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Producing of Low Calories Heat- Resistant Dark Chocolate Using Two Different Stabilizers Along with Study Its Quality Attributes

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Abstract:
The objective of this study is to produce low calories – heat resistant dark chocolate using two different stabilizers namely Revel – c (stabilizer – 1) and Grinsted P.S.101 (stabilizer-2). Physical, chemical and sensory properties of the prepared chocolate were determined, moreover their storage stability was also studied compared to the control which prepared without stabilizers and sweetened with sucrose. It was found that the sample which treated with stabilizer- 1 (Revel – c) was the most acceptable among the other samples in physical and sensory properties. To observe the effect of heat during processing on the sensory attributes properties of prepared low calories heat-resistant dark chocolate samples, a sensory attributes evaluation had done to evaluate the two samples treated with stabilizer-1 and stabilizer-2 compared to the control sample which prepared using sucrose after stuffing them into a bakery product (croissant) to estimate the accepted sample by the arbitrators, whereas sample which was treated with stabilizer - 1 (Revel-C) was the highest accepted sample chosen by the arbitrators. The storage stability for the chosen sample at room temperature (25 °C) and relative humidity not more than 60 % for 90 days was studied. Free fatty acids and peroxide value were determined every 15 days to estimate the oxidative stability of the samples during the storage period. The results revealed the high stability of the produced low calories high – resistance chocolate during the storage, whereas its percentages of free fatty acids and peroxide values were below the permissible limit till the end of storage time.

Keywords: *Dark chocolate, stabilizers, heat resistant chocolate, low calories chocolate*

1. Introduction

Chocolate is a complex fat suspension of around 70 % fine solid particles (from sugar and cocoa), in a continuous fat phase (Afaokwa, 2010). There are different types of chocolate (dark, milk and white), according to their composition in terms of cocoa solid, milk fat and cocoa butter. Ostrowska-Ligeza et al., (2019) found that regular consumption of dark chocolate resulted in lowering incidence of myocardial impaction and stroke (Johansson and Bergensthal, 1992). Sucrose-free chocolate have become popular among consumers and manufactures because of its reduced caloric values and the fact that those are both non-carcinogenic and suitable for diabetics. Chocolate is solid at ambient temperature (around 25 °C) and melts at oral temperature (37°C), generating a smooth suspension of solid particles in cocoa butter (Morgan 1994; Olinger and Pepper 2001;Sokmen andGunes 2006). The characterization of melting properties of dark chocolate during its manufacture process is very important in order to evaluate the effect of each step on the fat system behavior (Foubert et al., 2003;Marangoni, and McGauley2003). Hardness could be effectively used to predict the melting time or duration of finishing dark chocolate during consumption (Afoakwa et al., 2008). According to Fernandeset al. (2013) the composition of chocolate plays an important role during its processing because it defines the different interaction that take place among ingredient, it determines the final microstructure of the product that influence the melting heat resistance. As demand for molten and solid chocolate is increasing in gold market, understanding factor influencing texture and appearance would be of value in predicting changes in the quality (Afoakwa, 2010). Moreover, Konar (2013) reported that the quality of chocolate mainly depends on its attributes properties, chocolate with a good quality must be softs smooth with velvety texture. The chocolate properties should be similar to those of the raw materials used namely, the aroma, taste and softness. According to Machalkova et al., (2014) storage temperature of 20°C resulted in good results in the measurement of both color and texture of chocolate. Temperature of 6 °C and 12 °C were analyzed for texture and were found that it is more favorable. Moreover, it could be concluded that when the chocolate was stored at 6°C, their initial properties are preserved up to 10 weeks after production.

Schmitz and Shapiro (2012) reported that the main fat constituent in chocolate, being slightly melts below body temperature (37°C). However, this melting point is problematic when manufacturing or selling chocolate at ambient temperatures close to or above this temperature such as what occurs in summer time or in tropical climate. A chocolate that resists melting and deformation at temperature above 34 °C is therefore an advantageous in these situations. This study was carried out to produce low calories heat resistant dark chocolate using two different stabilizers a long with study its quality attributes. The effect of baking on sensory attributes properties of the prepared chocolate samples after stuffing them in a baking product (croissant) and the effect of storage on prepared low calories heat resistant dark chocolate on 25 °C for 3 months were also studied.

2. Materials and Methods

2.1. Materials

The dark natural chocolate was manufactured from natural raw materials according to Egyptian standard (2007),Ghanain cocoa mass was obtained from Cargill Cocoa Processing Company, Accra, Ghana. Cocoa Butter was obtained from Cargill Cocoa Processing Company, Accra, Ghana. Cocoa powder was obtained from ADM international sarl cocoa division, Switzerland. Sucrose was obtained from Dakahlia sugar Co, Dakahlia, Egypt. Whey powder was obtained from Polmlek group, Warsaw, Poland. Lethicin was obtained from Alexandria Company for seed processing and derivatives, Alexandria, Egypt. Poly glycerol poly ricinolate (P.G.P.R.) was obtained from Oleon N.V. oelegem, Belgium. Ethyl vanillin was obtained from Redwood biotech CO., LTD, Shanghai, China. Wheat fibers isolate was obtained from ID food, Garancieres en Beauce, France. Grinsted P.S.101 (hydrogenated palm oil based on tri-glyceride) and sorbitol were obtained from Danisco. Dordrecht, Holland. Revel-C (hydrogenated, fractionated, refined palm oil) was obtained from BUNGE- LodersCroklaan Johor, Malaysia. The bakery (croissant) ingredient (wheat flour, yeast and butter) was obtained from Egyptian market. All chemicals used in analysis were obtained from El-Nasr pharmaceutical Chemicals CO – Egypt and Al Safwa for Trading Est. Agent & Importer of Sigma Aldrich Chemicals – Egypt.

2.2. Technological Methods

Low – calories dark chocolate (free from sucrose) with high quality properties was produced as mentioned by Ahmed et al. (2012) the recipes used are shown in Table (1) as follow

%Ingredients / Sample	**A**	**B**	**C**	**D**	**E**
Sucrose	45.16	0.00	0.00	0.00	0.00
Sugar alcohol (sorbitol)	0.00	17.00	17.03	17.04	15.27
Cocoa mass	20.06	20.03	20.03	20.05	17.95
Cocoa butter	20.85	18.96	18.96	18.97	16.99
Cocoa powder	9.04	9.03	9.03	9.03	8.09
Whey powder	3.99	3.99	3.99	3.99	3.57
Wheat fibers isolate	0.00	29.93	29.93	29.95	26.83
Lecithin	0.50	0.50	0.50	0.50	0.50
P.G.P. R	0.20	0.20	0.20	0.20	0.20
Ethyl vanillin	0.07	0.07	0.07	0.07	0.07
Stevioside	0.00	0.13	0.00	0.00	0.00
Acesulfam-K	0.00	0.00	0.19	0.00	0.00
Sucralose	0.00	0.00	0.00	0.06	00.00
Inulin	0.00	0.00	0.00	0.00	10.50

Table 1: The Recipe Used to Prepare Low Calories Dark Chocolate (Ahmed et al., 2012)

A: Control sample which sweetened using sucrose. B: Steviosid dark chocolate sample.
C: Acesulfam-k dark chocolate sample. D: Sucralose dark chocolate sample.
E: Inulin dark chocolate sample.

2.3. Preparation of Chocolate

Chocolate was prepared according to Food and Drug Administration (FDA) regulates. Chocolate was manufactured in Al – Ahmady factory, Alexandria Egypt.

2.4. Physical Properties

The pH of chocolate was measured with pH meter AD/11 ADWA made in Europe – Romania, calibrated with two buffer solutions with higher and lower pH values (pH= 4 - 7), according to AOAC. (2005). Chocolate' s slip melting point was determined according to AOAC (2005). The slip melting point of the sample = water temperature when the sample column begins to rise in the capillary tube Hardness of the chocolate samples was evaluated with a texture analyzer (TAXT plus), (Stable Micro Systems Ltd, Surrey, UK) equipped with a stainless steel needle (P/2) probe and the trigger force of 5g. Hardness (N) was defined as the maximum penetration force required for the needle to penetrate through the chocolate sample (12mm width × 12mm length × 15mm mm height) at room temperature (24°C) over an interval of 3mm at stable rate of 1mm/s. Measurement was determined in 3 replications and the mean value was used (Bourne 1978). Color of chocolate samples was determined according to Keijbets et al. (2010) using colorimeter (Minolta Model CM-2500D Spectrophotometer, Tokyo, Japan) calibrated with white reference standard. The SCE-mode (Specular light excluded) was used with the color expressed in terms of the CIELAB system. The measured parameters were L* for lightness, b* for yellowness and a* for redness (Minolta, 1994). The caloric value of chocolate samples was calculated from the results of the chemical composition of chocolate samples by the following equation: -

Caloric value (Kcal) = (% Carbohydrates g × 4) + (%Total fat g × 9) + (%Total protein g × 4) + (%Sugar alcohol {Sorbitol} × 4.6).

2.5. Chemical Composition

Moisture content was measured according to AOAC (2005). Crude protein was determined using Kjeldahl method as described in AOAC (2005) method, factor of 6.25 used to convert nitrogen to crude protein content (Leung et al., 1968). Crude ether extract (crude fat), crude fiber and ash content were determined according to AOAC (2005). Nitrogen free extract was estimated by difference {100- (% moisture+ protein + crude fat + ash + crude fibers)}.

2.6. Peroxide Value

Peroxide value of stored chocolate was determined according to AOAC (2005).

2.7. Free Fatty Acid

Free fatty acids of stored chocolate were determined according to the method AOAC (2005).

2.8. Sensory Attributes Evaluation

Sensory evaluation of the prepared chocolate samples and croissant was carried out according to Iwe (2010) using a scale for different parameters such as texture, color, smell, sweetness, bitterness, aftertaste and overall acceptability.

2.9. Statistical Analysis

The results of each experiment were analyzed statistically by one-way analysis of variance (ANOVA) using an SPSS Vol.6, No.4, pp.369-392 program. Statistical significance was measured by ANOVA using the LSD test (Landau et al., 2004), diagrams were constructed in Microsoft excel 2016 using the parameters collected on the computer.

3. Result and Discussion

3.1. Production of Low Calories – Heat Resistant Dark Chocolate

Low calories dark chocolate was produced by the method mentioned by Ahmed el al. (2021). It was sweetened with stevioside (free from sucrose). Chocolate was prepared according to Food and Drug Administration (FDA).

This study aimed to produce low calories – heat resistant dark chocolate, two stabilizers were used (stabilizer - 1) which was Revel – C and stabilizer – 2, which was Grinsted P101, by substituting (2%) of cocoa butter from the mixture with the stabilizer. This proportion was determined after preliminary experiments and according to the recommended dose rang for each stabilizer to choose the best percentage of stabilizer which resulted in acceptable texture. Table (2) shows the recipes used to prepare control sample (A), low calories dark chocolate (B), without stabilizers and both of low calories heat resistant dark chocolate with stabilizer -1 (B*) and that with stabilizer -2 (B**).

%Ingredients / Samples	A	B	B*	B**
Sucrose	45.16	0.00	0.00	0.00
Sugar alcohol (sorbitol)	0.00	17.00	17.00	17.00
Cocoa mass	20.10	20.03	20.03	20.03
Cocoa butter	20.85	18.96	18.96	18.96
Cocoa powder	9.10	9.03	9 .03	9.03
Whey powder	3.99	3.99	3.99	3.99
Wheat fibers isolate	0.00	29.93	29.93	29.93
Lecithin	0.50	0.50	0.50	0.50
P.G.P.R	0.20	0.20	0.20	0.20
Ethyl vanillin	0.07	0.07	0.07	0.07
Stevioside	0.00	0.13	0.13	0.13

Stabilizer – 1 (Revel –C)	0.00	0.00	0.41	0.00
Stabilizer -2 (Grinsted P.S.101)	0.00	0.00	0.00	0.41

Table 2: The Recipes Used in Producing Low Calories Heat-Resistant Dark Chocolate

A= Control sample which sweetened using sucrose.
B= Low calories dark chocolate sample (sweetened with stevioside)
B*= Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-1.
B** = Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-2.

3.2. Physical and Chemical Properties of the Prepared Low Calories Heat- Resistant Dark Chocolate

Table (3) shows the physical properties of low calories heat-resistant dark chocolate prepared using stabilizers. The data revealed that there was no significant difference in pH values between control sample (A) and the other chocolate samples (B, B* and B**), Lillah et al. (2017) reported that there was no significant difference in pH value was noticed between the control sample and the sample prepared using 2% cocoa butter substitute (CBS).

Also the color values were estimated and the results showed that the control sample had the highest value of lightness, redness and yellowness compared with other samples whereas there were no significance differences were observed between B, B* and B** samples in lightness and redness and significant difference was observed in yellowness and these results are in agreement with Furlán et al. (2017), who reported that the control white chocolate sample which contained 75% stevia and 29% sucralose had significant difference, since its lightness value were (81.28) and the sample with 20% cocoa butter replacer (CBR) had a lightness value of 81.13.

The chocolate samples with stabilizer (B* and B**) had slightly higher value of hardness compared with low calories dark chocolate sample (B) and the control sample (A). These results are in accordance with Furlan et al. (2017) who reported that there was a significant difference between the hardness value for the control chocolate sample contained (75% stevioside and 25% sucrose), which was less than that of the sample with 20% cocoa butter replacer in hardness value.

Moreover, results of the studied samples demonstrated that slip melting point showed a noticeable difference between the prepared chocolate samples using stabilizer compared with the control one. Meanwhile the sample with stabilizer -1 (B*) possessed the highest slip melting point among all the samples, being (38,1 °C).Aidah et al. (2014) reported that addition of cocoa butter emulsion increased the melting point.

Samples	**pH**	**Color**			**Hardness N**	**Slip melting point(°C)**
		L*	a*	b*		
A	6.33^a±0.02	25.46^a±0.06	6.97^a±0.15	4.76^a±.0.06	14.20^b±0.06	33.76^d±0.06
B	6.43^a±0.06	24.83^b±0.06	5.07^b±0.06	4.73^a±0.06	14.30^b±0.10	34.63^c±0.06
B*	6.36^a±0.06	25.00^b±0.12	5.00^b±0.00	4.53^b±0.06	14.63^a±0.06	38.10^a±0.10
B**	6.40^a±0.10	25.00^b±0.10	5.00^b±0.00	4.56^b±0.06	14.53^a±0.06	35.93^b±0.12

Table 3: Physical Properties of the Low Calories Heat-Resistant Dark Chocolate Compared with Control One

Means in Columns Sharing Same Letters Are Not Significantly Different, Using the Reversed LSD Test At 0.05 Levels
L* (Lightness).a* (redness). b* (yellowness).
N= maximum penetration force. to penetrate sample
A= Control sample which sweetened using sucrose.
B=Low calories dark chocolate sample (sweetened with stevioside)
B*=Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-1.
B** = Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-2.

Data in Table (4) illustrates proximate chemical composition of prepared low calories heat-resistant dark chocolate, from the presented data it could be concluded that there were a slightly significant differences between studied chocolate sample in moisture content whereas control sample had the lowest moisture content 0.75% compared with the other samples which had moisture content ranged from 0.90 – 0.92%.

Crude ether extract (crude fat) ranged from 31.53 to 31.54% for the samples prepared using stabilizers 1 and 2 and 34.03% for the control one which shows that there was a significant reduction in crude ether extract (crude fat) for samples made using stabilizers comparing with the control one., meanwhile there was no significant difference between samples prepared with stabilizers and control one in protein content. Meanwhile no significant differences were noticed in fiber and ash contents between two samples (B* and B**) but the control sample had the lowest fiber and ash content. Low calories heat resistant dark chocolate had significant high values of both fiber and ash content (Table 4).Moreover, it was noticed that the nitrogen free extract content was low in sample (B) which was made without stabilizer and samples (B* and B**) which prepared using stabilizer (1) and (2), respectively compared to the control one, where it was (51.64%) in control sample and ranged between 24.41 to 24.61 % in the other samples. Aidah et al. (2014) reported that the moisture content was 1.5% for the control sample and increased to 2.3% after the addition of 2% cocoa butter emulsion (CBE). Also, fat content increased as a result of adding 2% cocoa butter emulsion to the manufactured chocolate.

Samples	Moisture (%)	Crude Ether Extract (%)	Crude Protein (%)	Fibers (%)	Ash (%)	N.F.E (%)
A	0.75^{b}±0.01	34.03^{a}±0.03	5.11^{a}±0.01	6.25^{b}±0.01	2.22^{b}±0.01	51.64^{a}±0.50
B	0.90^{a}±0.03	31.80^{b}±0.02	5.11^{a}±0.02	34.87^{a}±0.02	3.00^{a}±0.03	24.41^{b}±0.18
B*	0.90^{a}±0.03	31.53^{c}±0.47	5.10^{a}±0.01	34.86^{a}±0.06	3.02^{a}±0.03	24.61^{b}±0.10
B**	0.92^{a}±0.05	31.54^{c}±0.46	5.10^{a}±0.01	35.01^{a}±0.06	3.01^{a}±0.05	24.43^{b}±0.06

Table 4: Proximate Chemical Composition of the Low Calories Heat- Resistant Dark Chocolate Compared with Control One

Means in columns sharing same letters are not significantly different, using the reversed LSD test at 0.05 levels.
N.E.F=Nitrogen free extract.
A=Control sample which sweetened using sucrose.
B= Low calories dark chocolate sample (sweetened with stevioside)
B*= Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-1.
B** = Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-2.

3.3. Sensory Evaluation of Prepared Low Calories Heat -Resistant Dark Chocolate

The sensory attributes properties of low calories heat resistant dark chocolate compared to control sample were evaluated and the results are shown in Table (5). Generally, no significant differences were noticed in sensory attributes properties between the prepared low calories heat resistant dark chocolate samples compared to the control sample. However, the data in Table (5) show that the control sample and the samples without stabilizer (A and B) showed higher values in hard texture, dark color, smell, sweetness and bitterness and lower values in aftertaste compared to the samples with stabilizers (B* and B**).Lillah et al. (2017) reported that a significant difference was observed between the dark (control sample) and the sample with 2% cocoa butter (CBS).

Samples	Hard texture (25 degree)	Dark color (15 degree)	Smell (10 degree)	Sweetness (20 degree)	Bitterness (20 degree)	Aftertaste (10 degree)	Overall acceptability (100 degree)
A	21.36^{a}±3.08	12.18^{a}±1.12	8.36^{a}±2.40	15.27^{a}±4.34	11.27^{a}±5.80	0.85^{a}±1.92	88.27^{a}±11.66
B	20.63 ^{a}±2.02	15.56^{a}±1.51	9.83 ^{a}±0.87	15.64^{a}±1.36	12.66^{a}±1.21	0.81^{a}±0.94	86.29^{a}±5.88
B*	18.63^{a}±4.97	11.72^{a}±2.01	7.36^{a}±2.97	13.54^{a}±4.72	10.00^{a}±6.00	2.54^{a}±1.86	87.36^{a}±10.53
B**	18.81^{a}±3.84	11.54^{a}±2.18	6.81^{a}±2.55	12.18^{a}±3.87	8.63^{a}±5.94	2.27^{a}±1.42	81.45^{a}±8.35

Table 5: Sensory Attributes Evaluation of Prepared Low Calories Heat-Resistant Dark Chocolate Compared with Control Samples

Means in columns sharing same letters are not significantly different, using the reversed LSD test at 0.05 levels
A=Control sample which sweetened using sucrose.
B= Low calories dark chocolate sample (sweetened with stevioside)
B*= Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-1.
B** = Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-2.

3.4. Evaluation of Low-Calorie Heat - Resistant Dark Chocolate Stuffed Inside Bakery Product (Croissant)

The effect of heat on the sensory properties of chocolate after backing process were evaluated and the data are shown in Table (6). The results concluded that there were no significant differences between control sample and samples prepared with the two stabilizers in hard texture and smell. However slightly significant differences were noticed between the samples in dark color, sweetness, bitterness, burned taste, aftertaste and overall acceptability. Control sample had the highest values for dark color, sweetness, burned taste, but it had the lowest value in overall acceptability. In addition, the results indicated that the burned taste was the highest in the control sample (7.09), followed by sample B** (6.45) whereas sample (B*) which prepared using stabilizer – 1 showed the lowest value (1.72).

From the above results of Table (6), it could be concluded that low calories heat resistant dark chocolate sample which prepared with stabilizer -1 (B*) and stuffed in bakery product was more acceptable compared to control sample (A) and low calories –heat resistant dark chocolate sample which prepared with stabilizer – 2 (B**), whereas it had the highest value of overall acceptability (83.54) and the lowest value of aftertaste (0.72) compared to sample (B**) and the control sample (A).

Samples	Hard texture (25degree)	Dark color (15degree)	Smell (10degree)	Sweetness (20degree)	Bitterness (20degree)	Burned taste (10degree)	Aftertaste (10degree)	Overall acceptability (100 degree)
A	17.54^{a}±3.73	13.45^{a}±2.24	8.27^{a}±2.21	12.00^{a}±5.55	6.64^{b}±7.10	7.09^{a}±3.30	0.73^{b}±0.79	55.45^{c}±8.20
B*	17.45^{a}±4.44	13.09^{ab}±1.62	7.27^{a}±1.87	11.63^{a}±4.27	11.63^{a}±4.27	1.72^{b}±1.42	0.72^{b}±0.19	83.54^{a}±9.97
B**	16.63^{a}±4.25	10.72^{b}±1.74	7.81^{a}±4.13	6.72^{b}±2.65	14.09^{a}±3.30	6.45^{a}±1.37	2.63^{a}±0.57	70.00^{b}±9.75

Table 6: Sensory Attributes Properties of Low Calories Heat-Resistant Dark Chocolate After Stuffing in Bakery Product Comparing with the Control

Means in columns sharing same letters are not significantly different, using the reversed LSD test at 0.05 levels.
A=Control sample which sweetened using sucrose.
B*= Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-1.
B** = Low calories heat-resistance dark chocolate sample (sweetened with stevioside) with stabilizer-2.

These results of this study confirmed the ability of stabilizer -1 to increase the heat resistance of chocolate and give more stability to the chocolate on baking temperature with high acceptability of the bakery product. Aidah et al. (2014) reported that according to the heat resistant test which had been done for a control chocolate sample and sample with 2% cocoa butter emulsion by incubating them under incubating temperature of 30 °C. The control chocolate and chocolate with 1% cocoa butter emulsion were slight soft, but the texture remained firm.

3.5. Storage of Low Calories Heat – Resistant Dark Chocolate

After producing dark chocolate that was low in calories value and also resistant to high temperature by using stabilizer – 1 (Revel-C) it was necessary to test its stability when stored.Therefore, the prepared sample of low calories heat-resistant dark chocolate that was used in the manufacture of baked products was stored at room temperature (25±2°C)for a period of three months with estimation of free fatty acids as well as peroxide value every 15 days.

Figures (1,2) show the behavior of low calories heat-resistant dark chocolate samples during storage at room temperature for 90 days compared with control samples, the results in the Figure (1,2) indicated a good degree of stability for the low calories heat-resistant dark chocolate during storage, since the free fatty acids reached 0.058% for the control sample and 0.060% for the low calories heat-resistant dark chocolate sample in the end of storage period , meanwhile the peroxide value reached 0.133M.eq/Kg fat for the control sample and 0.140 M.eq/Kg fat for the low calories heat-resistant dark chocolate sample.

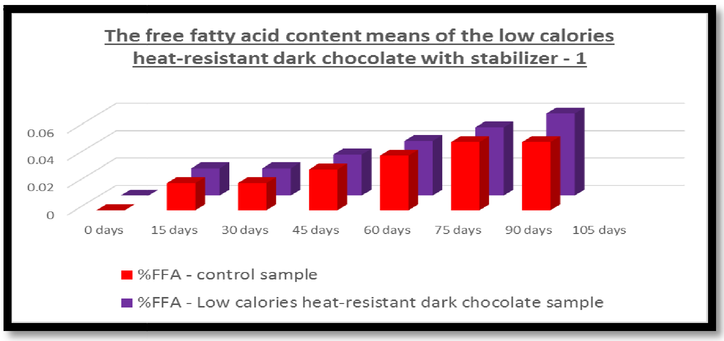

Figure 1: Free Fatty Acid Content of Low Calories Heat-Resistant Dark Chocolate Samples with Stabilizer – 1 during Storage at Room Temperature for 90 Days Compare with the Control

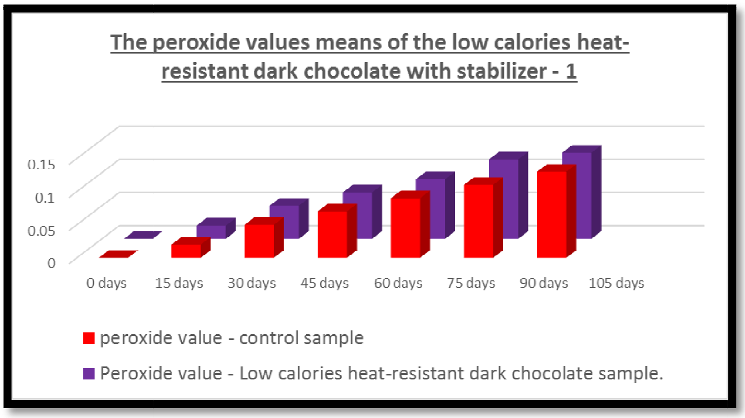

Figure 2: Peroxide Value of Low Calories Heat-Resistant Dark Chocolate Samples with Stabilizer – 1 during Storage at Room Temperature for 90 Days Compare with the Control

From our results it can be concluded that addition of stabilizer -1 to low calories dark chocolate during processing enable the product to be stored at room temperature till period up to 90 days.

4. Conclusion

This study was carried out to produce low caloric – heat resistant dark chocolate. From the results it could be concluded that when two stabilizers (Revel – C and Grinsted P101) were used to produce low calories heat resistant dark chocolate (sweetened with stevioside) it was found that the chocolate contained Revel-C was more acceptable in sensory attributes properties than the other one even after stuffed it in bakery product (croissant).

Storage experiment was carried out to store the low calories heat resistant dark chocolate (prepared by stabilizer – 1) at room temperature (25±2°C)to compare its stability with control sample (prepared without stabilizers). The results showed that the low calories heat resistant dark chocolate has high degree of storage stability since the value of free fatty acids and peroxide value were less than the permissible value during the storage period.

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