Potentials of Red Palm Oil as A Functional Food :Some Experiences in Egypt.

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ORIGINAL PAPER

Red Palm Olein: Characterization and Utilization in Formulating Novel Functional Biscuits

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Abstract Functional biscuits were formulated by replacing white shortening (WS) by red palm olein (RPOL) at 20, 40, 60, 80 and 100%. Sensory evaluation of fresh biscuits indicated that all RPOL levels were significantly as acceptable as or superior to the control. Consequently, two superior RPOL levels (40 and 60%) were chosen for further investigation along with the control. Biscuits made from 40% WS + 60% RPOL exhibited significantly the lowest values regarding water loss during baking, volume before baking, specific volume, specific lightness, water activity and shearing force. Triacylglycerol and fatty acid composition of formulated biscuits resembled their counterparts for RPOL. These biscuits contained 1.8 times more tocopherols and tocotrienols and 10.4–14.8 times more carotenes than the control. Meanwhile, packaged biscuits were able to be stored at room temperature in the light for not less than 6 months without any deterioration in their quality.

Keywords Physical properties · Chemical composition · Triacylglycerol · Fatty acid composition · Tocopherols · Tocotrienols · Carotenes · Sensory evaluation · Storage stability

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Introduction

Palm oil is becoming increasingly important worldwide. Palm oil and its fractions (olein and stearin) are used in different food applications, such as a cooking oil for various type of dishes, frying oil and manufacturing shortening and margarine [1, 2].

A novel process for refining crude palm oil has been applied, retaining about 80% of the nature goodness in the form of carotenoids and vitamin E in the original crude oil [3]. This novel health-promoting oil is known as red palm oil (RPO). The characteristic red color of RPO is due to the multi-carotenoids present in the oil, totaling about 575 ppm with 90% as the provitamin A carotenoid, especially β-carotene and α-carotene. Meanwhile, tocopherols (vitamin E) and tocotrienols (provitamin E) are powerful antioxidants that confer oxidative stability to RPO as well as help to keep the carotenoids and other quality parameters of the oil stable [4, 5].

The RPO can be processed into several fractions (olein and stearin) with different physicochemical properties, thereby facilitating its use in a wide range of food applications. The RPO supplementation has been used successfully to elevate vitamin A content in human diet, such as utilizing RPO in cakes, biscuits, bread, cookies, rusks and red shortening [6–9].

Nowadays, people are becoming more health conscious and are seeking foods with functional properties that may positively affect their health. For the last three decades, vitamin A deficiency has been recognized as a major public health problem in the developing countries. However, one of the most effective and sustainable ways to overcome vitamin A deficiency is through a food-based strategy, which has become a way of life. Some inexpensive vitamin A enriched foods are available in poor communities, but

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ABSTRACT

Functional biscuits were formulated by replacing white shortening (WS) by red palm olein (RPOL) at 20,40, 60, 80 and 100%. Sensory evaluation of fresh biscuits indicated that all RPOL levels were significantly as acceptable as or superior to the control. Consequently, two superior RPOL levels (40 and 60%) were chosen for further investigation along with the control. Biscuits made from 40% WS + 60% RPOL exhibited significantly the lowest values regarding water loss during baking, volume before baking, specific volume, specific lightness, water activity and shearing force. Triacylglycerol and fatty acid composition of formulated biscuits resembled their counterparts for RPOL. These biscuits contained 1.8 times more tocopherols and tocotrienols and 10.4 – 14.8 times more carotenes than the control. Meanwhile, packaged biscuits were able to be stored at room temperature in the light for not less than 6 months without any deterioration in their quality.

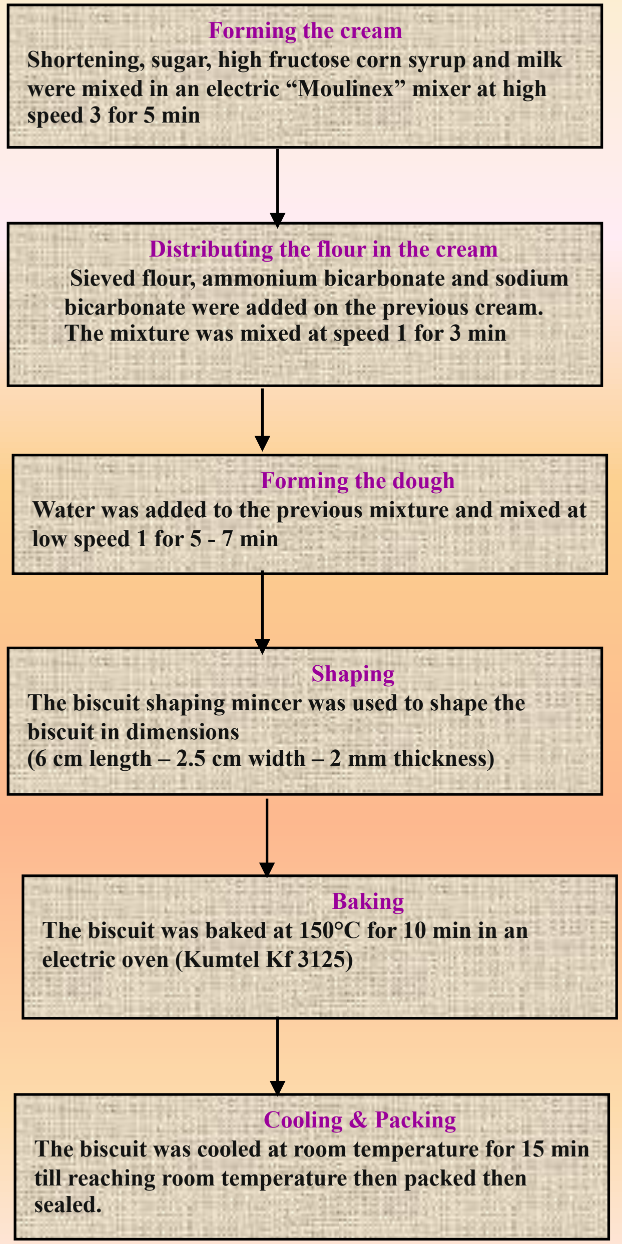
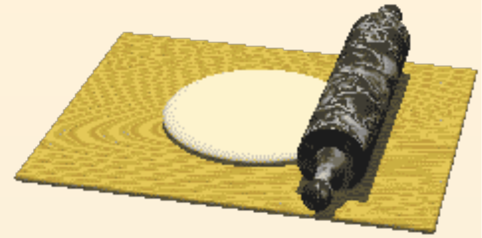


Fig. 1 Flow sheet of biscuit manufacturing

Table I The recipe of biscuit manufacturing



Wheat flour (72% extraction)	200
Sugar powder	45
White shortening	40
High fructose corn syrup (HFCS)	13
Skimmed powdered milk	3
Ammonium bicarbonate	1.25
Sodium bicarbonate	3.75
Water	62.5
Vanillin	0.1

Table 2

Physicochemical properties of red palm olein

Properties	Value	Properties	Value
Specific gravity (at 50 ^{0}C)	0.903 ± 0.153	Saponification value	209.0 ± 1.72
Slip point (^{0}C)	23.8 ± 0.03	Unsaponifiable matter (%)	1.3 ± 0.05
Cloud point (^{0}C)	8.5 ± 0.12	Peroxide value (mequiv peroxide/kg)	1.5 ± 0.22
Refractive index	1.455 ± 0.00	Anisidine value	0.02 ± 0.00
Color	50R-20Y	Acid value	0.25 ± 0.03
Moisture %	0.021 ± 0.008	FFA %	0.12 ± 0.02
Iodine value	56.7 ± 0.42	Impurities (%)	0.48 ± 0.00

Results are mean values of three determinations ± standard deviation (SD)

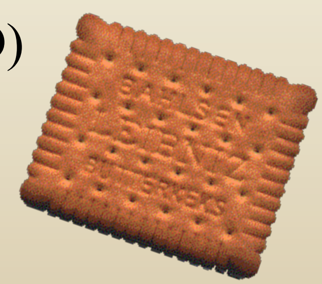


Table 3

Triacylglycerols (TAG) and fatty acid compositions of red palm olein

Triacylglycerols		Fatty acid composition	
TAG	%	Fatty acid	%
POP	28.93	Lauric($c_{12:0}$)	0.2
POO	25.32	Myristic($c_{14:0}$)	0.9
PLP	9.97	Palmitic($C_{16:0}$)	39.3
POL	10.86	Margaric ($C_{17:0}$)	0.1
POS	5.10	Stearic ($C_{18:0}$)	4.2
OOO	4.15	Arachidic ($C_{20:0}$)	0.4
SOO	2.90	TSFA	45.1
PLL + MOL	2.37	Palmitoleic ($C_{16:1}$)	0.2
OOL	1.94	Oleic ($C_{18:1}$)	43.7
PPP	0.55	TMUFA	43.9
MLP + MOM	0.65	Linoleic ($_{C18:2}$)	10.5
OLL	0.50	Linoleic ($C_{18:3}$)	0.5
MMP	0.24	TPUFA	11.0
Unknown DAG	5.11	Others	0.2

L Linoleic acid, P palmitic acid, M myristic acid, S stearic acid,O oleic acid, DAG diacylglycerols, MAG monoacylglycerols, TSFA total saturated fatty acids, TMUFA total monounsaturated fatty acids,TPUFA total polyunsaturated fatty acids, S/U saturated fattyacid:unsaturated fatty acids

Table 4 Composition of the most abundant antioxidants present in red palm olein

Antioxidant	Content (ppm)
α-Tocopherol	173
α -Tocotrienol	254
β-Tocotrienol	266
γ-Tocotrienol	261
δ-Tocotrienol	104
Total α - tocopherol and tocotrienols	820
Carotenes	580

Table 5 Sensory evaluation of biscuits made from 100% white shortening (WS) and by replacing it with red palm olein at different levels

Biscuit samples	Organoleptic properties					
	Color	Crispness	Air pores	Odor	Taste	Overall acceptability
100% WS (control)	5.88^{c}	7.75^{a}	6.38^{b}	7.88^{a}	8.13^{a}	5.23^{c}
80% WS +20% RPOL	6.88^{b}	7.88^{a}	6.63^{b}	7.63^{a}	7.63^{a}	5.11^{c}
60% WS + 40% RPOL*	7.69^{ab}	8.75^{a}	5.63^{b}	8.00^{a}	7.13^{a}	7.58^{a}
40% WS +60% RPOL*	8.25^{a}	7.69^{a}	8.13^{a}	7.75^{a}	7.63^{a}	7.92^{a}
20% WS + 80% RPOL	7.69^{ab}	7.81^{a}	6.88^{ab}	7.63^{a}	7.81^{a}	6.80^{b}
100% RPO	8.06^{a}	7.88^{a}	6.13^{b}	7.00^{a}	7.69^{a}	6.40^{b}

* Samples that were chosen for further investigation
Hedonic scale of sensory evaluation: means (n = 10) in a column not sharing the same superscript are significantly different at $P < 0.05$

Table 6 Physical properties of biscuits made using 100% white shortening (WS) and by replacing it with 40 and 60% red palm olein

Physical properties	Biscuit samples		
	100% WS (Control)	**60% WS + 40% RPOL**	**40% WS+ 60 RPOL**
Water loss during baking (%)	**1.23 ± 0.54^{a}**	**1.27 ± 0.58^{a}**	**1.17 ± 0.43^{b}**
Volume before baking (cc)	**8.27 ± 0.78^{b}**	**9.28 ± 1.55^{a}**	**7.86 ± 0.52^{c}**
Volume after baking (cc)	**13.5 ± 0.97^{a}**	**10.00 ± 1.12^{c}**	**11.43 ± 0.78^{b}**
Specific volume	**37.51^{a}**	**26.37^{b}**	**20.00^{c}**
Specific lightness	**45.98^{a}**	**33.50^{b}**	**31.65^{b}**
Water activity (21 ^{0}C)	**0.26 ± 0.07^{a}**	**0.23 ± 0.07^{a}**	**0.22 ± 0.14^{a}**
Shear force (g)	**1033.4 ± 23.9^{b}**	**1107.6 ± 14.6^{a}**	**810.8 ± 10.5^{c}**

Results are mean values of three determinations ± SD
Means (n = 3) in a row not sharing the same superscript are significantly different at P< 0.05

Table 7 Triacylglycerol (TAG) composition of biscuits made from 100% white shortening (WS) and by replacing it with 40 and 60% red palm olein

TAG %	Biscuit samples		
	100% WS (Control)	60% WS+40% RPOL	40% WS + 60% RPOL
POP	29.41	28.25	28.07
POO	19.41	21.11	22.08
PLP	8.92	9.03	9.24
POL	8.11	8.96	9.47
POS	5.21	4.92	4.93
PPP	5.09	4.43	4.32
OOO	3.31	3.66	3.71
SOO	2.24	2.40	2.56
PLL+ MOL	2.23	2.44	2.57
OOL	1.57	1.69	1.78
PPS	1.19	1.13	0.86
OLL	0.72	0.71	0.72
MMP	0.67	0.61	0.50
MLP + MOM	0.55	0.58	0.58
Unknown DAG	6.39	5.71	5.31
Unknown MAG & FAA	4.04	2.43	2.33

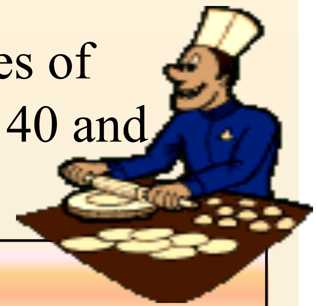
Triacylglycerol (TAG) composition: one analysis L Linoleic acid, P palmitic acid, M myristic acid, S stearic acid, O oleic acid, DAG diacylglycerols, MAG monoacylglycerols

Table 8 Fatty acid composition of biscuits made from 100% white shortening (WS) and by replacing it by 40 and 60% red palm olein

Fatty acids %	Biscuit samples		
	100% WS (Control)	60% WS + 40% RPOL	40% WS + 60% RPOL
Lauric ($C_{12:0}$)	0.1	0.13	0.14
Myristic ($C_{14:0}$)	1.0	0.97	0.98
Palmitic ($C_{16:0}$)	46.3	43.55	42.24
Margaric ($C_{17:0}$)	0.1	0.11	0.14
Stearic (C18:0)	4.9	4.59	4.47
Arachidic (C20:0)	0.4	0.38	0.38
TSFA	52.8[a]	49.73[b]	48.35[c]
Palmitoleic ($C_{16:1}$)	0.2	0.18	0.19
Oleic ($C_{18:1}$)	36.5	38.91	39.02
TMUFA	36.7[c]	39.09[b]	40.11[a]
Linoleic ($C_{18:2}$)	9.6	10.47	10.78
Linolenic ($C_{18:3}$)	0.3	0.42	0.45
TPUFA	9.9[c]	10.89[b]	11.23[a]
Others	0.3	0.29	0.34

TSFA Total saturated fatty acids, TMUFA total monounsaturated fatty acids, TPUFA total polyunsaturated fatty acids, S/U saturated fatty acid : unsaturated fatty acids

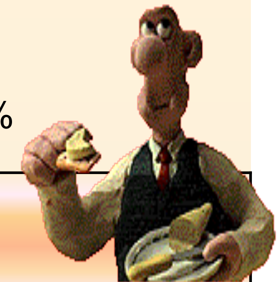
Table 9 Effect of storage at room temperature on some quality attributes of biscuits made from 100% white shortening (WS) and by replacing it by 40 and 60% red palm olein



Properties	Storage period								
	Zero time			6 Months			12 Months		
	100% WS (Control)	60% WS + 40% RPOL	40% WS + 60% RPOL	100% WS (Control)	60% WS + 40% RPOL	40% WS + 60% RPOL	100% WS (Control)	60% WS + 40% RPOL	40% WS + 60% RPOL
Water activity (21 ^{0}C)	0.26 ± 0.07^{a}	0.23 ± 0.07^{a}	0.22 ± 0.14^{a}	0.29 ± 0.12^{a}	0.29 ± 0.09^{a}	0.29 ± 0.14^{a}	0.32 ± 0.17^{a}	0.32 ± 0.13^{a}	0.39 ± 0.17^{a}
Peroxide value (mequiv peroxide/kg)	1.0 ± 0.44^{b}	1.5 ± 0.59^{a}	1.7 ± 0.23^{a}	6.5 ± 0.52^{a}	5.3 ± 0.37^{b}	4.2 ± 0.27^{c}	10.0 ± 0.46^{a}	9.8 ± 0.52^{b}	7.3 ± 0.35^{c}
Anisidine value	1.5 ± 0.04^{a}	0.7 ± 0.04^{b}	0.72 ± 0.12^{b}	1.6 ± 0.06^{a}	1.3 ± 0.07^{b}	1.0 ± 0.07^{c}	1.8 ± 0.04^{a}	1.8 ± 0.03^{a}	1.2 ± 0.15^{b}
Acid value	0.15 ± 0.08^{a}	0.17 ± 0.05^{a}	0.17 ± 0.07^{a}	1.44 ± 0.45^{a}	1.53 ± 0.52^{a}	1.5 ± 0.18^{a}	1.7 ± 0.44^{a}	1.72 ± 0.31^{a}	1.8 ± 0.2^{a}
FFA (%)	0.07 ± 0.05^{a}	0.08 ± 0.03^{a}	0.08 ± 0.05^{a}	0.67 ± 0.31^{a}	0.71 ± 0.38^{a}	0.7 ± 0.11^{a}	0.79 ± 0.32^{a}	0.80 ± 0.17^{a}	0.84 ± 0.14^{a}

RPOL Red palm olein
Means (n = 3) in a row within the same storage period not sharing the same superscript are significantly different at $P < 0.05$

Table 10 Effect of storage at room temperature on the natural antioxidant content (ppm) of biscuits made from 100% white shortening (WS) and by replacing it by 40 and 60% red palm olein



Properties	Storage period								
	Zero time			6 Months			12 Months		
	100%WS (ControL)	60% WS + 40% RPOL	40% WS + 60% RPOL	100% WS (Control)	60% WS + 40% RPOL	40% WS + 60% RPOL	100% WS (Control)	60% WS + 40% RPOL	40% WS + 60% RPOL
α- Tocopherol	51.2	93.0	116.0	48.9	66.7	95.0	36.7	53.3	83.6
α -Tocotrienol	69.9	126.4	158.0	69.5	94.0	123.4	53.5	75.0	115.7
β -Tocotrienol	88.0	85.2	85.7	60.0	84.0	89.6	62.0	67.0	80.6
γ -Tocotrienol	64.3	123.0	154.3	71.0	112.5	136.0	71.0	91.0	132.0
δ -Tocotrienol	32.5	52.7	63.2	27.0	53.0	58.0	31.0	43.0	58.7
Total α- tocopherol + tocotrienols	306.0^{c}	480.0^{b}	577.0^{a}	267.0^{c}	410.0^{b}	502.0^{a}	254.0^{c}	329.0^{b}	471.0^{a}
Carotenes	18.0^{b}	173.0^{a}	188.0^{a}	13.0^{b}	172.0^{a}	184.0^{a}	12.0^{c}	126.0^{b}	177.0^{a}

Means in a row within the same storage period not sharing the same superscript are significantly different at P\0.05

Business Publications

Red Palm Olein: Characterization and Utilization in Formulating Novel Functional Biscuits

JAOCS, Journal of the American Oil Chemists' Society, Mar 2010 by El-Hadad, Nesma, Abou-Gharbia, Hany Aly, El-Aal, Mohammed Hamadi Abd, Youssef, Mohammed Mohamoud

Abstract

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Utilisation of red palm olein in formulating functional chocolate spread

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Utilisation of red palm olein in formulating functional chocolate spread

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ABSTRACT

Novel functional chocolate spreads were formulated by replacing butter fat in conventional chocolate spread by red palm olein at 20%, 40%, 60%, 80% and 100% levels. Sensory evaluation revealed that chocolate spread made from 20% red palm olein (RPOL) and 80% butter fat was accepted as the conventional chocolate spread (100% butter fat). Hence, the former two chocolate spreads were selected for further study. Samples were stored at room temperature and fridge for 6 months and monitored for their physical properties, fat stability, fatty acid composition and natural antioxidants.

The data revealed that the replacement of butter fat in functional chocolate spread led to a significant increment in tocopherols and tocotrienols (3.7 folds) and carotenes (19.8 folds), as compared to the control. The functional chocolate spreads could be stored at room temperature for 6 months without any deteriorative effects on their quality.

1. Introduction

Palm oil is one of the 17 major oils and fats that are produced and traded worldwide. The extracted crude palm oil is fluid at tropical temperature and has a deep orange red colour, contributed by a high carotene content. Accordingly, it is considered as a rich natural source of carotenes (500–1500 ppm), as well as tocols (700–1000 ppm) (Mayamol, Balachandram, Samuel, Sundareson, & Arumughan, 2007; Nwokolo & Smart, 1995; O'Brien, 2004). The crude palm oil is refined (physically or chemically) to remove undesirable impurities and produce refined, bleached and deodorized palm oil (RBDPO), which can be fractionated into palm olein and palm stearin (Gee, 2007). As a result, the final products become light golden in colour and devoid of carotenes, and unfortunately most of tocols (Al-Saqer et al., 2004).

In recent years, efforts have been made to retain carotenes in palm oil and its products; red palm olein (RPOL) has been developed by Malaysian Palm Oil Board (MPOB). The RPOL is a unique product derived from crude palm oil, refined by an especially mild process so as to retain most of its valuable components, i.e., carotenes and tocols.

The RPOL is increasingly becoming available in food stores as well. The carotenes in RPOL have been demonstrated to have the highest bioavailability among all known plant carotenes. RPOL has been used in many forms to deliver its pro-vitamin A carotenes to children at risk, in several cross-continental studies. The findings are consistent: red palm oil administered even in low dose, protects the malnourished child against vitamin A deficiency and the risk of going blind. Moreover, carotenes are known to have several other physiological functions, i.e., antioxidant activity, immune function enhancements and anti-cancer activity (Sundram, 2005).

In nature, vitamin E occurs in eight isomeric forms: four tocopherols and four tocotrienols isomers. Tocotrienols are considered as a nature curiosity and occur in appreciable quantities in RPOL. Tocotrienols appear to have important physiological effects that differ from those of tocopherols. Tocotrienols have been shown to be far superior chain breaking antioxidants than tocopherols. In addition, because of the unsaturation in the phytyl chain of their molecular structures, they actually demonstrate physiological properties that are often different from those of tocopherols. Palm tocotrienols have been proved to have blood cholesterol lowering properties and inhibit the growth of cancer cell (Sundram, 2005; Yew, Selvaduray, & Nesaretnam, 2007).

Although there is no consensus on the exact definition of the "Functional Food" term, according to the American Dietetic Association, functional food is defined as: any modified food or food

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Fig. 1. Flowchart of processing chocolate spread.

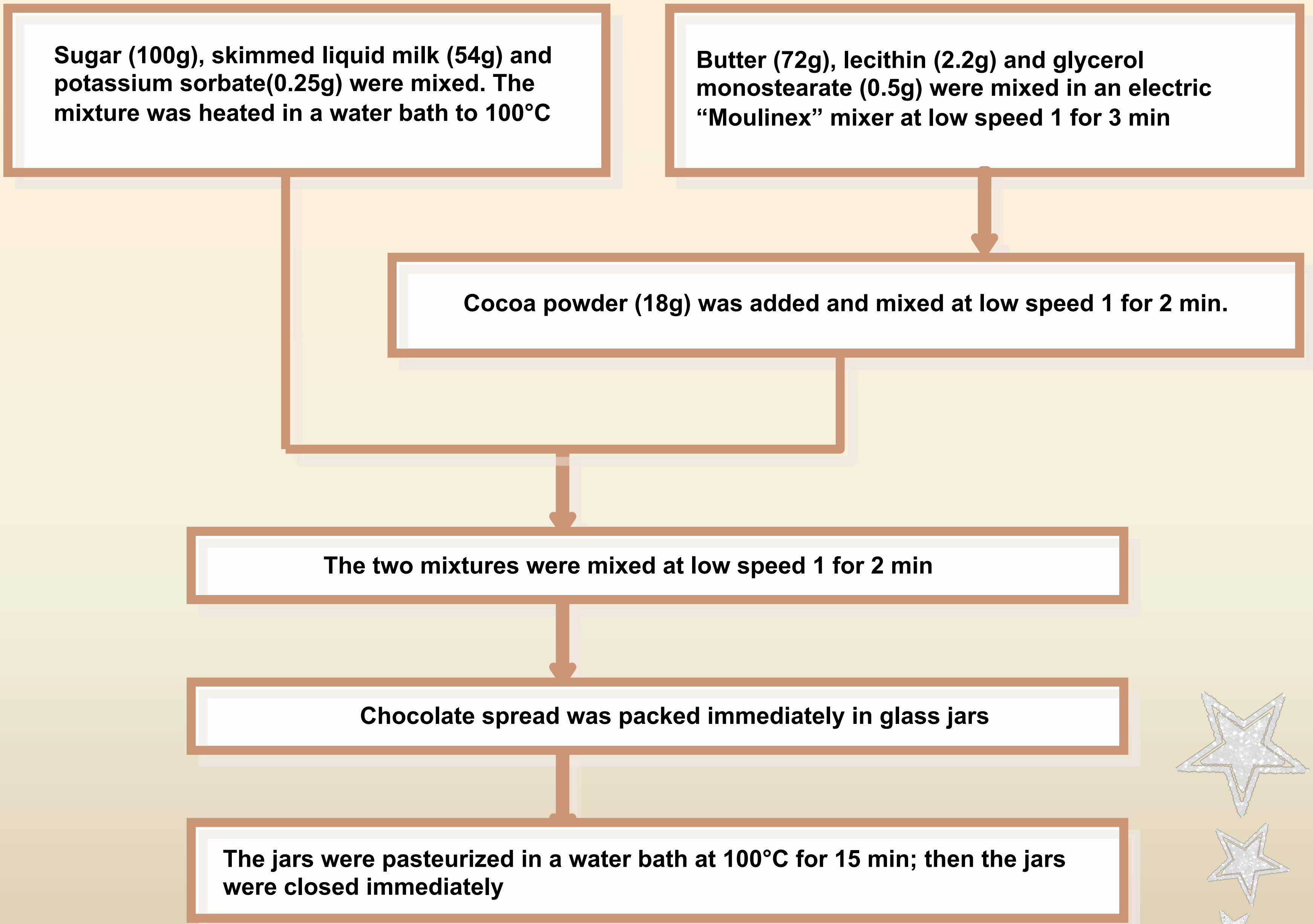

Table 1

Sensory evaluation of chocolate spreads made from 100% butter and by substituting with RPOL at different levels.

Chocolate spreads	Organoleptic properties				
	Colour	Flavour	Taste	Consistency	Overall acceptability
100% butter	6.42[a]	6.42[a]	6.42[a]	6.58[a]	6.42[a]
80% butter + 20%RPOL	5.92[ab]	5.83[ab]	6.00[ab]	6.17[ab]	5.92[ab]
60% butter + 40%RPOL	5.50[ab]	5.75[ab]	5.25[bc]	5.75[bc]	5.33[bc]
40% butter + 60%RPOL	5.00[bc]	5.25[bc]	5.08[c]	5.50[c]	4.83[cd]
20% butter + 80%RPOL	5.00[bc]	4.83[c]	4.92[cd]	5.42[c]	4.58[d]
100% RPOL	4.50[c]	4.83[c]	4.08[d]	4.25[d]	4.12[d]

RPOL: red palm olien.Each value is expressed as the mean of three replications.
Means with the same letter within a column are not significantly different at $P < 0.05$.

Table 2

Physical properties of chocolate spreads stored for 6 months at room temperature and in a refrigerator.

Physical properties	Storage period and conditions Zero time		Room temperature				Refrigerator			
			3 months		6 month		3 months		6 months	
	100% butter	20% RPOL + 80% butter	100%butter	20%RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100%butter	20% RPOL + 80% butter	100% butter	20%RPOL +80%
Viscosity (p) Emulsion stability	50. 3 ± 1.24[ax] 1.0 ± 0.00[ax]	50.0 ±1.44[ax] 1.0 ± 0.00[ax]	48.7 ±2.03[ay] 1.0 ± 0.00[ax]	48.0 ± 1.38[ay] 1.0 ± 0.00[ax]	47. 2 ± 1.41[az] 1.0 ± 0.00[ax]	46.5 ±1.75[ax] 1.0 ± 0.00[ax]	50.7 ± 1.62[ax] 1.0 ± 0.00[ax]	50.5 ± 1.65[ax] 1.0 ± 0.00[ax]	50.7 ±1.73[ax] 1.0 ± 0.00[ax]	50.6±1.69[ax] 1.0 ±0.00[ax]

RPOL: red palm olien.
Each value is expressed as mean ± SD. of three determinations . Means in a row not sharing the same letter (a and b) at the same storage period, and means not sharing the same letter (x, y and z) at different storage periods and conditions, are not significantly different at $P < 0.05$.

Table 3

Stability indices of chocolate spreads stored for 6 months at room temperature and in a refrigerator.

parameter	Storage period and conditions		Room temperature				Refrigerator			
	Zero time		3months		6 months		3 months		6 months	
	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter
Peroxide value (meq peroxide/kg) p-Anisidine value Acid value FFA (%)	0.0±0.00^{az}	0.0±0.00^{az}	0.4±0.22^{ay}	0.3± 0.17^{ay}	0.7±0.20^{ax}	0.5±0.30^{ax}	0.4±0.15^{ay}	0.2±0.15^{ay}	0.5±0.20^{ax}	0.3±0.26^{ax}
	0.0± 0.00^{az}	0.0±0.00^{az}	1.0±0.02^{ay}	0.63±0.04^{ay}	1.53±0.05^{ax}	1.02±0.09^{ax}	0.61±0.05^{ay}	0.1±0.03^{ay}	0.75±0.04^{ax}	0.50±0.03^{ax}
	0.2± 0.09^{az}	0.25±0.08^{az}	0.76±0.08^{ay}	0.7± 0.07^{ay}	1.6±0.07^{ax}	1.58±0.11^{ax}	0.7±0.08^{ay}	0.68±0.09^{ay}	1.6±0.08^{ax}	1.5±0.09^{ax}
	0.09±0.05^{az}	0.12±0.04^{az}	0.35±0.02^{ay}	0.33±0.03^{ay}	0.73±0.04^{ax}	0.72±0.07^{ax}	0.33±0.03^{ay}	0.32±0.03^{ay}	0.73±0.04^{ax}	0.70±0.05^{ax}

RPOL: red palm olein.
Each value is expressed as mean ± SD. of three determinations. Means in a row not sharing the same letter (a and b) at the same storage period, and means not sharing the same letter (x, y and z) at different storage periods and conditions, are not significantly different at $P < 0.05$.

Table 4

Fatty acid composition of chocolate spreads stored for 6 months at room temperature and in a refrigerator.

Fatty acid	Storage period and conditions		Room temperature				Refrigerator			
	Zero time		3 months		6 months		3 months		6 months	
	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL+ 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter
Caprylic ($C_{8:0}$)	0.84	0.72	0.81	0.97	0.94	0.71	0.79	0.63	0.87	0.64
Capric ($C_{10:0}$)	2.34	2.00	2.25	1.90	2.65	2.0	2.24	1.78	2.47	1.86
Lauric ($C_{12:0}$)	3.15	2.80	3.05	3.07	3.74	2.84	3.06	2.62	3.63	2.78
Myristic($C_{14:0}$)	10.7	8.47	10.6	8.64	11.2	8.63	10.6	8.30	11.4	8.78
Palmitic($C_{16:0}$)	32.1	32.5	32.4	33.5	31.4	33.0	32.7	33.5	32.3	33.7
Margaric($C_{17:0}$)	0.02	0.69	1.05	0.67	0.86	0.66	1.02	0.68	0.88	0.68
Stearic ($C_{18:0}$)	10.8	9.02	11.1	10.1	10.8	9.23	11.1	9.5	11.4	9.69
Arachidic($C_{20:0}$)	0.23	0.25	0.24	0.26	0.20	4.77	0.24	0.29	0.22	0.26
TSFA	60.2^{az}	65.5^{bz}	61.4^{ay}	59.0^{by}	61.8^{ax}	61.8^{ax}	61.7^{ay}	57.3^{by}	63.1^{ax}	58.3^{bx}
Palmitoleic($C_{16:1}$)	2.30	1.72	2.20	1.67	0.28	1.64	2.23	1.62	2.13	1.65
Oleic ($C_{18:1}$)	24.2	29.6	22.5	28.3	24.2	28.2	23.9	28.9	23.0	28.0
TMUFA	26.5^{bx}	31.3^{ax}	24.7^{by}	30.0^{ax}	24.5^{by}	29.8^{ay}	26.1^{by}	30.5^{ay}	25.1^{by}	29.7^{az}
Linoleic ($C_{18:2}$)	3.17	5.05	2.85	4.71	0.50	0.12	2.59	4.96	2.58	4.73
Linolenic ($C_{18.3}$)	0.79	0.67	0.81	0.66	0.71	0.25	0.73	0.69	0.69	0.66
TPUFA	3.96^{bx}	5.72^{ax}	3.66^{bx}	5.37^{ax}	1.21^{ay}	0.37^{by}	3.32^{bx}	5.65^{ax}	3.27^{ax}	5.39^{ax}
Others	7.74	5.85	7.55	5.93	8.79	7.19	7.62	5.72	7.48	5.81

RPOL: red palm olein. TSFA: total saturated fatty acids
TMUSFA: total monounsaturated fatty acids. TPUSFA: total polyunsaturated fatty acids. M eans in a row not sharing the same letter (a and b) at the same storage period, and means not sharing the same letter (x, y and z) at different storage periods and conditions, are not significantly different at $P < 0.05$.

Table 5

Tocopherol, tocotrienols and carotenes of chocolate spreads stored for 6 months at room temperature and in a refrigerator.

Antioxidants (ppm)	Storage period and conditions									
	Room temperature					Refrigerator				
	Zero time		3 months		6 months		3 months		6 months	
	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter	100% butter	20% RPOL + 80% butter
α Tocopherol	21.3	60.8	17.5	57.0	17.0	55.6	20.0	58.5	17.0	56.6
α -Tocotrienol	Zero	66.3	Zero	59.7	Zero	60.0	Zero	61.7	Zero	60.0
β -Tocotrienol	49.7	57.0	43.5	52.2	42.3	53.0	46.0	55.0	42.6	54.0
γ -Tocotrienol	Zero	71.4	Zero	63.8	Zero	62.0	Zero	66.0	Zero	63.3
δ -Tocotrienol	Zero	26.5	Zero	23.6	Zero	23.3	Zero	24.7	Zero	23.3
Total α-tocopherol & tocotrienols	71.0^{bx}	282.0^{ax}	61.0^{by}	256.3^{ay}	59.3^{bz}	254.0^{az}	66.0^{by}	266.0^{ay}	59.7^{bz}	257.0^{az}
Carotenes	10.0^{bx}	148.0^{ax}	6.0^{by}	131.0^{ay}	5.0^{bz}	128.0^{az}	8.0^{by}	140.0^{ay}	6.0^{bz}	137.0^{az}

RPOL: red palm olein.
Means in a row not sharing the same letter (a and b) at the same storage period, and means not sharing the same letter (x, y and z) at different storage periods and conditions, are not significantly different at $P < 0.05$.

Red palm oil shows functional chocolate potential

By Nathan Gray, 23-Aug-2010

Related topics: Research, Antioxidants, carotenoids, Nutritional lipids and oils, Cardiovascular health

Adding red palm olein to chocolate spread could boost its antioxidant power and nutrient availability, according to new research published in the journal *Food Chemistry*.

The study, suggests that adding up to 20 per cent red palm olein (RPOL) into a functional chocolate spread could lead to nearly 20 times higher concentrations of carotenes.

"It was observed that when butter was replaced with 20% RPOL, all antioxidants were found to increase significantly," wrote the researchers, from the Food Science and Technology Department at Alexandria University, Egypt.

Palm olein has been suggested as a potential functional ingredient for the replacement of vegetable oils and cocoa butters in confectionary products because it contains a wide variety of antioxidants and functional ingredients, including carotenes, tocopherols and tocotrienols.

The aim of the new study was to formulate a functional chocolate spread using red palm olein, assessing its sensory qualities and storage stability over a 6 month period.

Higher antioxidants

Functional spreads were formulated by replacing butter fat in conventional chocolate spread with red palm olein at 20%, 40%, 60%, 80% and 100% levels.

Results of sensory evaluations suggest that functional spreads made from 20% red palm olein (RPOL) and 80 per cent butter fat were equally as accepted as the conventional chocolate spread (100 percent butter fat).

All antioxidants measured were reported to significantly increase when butter was replaced with 20 percent RPOL. With 3.7 times more tocopherols and tocotrienols and 19.8 times more carotenes than the 100 percent butter control.

It was found that the functional spreads could be stored at room temperature for 6 months without any deteriorative effects on their sensory quality – however it was seen that antioxidant levels decreased as the storage period extended, both at room temperature and in a refrigerator.

However, it was also seen that the addition of 20 per cent RPOL was responsible for an 8.8 percent increase in total saturated fats (SFA), and increase total polyunsaturated fat (PUFA) content by nearly 45 percent.

Effective formulation?

The researchers concluded that *"A high quality functional chocolate spread was able to be produced by replacing the butter fat with RPOL at 20% level."*

The researchers go on to suggest that a functional spread formulation with high levels of carotenes could *"act as one of the most effective means for overcoming*

vitamin A deficiency", adding that the spread formulation *"contains high concentrations of natural antioxidants that possess health benefits, as it has been extensively reported in literature."*

However, the addition of palm olein was not only associated with increased levels of functional ingredients such as carotenes and antioxidants, as increased levels of SFAs, PUFAs, and increased overall fat content were also observed.

Source: *Food Chemistry*

Published online ahead of print, doi: 10.1016/j.foodchem.2010.06.034

"Utilisation of red palm olein in formulating functional chocolate spread"

Authors: N.N.M. El-Hadad, M.M. Youssef, M.H. Abd El-Aal, H.H. Abou-Gharbia

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