3.57 ^{yzABCD}
		$LSD_{0.05}$ (temperature*time * pH level) = 1.29							

W: Water at pH 6.65 Means with different letters (a, b, c …K, J) indicate significant differences ($P < 0.05$) LSD= Least significant difference

Water activity of marshmallow candy samples during storage period at 5±1ºC:

Table 5 demonstrate that water activity values as affected by supplementing with Anthocyanin Enriched Extract (AEE) during cold storage period .The data showed that, control sample a_w recorded as the highest value (0.846) followed by marshmallow candy colored with (3%) (AEE) (0.830) at zero time. The lowest a_w value (0.806) was

recorded for marshmallow candy colored with 7% (AEE), followed by marshmallow candy colored with 5% (AEE) (0.807) and marshmallow candy colored with 0.1% synthetic red color (SRC) (0.808) was the next at zero time. Water activity of marshmallow candy tended to decrease with the addition of (AEE). It caused by the ability of (AEE) to prevent moisture absorption and retention.

Table 4. Significant trends on influence means of temperature, time and pH level on Anthocyanin Enriched Extract (AEE) (mg /100 ml) from Jamun (*Syzygium cumini)*

Temperature (ºC)	Total anthocyanin	Time (min)	Total anthocyanin	pH	Total anthocyanin
50	7.60^{b}	0	7.85^{a}	2.5	21.92^{a}
70	7.98^{a}	30	7.81^{a}	3	8.90^{b}
90	8.04^{a}	60	7.87^{a}	4	3.91^{e}
		90	7.94^{a}	5	3.34^{e}
		120	7.89^{a}	6	4.25^{e}
$LSD_{0.05}$=0.20				7	6.48^{d}
		$LSD_{0.05}$=1.07		8	10.87^{b}
				Water	3.29^{e}
				$LSD_{0.05}$=1.36	

W: Water at pH 6.65 LSD= Least significant difference Means with different letters (a, b, c …K, J) indicate significant differences ($P < 0.05$)

Table 5. Water activity values of marshmallow candy supplemented with different levels of (AEE) during cold storage periods at 5±1^{0}C

Treatments	Storage period				LSD at 0.05
	Zero time	After 1 month	After 2 months	After 3 months	
Control	0.846^{aA} ± 0.006	0.792^{aB} ± 0.013	0.758^{aC} ± 0.004	0.693^{bD} ± 0.003	0.022
synthetic color 0.10%	0.808^{cA} ± 0.004	0.801^{aA} ± 0.011	0.747^{aA} ± 0.050	0.663^{cB} ± 0.000	0.072
3%AEE	0.830^{bA} ± 0.003	0.802^{aAB} ±0.095	0.756^{aAB} ±0.037	0.660^{cB} ± 0.014	0. 143
5% AEE	0.807^{cA} ± 0.005	0.776^{aAB} ±0.035	0.767^{aAB} ±0.009	0.742^{aB} ± 0.003	0.050
7%EAE	0.806^{cA} ± 0.008	0.773^{aB} ± 0.002	0.715^{aC} ± 0.001	0.618^{dD} ± 0.003	0.012
LSD at0.05	0.014	0.118	0.073	0.017	

Synthetic red color Prepared with 0.10% (carmine). (AEE) = Anthocyanin Enriched Extract. In a column, means having the same superscript small letters are not significantly different at 5% level for marshmallow samples. In a row, means having the same superscript capital letters are not significantly different at 5% level for cold storage period. LSD = Least significant differences.

Regularly, recorded data of the same Table illustrated significance decrease of the a_w values for the control sample and all treatment by increasing the storage period from zero time up to three months at cold storage. Our results were agreement with Opriș *et al.*, (2020) found that the numerical value of the water activity varies in the range of (0.779) for control (fondant candy), (0.713) for fondant colored with grape extract and (0.724) for fondant colored with aronia powder after the first day of storage and reduced to (0.765) for control, (0.676) for grape extract sample and (0.705) for aronia powder sample after the 35 day of storage.

Color parameter of marshmallow candy samples during storage period at 5±1ºC:

From statistical analysis of data given in Table 6 it could be noticed that control sample was the highest L* value (91.12) followed by marshmallow candy colored with 0.1% synthetic red color (SRC) (75.25) indicating that they were the clearest samples, on the other hand, Marshmallow candy colored with 7% (AEE) (57.47) was the darkest samples. It was illustrated that, increasing the levels of (AEE) showed a tendency to decrease lightness (L*) at zero time. Finally, decrease in L* value suggests darkening of the product and can be attributed to the occurrence of non-enzymatic browning.

Table 6. Color measurement of marshmallow candy supplemented with different levels of (AEE) during cold storage period at 5±1^{0}C

Treatments	L*	a*	b*	C*
Zero time				
Control	91.12	-1.39	12.29	12.36
Synthetic color	75.25	8.27	4.20	9.27
3%AEE	74.68	1.22	12.30	12.3
5%AEE	64.92	2.55	5.22	5.08
7%AEE	57.47	2.65	5.71	6.29
After month				
Control	87.76	-0.17	10.69	10.69
Synthetic color	74.63	10.92	3.69	11.52
3%AEE	68.08	3.77	7.40	8.5
5%AEE	49.79	6.06	4.67	7.65
7%AEE	57.68	6.95	5.01	8.56
After 2 months				
Control	81.68	0.12	2.44	2.44
Synthetic color	70.38	12.21	-2.07	12.38
3%AEE	66.11	3.81	5.50	6.69
5%AEE	46.95	6.32	-0.73	6.36
7%AEE	54.72	8.11	-0.26	8.11
After 3 months				
Control	78.34	0.19	2.08	2.08
Synthetic color	54.97	13.16	-3.99	13.75
3%AEE	53.35	4.14	4.87	6.39
5%AEE	30.19	9.49	-1.37	9.58
7%AEE	34.22	11.09	-0.80	11.11

(L) =Lightness. (a) =redness. (b) =yellowness. (C) = Chroma. Synthetic red color Prepared with 0.10% (carmine) (AEE) =Anthocyanin Enriched Extract.

There were increased in redness (a*) with increasing the supplemented (AEE) ratio for the control sample and all treatments at zero time. This increase in red color was due to the anthocyanin activity as the red pigment in (AEE). Similar result was found by Ekie and Evanuarini, (2020) found that the average value of redness (a*) in milk candy was 12.68 to 19.10 where along with the increase of rosella powder percentage, this due to the anthocyanin activity as the red pigment giver in rosella where the different treatments; (12.68) for control treatment increased to (15.00, 17.15 and 19.10) for (1, 3 and 5%) rosella powder. These data showed that, there were increase in a* value among the control samples and all treated samples at zero time up to three months. (b*) values indicating yellowness, ranged from 4.20 to 12.30 in marshmallow samples at zero time. There were decrease in (b*) values among control sample and all other treatments at the end of storage period (3 months) comparing

to zero time. The yellowness (b*) should be considered as the physical parameters to describe the visual color degradation of the candy during storage. Changes in color intensity presumably caused by the presence of the enzyme. Change in color parameters of candy can be due to the occurrence of non-enzymatic browning reactions that also took place together with oxidation (Zhou *et al*., 2013).

It could be noticed that, there were general decrease in (C*) among the control sample and all treatments supplemented with (AEE) at zero time. Overall, the results showed that the marshmallow supplemented with (AEE) were redder and less yellow than control marshmallow. Jamun is a dark purplish fruit and its color undoubtedly contributed to the color of marshmallow by decreasing the L* and b* values and increasing a* value so that Jamun extract can be successfully used to improve color properties of candy.

Organoleptic characteristics of marshmallow candy samples during storage period at 5±1ºC:

The sensory panelists were recorded comparable appearance, odor, taste, texture and overall acceptability scores for marshmallow samples that supplemented with anthocyanin enriched extract (AEE) stored at 5±1^{0}c for three months

(Table 7). From tabulated data, score of appearance was 9.9 for control sample followed by samples colored with (3 and 5 %AEE) which recorded (9.8 and 9.7) which was the best appearance samples. On the other hand, sample colored with 7% (AEE) and synthetic red color samples recorded the same lowest score (9.5) at zero time. Score of appearance at all samples decreased during storage period. Furthermore, the highest appearance value found in control sample and 3% (AEE) (7.8), while the lowest (6.1) for synthetic red color samples at the end of storage period (three months).

The value of odor was highest at control samples (9.9) followed by samples treated with 3% (AEE) (9.8) but the lowest score recorded by 7% (AEE) (9.1) at zero time. On the other hand, there were general decrease in odor at all storage period ranged from 7.9 for control sample and 3% (AEE) to 7.1 for synthetic red which was the lowest at the end storage periods (three months).

The data showed that the highest score of taste was 3% (AEE) (9.9) which was the best taste, while the worst taste recorded by synthetic color (9.1) at zero time. Control samples, 3 and 5% (AEE) was the highest score at texture and over all acceptability (9.8, 9. 7 and 9.7) (9.9, 9.9 and 9.8), respectively and was the best at zero time and continues as the best at the end of storage (three months) (8.1, 7.9 and 7.6) (7.8, 7.8 and 7.7), respectively.

Maiia *et al*., (2017) found that marshmallow with Sudanese rose and black chokeberry extracts possesses a regular shape with clear outlines without deformation. Almost all of the organoleptic characteristics (shape, consistency, taste, smell, color) of the new products with natural anthocyanin dyes exceed the results of the control sample, manufactured without them.

Finally, consumer perception has been that natural food colorant ingredient would be healthful and considered as potential food colorants for preparing hard candy and Jellies these findings are in accordance with that of El-Gharably (2005).

Table 7. Organoleptic characteristics of marshmallow candy supplemented with different levels of (AEE) during cold storage period at 5±1^{0}C

Treatment	Appearance	Odor	Taste	Texture	Overall acceptability
			Zero time		
Control	9.9 ^{a}±0.32	9.9^{a} ±0.48	9.8^{a} ±0.42	9.8^{a}±0.52	9.9^{a} ±0.53
Synthetic color	9.5 ^{a}±0.74	9.6^{ab} ±0.74	9.1^{b}±0.85	8.7^{b} ±0.85	8.6^{b}±0.48
3% AEE	9.8^{a}±0.57	9.8^{a} ±0.57	9.9^{a}±0.57	9.7^{a}±0.74	9.9^{a}±0.94
5%AEE	9.7^{a}±0.57	9.2^{b}±0.32	9.6^{ab}±0.82	9.7^{b}±0.63	9.8^{a} ±0.70
7%AEE	9.5^{a}±0.67	9.1^{b}±0.57	9.4^{ab}±0.78	9.6^{a}±0.44	8.9^{b}±0.67
LSD at 0.05	0.45	0.51	0.52	0.50	0.54
			After month		
Control	8.9^{a} ±0.53	8.5^{ab} ±0.67	8.6^{a} ± 1.03	8.5^{a} ±0.74	8.9^{a} ±0.53
Synthetic color	7.5^{b} ±0.79	7.9^{bc} ±0.48	7.6^{b} ±0.57	8.1^{ab} ± 0.48	8.4^{ab} ±0.79
3% AEE	8.7^{a} ±0.79	8.7^{a} ±0.84	8.8^{a} ±0.67	7.9^{ab} ±0.57	8.7^{a} ±074
5%AEE	7.8^{b} ±0.63	7.8^{c} ±0.82	7.8^{b} ±0.71	7.8^{b} ±0.57	7.8^{b} ±0.79
7%AEE	7.8^{b} ±0.78	7.9^{bc} ±0.33	7.5^{b} ±0.60	7.9^{ab} ±0.93	7.9^{b} ±0.60
LSD at 0.05	0.68	0.66	0.59	0.67	0.64
			After 2 months		
Control	8.4^{a} ±0.88	8.8^{a} ±0.70	7.6^{b} ±0.94	8.4^{a} ±0.82	8.4^{a} ±0.52
Synthetic color	7.4^{b} ±0.52	7.6^{b} ±0.82	7.8^{b} ±0.79	6.6^{c} ±0.63	7.7^{b} ±0.70
3% AEE	7.7^{b} ±1.08	7.9^{b} ±0.63	8.9^{a} ±0.82	7.7^{b} ±0.74	7.8^{ab} ±0.82
5%AEE	7.9^{ab} ±0.74	7.7^{b} ±0.57	7.7^{b} ±0.71	7.6^{b} ±0.85	7.7^{b} ±0.71
7%AEE	7.4^{b} ±0.53	7.4^{b} ±0.60	7.4^{b} ±0.53	7.4^{b} ±0.73	7.4^{b} ±0.97
LSD at 0.05	0.69	0.67	0.68	0.59	0.67
			After 3 months		
Control	7.8^{a} ±0.70	7.9^{a} ±0.63	7.5^{a} ± 0.92	8.1^{a} ±0.57	7.8^{a} ±0.59
Synthetic color	6.1^{b} ±0.67	7.1^{b} ±0.85	7.3^{a} ±0.63	6.1^{c} ±0.84	6.5^{c} ±0.54
3% AEE	7.8^{a} ±0.74	7.9^{a} ±0.85	7.6^{a} ±0.63	7.9^{ab} ±0.84	7.8^{a} ±0.84
5%AEE	7.7^{a} ±0.52	7.8^{a} ±0.70	7.5^{a} ±0.67	7.6^{ab} ±1.03	7.7^{ab} ±0.48
7%AEE	7.5^{a} ±0.71	7.4^{ab} ±0.67	7.4^{a} ±0.71	7.4^{b} ±0.92	7.2^{b} ±0.71
LSD at 0.05	0.54	0.59	0.52	0.61	0.56

Synthetic red color Prepared with 0.10% (carmine) (AEE) =Anthocyanin enriched extract. Means having the same superscript letters are not significantly different at 5% level for marshmallow samples LSD = Least significant differences.

CONCLUSION

This study provides clear evidence it is economic, proper and successful applicable to produce children marshmallow candy colored by natural color (anthocyanin extract from *Syzygium cumini*) as a substitute of the artificial colors, hence must resort to natural sources which are very suitable to be taken as a good natural food or natural-food additive with many categories of healthy foodstuffs.

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خصائص حلوى مارشميلو الأطفال الملونة بمستخلص الأنثوسيانين الطبيعي من ثمار البامبوزيا أثناء التخزين المبرد

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من الصعب إنتاج حلوى الأطفال (المارشيملو) الملونة بمستخلص الأنثوسيانين الطبيعي من ثمرة البامبوزيا دون البحث أولاً عن صفات المنتج لذلك فقد تم إضافة مستويات مختلفة من مستخلص الصبغة بنسب 3 , 5 و 7 جرام لكل 100 جرام وخلطها مع حلوى المارشميلو الكنترول ومقارنتها مع عينة مارشميلو تم تلوينها باللون الصناعي (كارمين) بنسب إضافة 0.10جم لكل 100 جرام. تم تحليل خصائص المنتج من حيث تقدير النشاط المائي وتقييم خصائص اللون والخصائص الحسية للمنتجات عند التخزين المبرد لمدة 90 يوما. في هذه الدراسه أيضا أظهر المستخلص نشاط أكبر في إزالة الشقوق الحرة عند تركيز0.6 , 0.8 و 1 مجم / مل عند مقارنته بمضاد الأكسده الصناعي عند تركيز 200 و 300 جزء في المليون .أيضا لم يكن هناك فروق معنوية للمستخلص الغني بالصبغة عند الأس الهيدروجيني 5 وكانت فترة التحضين 0 , 30 , 60 , 90 و 120 دقيقة عند 50 درجة مئوية 2.65, 3.06, 3.03 ,3.18 و 3.16 ملجم / 100 مل ، قيم النشاط المائي لحلوى المارشميلو اتجهت إلى الإنخفاض مع إضافة المزيد من نسب المستخلص بسبب قدرته على منع امتصاص الرطوبة والاحتفاظ بها،ولم يكن هناك فروق معنوية فى الخواص الحسية من حيث (المظهر ، الرائحة ، الطعم، والملمس والقبول العام) بين العينة الكنترول وعينات المارشميلو الملونة بنسبة إضافة 3٪ من المستخلص .البامبوزيا فاكهة أرجوانية داكنة اللون ولونها هذا ساهم بلا شك في تلوين حلوي المارشميلوعن طريق تقليل قيم اللمعان والاصفرار وزيادة قيم اللون الأحمر بحيث يمكن بنجاح استخدام مستخلص الثمره في تحسين خصائص حلوي المارشميلو.

الكلمات الاسترشادية: منتجات الحلوى ، الجامبولان ، الثبات ، النشاط المائي والخصائص الحسية