INCORPORATION OF HEALTHY FATS INTO SUGAR FREE PLAIN CHOCOLATE AND THEIR EFFECT ON FATTY ACID COMPOSITION, PEROXIDE VALUE AND GLOSSINESS

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ABSTRACT - *Sugar free plain chocolate was value added by incorporating healthy fats namely Virgin Coconut (VCO) and Virgin Olive Oil (VO) as well as Cocoa Butter (CB) into the chocolate formulations. Factorial Design of 16 treatments and 1 replication was carried out using Minitab Version 14 software on 3 levels amount of abovetypes of healthy oils within the minimum and maximum range of their Recommended Daily Allowance (RDA) value. The total fats is remained to 36% in the chocolate formulations. In the preliminary observation. it was found that only nine out of 16 treatments of VCO, VO and CB combinations within the ranged of 0 to 8.64%, 0 to 7.92% and 28.08 to 36%, respectively, were able to form a solid chocolate with no fingerprint at ambient temperature. Sugar free plain chocolate which containing solely CB was used as a control. In general, chocolate samples which contained high amount of olive oil showedslightly higher in Omega 6, unsaturated and polyunsaturated fatty acid content while samples with high cocoa butter were gave higher value in saturated fat. Peroxide value of control sample was significantly lower at p<0.05 compared to those containing VCO and VO. The values were ranged from 3.3 ± 0.42 to 6.3 ± 0.14 mEq/kg. Glossiness at projection angle of 85º at 24ºC showed that control sample with solely cocoa butter gave the most glossy chocolate surface at P<0.05 compared to others.*

Keywords: chocolate, fatty acid composition, glossiness, healthy fats, peroxide value

INTRODUCTION

Virgin coconut (VCO) and olive oils (VO) are widely marketed as a superfood. The fatty acids in both oil can encourageour body to burn fat, and they provide quick energy to our body and brain. They also raise HDL cholesterol in our blood, which may help reduce heart disease risk. Most dietary fats are categorized as long-chain triglycerides (LCTs), while coconut oil contains some medium-chain triglycerides (MCTs), which are shorter fatty acid chains (Boateng *et al*., 2016).The MCTs in coconut oil can increase the number of calories your body burns compared with longer-chain fatty acids (Mumme & Stonehouse , 2015). One study found that eating 15–30 grams of MCTs per day increased 24-hour energy expenditure by 5% (Dulloo *et al*., 1996) as well as could improve brain function in people with milder forms of Alzheimer's disease (Reger *et al*., 2004). Lauric acid makes up about 50% of the fatty acids in coconut oil (USDA, 2019). Studies show that these substances help kill the bacteria *Staphylococcus aureus*, which causes staph infections, and the yeast *Candida albicans*, a common source of yeast infections in humans (Ruzinm. & Novic, 2000, Ogbolu, *et al*., 2007; Ttipoli *et al*., 2005).

The predominant fatty acid invirgin olive oil is a monounsaturated fat called oleic acid, making up 73% of the total oil content but 14% of the olive oil is saturated fat, whereas 11% is polyunsaturated, such as omega-6 and omega-3 fatty acids (SELF, 2018). Olive oil is also loaded with powerful antioxidants. These antioxidants are biologically active and may reduce your risk of chronic diseases (Tripoli *et al*., 2005; Tuck &

Hayball, 2002) and significantly reduce heart disease risk (Beauchamp *et al*., 2005 : Coni *et al*., 2000) besides benefitted brain function (Lapiscina *et al*, 2013). It also appear to improve inflammatory markers and reduce oxidative stress in individuals with rheumatoid arthrits (Kremer et al., 1990; González *et. al*., 2014).Several studies also have linked olive oil to beneficial effects on blood sugar and insulin sensitivity (Kastorini & Panagiotakos, 2009; Estruch *et al*., 2006).

Due to the healths benefit of the above fats, a study was carried out by incorporating those fats besides cocoa butter (CB) into sugar free plain chocolate and the physico-chemical study mainly on fatty acid composition, peroxide value and glossiness will be evaluated.

METHODS

Sugar free plain chocolate was value added by incorporating healthy fats namely Virgin Coconut (VCO) and Virgin Olive Oil (VO) as well as Cocoa Butter (CB) into the formulation. Factorial Design of 16 treatments in 1 replication was carried out using Minitab Version 14 software on 3 levels amount of above types of healthy oils within the minimum and maximum range of their RDA value. The total fats is remained to 36% in the chocolate formulations, Preliminary observation was found that only nine out of 16 treatments of combined amount of VCO, VO and CB which ranged from 0 to 8.64%, 0 to 7.92% and 28.08 to 36%, respectively, could formed chocolate products in solid state without fingerprint at ambient temperature. Sugar free plain chocolate containing solely cocoa butter was used as a control (Table 1). All samples were then analyzed their fatty acid composition, glossiness sand peroxide value.

Table1: Healthy fat formulations in sugara free plain chocolate

No	Formulation	Virgin olive oil (%)	Virgin coconut oil (%)	Cocoa butter (%)
1	**SDCHF0**	0	0	36
2	**SDCHF1**	1.98	2.16	31.86
3	**SDCHF2**	1.98	5.4	28.62
4	**SDCHF4**	4.95	2.16	28.89
5	**SDCHF10**	0	5.4	30.6
6	**SDCHF12**	0	2.16	33.84
7	**SDCHF13**	4.95	0	31.05
8	**SDCHF14**	7.92	0	28.08
9	**SDCHF15**	1.98	0	34.02

Gloss

The gloss value of all sugar free dark chocolate samples were measured monthly by using Trimicrogloss (Shenn, England) at projection angle of 85° at 24°C. A beam of light was projected on to the flat surface of chocolate and the strength of light reflected within a narrow angle was measured. Angle of projection used was 85 degree. The numerical scale used was a reference to 100 for a black glass, which was calibrated at each time of measurement. Measurement was made in 6 replications and the mean values was calculated.

Peroxide value (PV)

The determination of peroxide value for sugar free dark chocolate samples was carried out according to Tee et al, (1996). One (1) to 4 g of oil sample was weighted and transferred into 250ml round bottom flask, and then 10 ml of chloroform was added to dissolve the oils and swirled for few seconds. Later, 15 ml of glacial acetic acid was added followed with 1 ml fresh saturated aqueous potassium iodide solution. The solution then was shaken for 1 minute and kept in dark for 5 minutes. After that, 75 ml of distilled water was added followed by few drops of starch solution (1%). The sample solution was then titrated with 0.002N sodium thiosulphate. The peroxide value was calculated as the difference between the volumes, in ml, of 0.002N sodium thiosulphate consumed, multiplied by Normality then multiplied by 10 and divided by the weight, in g, of the sample taken.

Fatty Acid composition

Free fatty acid was measured using rapid methodfor the preparation of methylesters of fatty acid. 50 mg of test samples was weighted from melted sample and homogenized at 50 to 70 ◦C and put.0.95 ml of hexane was added into 2 ml vial size by using graduated pipette and closed the capands shaken to dissolve the oil. 0.05 ml of sodium metoxide was then s added by using a glass pipette.. The vial cap was quickly replaced and vigorously shake using vortex mixer. The clear mixture was changed to turbid once sodium glyceroxide was precipitated. After 5 minutes or more, the clear upper layer of methyleste was pipetted for further analysis.

Statistical analysis

ANOVA was carried out by using Minitab version 13 software to compare glossiness, water activity and peroxide value among samples during the study. .

RESULTS

In general, the fatty acid composition analysis showed that the ratios of omega 6:3 for all samples fall within14.0 to 15.8 : 1 while total saturated fat were within 55.83 to 66.21% (Table 2), Total monounsaturated fatty acid were within 26.49-38,71% and the total polyunsaturated fatty acid were from 3.19 to 5.25%. Sample of SDHF14 which contained highest amount of virgin oil and lowest amount of cocoa butter were found to contain the lowest ration of omega 6:3, highest amount of monounsaturated as well as polyunsaturated fat but lowest in saturated fat compared to other samples. Sample of SDHF10 which contain the highest amount of VCO and CB gave the highest ratio of omega 6:3 and lowest amount of total mono unsaturated and polyunsaturated as well. The optimal ratio (ω6/ω3) is suggested to be 4 / 1 or lower to 1/1 to reduced the negative effect to health (Simopoulos, 2002 *)*.

Table 2: Fatty acid composition (FAC) in sugar free plain chocolate containing healthy fats

No	Sample	Total omega 6 (%)	Total omega 3 (%)	Ratio Omega 6:3	Total saturated fat (%)	Total monounsaturated fat (%)	Total polyunsaturated fat (%)
1	**SDCHF0**	3.38	0.22	15.4 : 1	66.21	30.08	3.6
2	**SDCHF1**	3.61	0.24	15.0 : 1	60.50	30.8	3.85
3	**SDCHF2**	3.38	0.22	15.4 : 1	55.83	28.66	3.61
4	**SDCHF4**	4.18	0.29	14.4 : 1	56.66	34.09	4.47
5	**SDCHF10**	3	0.19	15.8 : 1	61.39	26.49	3.19
6	**SDCHF12**	3.23	0.21	15.4 :1	63.07	28.64	3.44
7	**SDCHF13**	4.33	0.3	14.4 : 1	59.78	35.48	4.63
8	**SDCHF14**	4.9	0.35	14.0 : 1	55.93	38.71	5.25
9	**SDCHF15**	3.76	0.25	15.0 : 1	63.64	32.24	4.01

The results in Table 3 showed that the glossiness of all samples at 85◦ which fall within 64.767 to 85,833 out of 100. Statistically, a chocolate surface of Control sample of CB was significantly most glossy at 85◦ of projection angle compared to other chocolate samples containing VCO and VO in CB. Combination of VCO and/ or VO with CB in cholate will make the surface of chocolate slightly dull in appearance at $p<0.05$.

Table 3: Glossiness at 85º of sugar free plain chocolate containing healthy fats.

No	Chocolate sample	Glossiness at 85◦ ± std. dev. (Reference to 100)
1	SDHF0	85.833 ± 1.872 a*
2	SDHF1	67.333 ± 2.155 bc
3	SDHF2	64.767 ± 2.829 c
4	SDHF4	70.500 ± 5.963bc
5	SDHF10	71.467 ± 0.981 bc
6	SDHF12	69.933 ±.646 bc
7	SDHF13	70.967 ± 4.716 bc
8	SDHF14	75.400 ± 0.819 b
9	SDHF15	81.667 ± 4.400 ab

Note: Means followed by the same alphabet are not significantly different at p<0.05.

The values of peroxide value of all samples were fall from 3.3 to 6.3mEq/kg. The result showed that the control sugar free chocolate sample with solely cocoa butter was the most stable with lowest peroxide value as compared to those containing VCO and /or VO with CB which were significantly similar among them at $p<0.05$. However all samples were still accepted since the values were still below 10 mEq/kg which is save for consumption according to Codex Alimentarious,2001 for all vegetable fats..

Table 4: Peroxide value of sugar free plain chocolate containing healthy fats.

No	Sample	Peroxide value + stand. dev. (mEq/kkg)
1	SDCH0	3.3000 ± 0.4243 a*
2	SDHF1	5.8000 ± 0.2828 b
3	SDHF2	5.9500 ± 0.6364 b
6	SDHF4	5.9000 ± 0.1414 b
5	SDHF10	6.3000 ± 0.1414 b
6	SDHF12	6.1000 ± 0.1414 b
7	SDHF13	5.9000 ± 0.7071 b
8	SDHF14	6.0000± 0.2828 b
9	SDHF15	5.9000 ± 0.1414 b

Note: **Means followed by the same alphabet are not significantly different atp<0,05.**
Note: The acceptable value of peroxide value stated by CODEX Alimentarius, 2001 is below10 mEq/kg.

CONCLUSION

Nine products of sugar free plain chocolate products with healthy fat were successfully developed by using virgin coconut and olive oil with cocoa butter in sugar free plain chocolate. The sample which contained highest amount of VO and lowest amount of CB were found to contain the lowest ration of omega 6:3, highest amount of monounsaturated as well as polyunsaturated fat but lowest in saturated fat while sample which contain highest amount of VCO and CB gave the lowest ratio of omega 6:3, total monounsaturated and polyunsaturated fatty acids compared to other sample. A control sample with solely CB without VCO or VO showed the lowest reading of peroxide value besides produced a glossy surface as compared to the other samples ($p<0.05$).

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