Palm Fats as Animal Fat Analogues in Beef Burgers

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Abstract

Palm fat and red palm fat were used to replace beef fat in beef burgers. The vitamin E content was higher in palm fat burgers and red palm fat at 428 and 367 μg/g, respectively. Replacing beef fat with palm fat decreased cholesterol to 87 mg and 92 mg/100g (16-24%) in raw and cooked beef burgers, respectively. Red palm fat burgers had the highest carotene values, while beef fat burgers were the lowest. Substitution of animal fat with palm fat did not change the overall sensory acceptability of the beef burgers, showing the potential of palm fats as animal fat analogues.

Key words: Palm fat, red palm fat, animal fat, processed meat, Vitamin A, Vitamin E

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Acknowledgement: The authors appreciated the fundings from Universiti Kebangsaan Malaysia-Ministry of Science, Technology and Environment (MOSTE) for IRPA Grant and CAROTINO SDN. BHD. Towards this research and findings.

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Introduction

Animal fats and skin are common raw materials added in emulsion-type meat products. They are also high in cholesterol and contaminating microorganisms. With consumers demanding healthful foods, meat manufacturers have focused production toward processed meats that are lean, low fat and high in protein content. Animal fats are added to meat products for economic, texture and flavour reasons. As more companies venture into further processing of meat, the prices of animal fats and skin may increase due to increased demand (Babji *et al*., 1999).

The American Heart Association (1985) and other health groups have recommended a decrease in the consumption of animal fats. Decreases in calories from fat, from 40% to 30%, and in saturated fat intake from 18% to 10%, have also been recommended (Carrol, 1998).

High saturated fat and cholesterol intakes have led to meat products being scrutinized by nutritional, medical, and consumer groups. As more evidence concerning the benefits and risks associated with dietary nutrients are emerging in both the scientific field and the mass media, today's consumers are more informed on the link between health and diet.

Palm fats are stable and resistant to oxidation, containing vitamin E which is an antioxidant. Palm fats are readily available in the tropics and priced competitively with animal fats. Compared to animal fats, palm fats offer a wider range of choice for meat manufacturers to meet product requirements.

The use of functional palm fat, which is cholesterol free, trans fatty acid free and naturally fortified with carotenoids, tocopherol and tocotrienols, may generate safer, nutritious and high quality processed meat products for domestic and international markets. There is also the potential to develop this food product to promote palm fat analogues carrying the Malaysian brand name and offering the 'halal' advantage in international markets. Researchers believed that palm fats make sausages and other meat products better and healthful (Babji *et al*., 2001; Wan Sulaiman *et al*., 2001).

This paper highlights the utilization of palm fats as animal fat analogues in beef burgers as a new designer food ingredient naturally fortified with vitamins and antioxidants and cholesterol free.

Materials and Methods

Three beef burger formulations were compared, each containing 15% fat from Beef Fat (control), Palm Fat or Red Palm Fat (Carotino®) (Table 1). Palm Fat (white in colour) was supplied by Cargill Fats & Oils Specialty Pte. Ltd. while Red Palm Fat (yellow in colour) was supplied by Carotino Pte. Ltd. Other dry materials were purchased from local suppliers. Frozen New Zealand beef was manually cut using a band saw (JG-210) and minced through a 4 mm-diameter grinder plate. The minced beef was stored at –18^{o}C until processed. Isolated soy protein was blended with water and fat at a ratio of 1:5:5 in a Hobart mixer (N-50 Canada). This pre-emulsion was kept in a chiller (2-5^{o}C) until ready for use. Salt was added to frozen minced beef and mixing was carried out using the Hobart mixer for 3 minutes. Water mixed with tripolyphosphate and spices, potato starch and textured vegetable protein were added and mixed for another 2 minutes. The pre-emulsion was then added and mixing continued for another 2 minutes. The finished meat batters were then weighed into 70g portions, then manually stamped to produce uniform beef burgers which were then placed in a freezer at –18^{o}C. Beef burgers were cooked for 7 min (internal temperature, 72-74^{o}C).

Fat was extracted using a method of Kinsella *et al*., (1977). Vitamin E was analysed using HPLC (AOCS, 1992). Carotene content was determined using a spectrophotometer reading at 446 nm (PORIM, (1995). Cholesterol content was determined using a spectrophotometer (Bohac *et al*., 1988). TBA values were determined by the method of Tarladgis *et al*., (1960). A sensory panel of 100 untrained consumers evaluated samples for colour, springiness, juiciness, meaty taste, oiliness and overall acceptance on a 7 scale or 15-cm descriptive analysis scale (0 = dislike extremely and 7 = like extremely). Data obtained were tested for significance using ANOVA and Duncan Multiple Range Test with SAS version 6.12 (SAS, 1989). Significance was established at $P \leq 0.05$ unless otherwise indicated.

Results

The vitamin E content was highest in palm fat (PF) cooked beef burgers, followed by red palm fat (RF) and control (C) formulations at 428, 367 and 0 μg/g respectively. Interestingly, α-tocopherol, α-tocotrienol, γ-tocotrienol and δ-tocotrienol were present in PF and RF but absent in the C burgers. RF burgers had the highest carotene values, while beef fat burgers had the lowest (Table 2).

Substituting beef fat with palm fat based decreased the cholesterol level by 16-24% from 103 and 121 mg to 87 mg and 92 mg/100g in raw and cooked beef burgers, respectively (Table 2). Other researchers reported that substituting chicken skin fat with palm fat reduced cholesterol by 35-45% in chicken nuggets (Alina, 2000); 40% in chicken burgers (Wan Sulaiman *et al*., 2000); 29-39% in beef burgers (Mat *et al*., 2001) and 28-33% in duck burgers (Lee *et al*., 2001). Replacing chicken fat in nuggets with palm fat and red palm fat also decreased the cholesterol content to 29 and 40 mg/100 g, respectively (Nurhidayah, 2001).

TBA values for all beef burger samples increased after 3 months of storage. However, red palm fat (RF) and palm fat (PF) burgers had significantly lower TBA values compared to the control burgers after 3 months storage (Figure 1).

Table 3 shows the sensory evaluation score of beef burgers containing palm fat and red palm fat. There were no significant differences ($P>0.05$) for all sensory attributes score for beef burgers containing palm fat, red palm fat and beef fat (control). Consumers were not able to differentiate the substitution of animal fat with palm fats.

Discussion

This study investigated the nutritional quality and sensory attributes of beef burgers using palm fats as animal fat analogues. Substituting animal fats,which are high in cholesterol and saturated fat, with red palm fats rich in natural vitamin E and carotenes can provide healthier meat products. The initial amount of vitamin E in animal tissues may influence the rate of lipid oxidation in the products. However, the limited natural antioxidant benefit from vitamin E available in beef fat treatment may be due to denaturation of muscle microstructure during cooking. α-Tocopherol has also been detected in the muscle tissue of beef, pork, chicken and fish, the levels depending on the animal's diet. Marmer (1995) reported that chicken fat contained 2.7 mg tocopherol per 100g fat whilst palm fat had 38.4 mg /100 g of fat.

While α-tocopherol has been reported to be the most biologically active of all the tocopherols, scientific evidence has shown that, tocotrienols may reduce cholesterol concentrations in people with hypercholesterolemia, may slow down the progression of atherosclerosis and inhibit the proliferation and growth of human breast cancer cells (Nesaretnam, 2000). Recently, gamma (γ), the largest vitamin E homologue in palm oil and delta (δ) forms of tocotrienols have been found to exhibit a strong activity against tumor promotion by inhibiting Epstein-Barr virus (Kamen, 2000). δ-Tocotrienol also has the best makeup to neutralize free radicals while γ-tocotrienol may prevent development of increased blood pressure (Kamen, 2000).

Vitamin E supplementation in meat was found to increase colour stability. Lipid oxidation products catalyse the oxidation of oxymyoglobin to metmyoglobin. The direct antioxidant action of α-tocopherol on membrane lipids may indirectly delay oxymyoglobin oxidation and thus meat discoloration (Gray *et al*., 1996).

Values in the literature for the cholesterol concentrations of meats vary widely. Rhee *et al*., (1982) reported that cholesterol values for uncooked of beef longissimus steaks ranged from of 52-66 mg/100 g, while Hoelscher *et al*. (1987) found the cholesterol content of raw ground beef patties in the range of 77-92 mg/100 g. This present study showed that substitution of animal fats with palm based fats decreased the content of cholesterol in beef burgers because vegetable products contain no cholesterol. Marquez *et al*., (1989) also reported that substituting 60% of the beef fat with peanut oil in beef frankfurters resulted in lower cholesterol content (52-56 mg/100 g) compared to beef frankfurters containing all beef fat which contained 62-87 mg/100 g cholesterol.

The lower TBA value of red palm and palm fat burgers after storage may be due to the higher amount of antioxidants naturally in the products. The carotenes and vitamin E in palm fat and red palm fat retarded oxidative deterioration according to the TBA values. β-carotene and other carotenoids function as antioxidants through their ability to inactivate singlet oxygen and triplet sensitizers (Briviba and Sies, 1994). Barroeta and King (1991) found that 3.6 ppm β-carotene decreased thiobarbituric acid reactive substances (TBARS) values of fresh poultry muscle by 30%, while Ruiz *et al*., (1999) reported reduced TBARS values in cooked leg meat from chickens fed a diet containing 6% sunflower oil and 15 or 50 mg β-carotene / kg feed. Comminution of meat and subsequent exposure to air can develop rancidity within one hour, and salt has been shown to increase TBA numbers of restructured pork (Crackel *et al*., 1988).

Table 3 shows that the substitution of animal fat with palm fat did not change the overall sensory acceptability of beef burgers. Alina *et al*., (2000) also suggested the potential of palm oil products, especially palm olein, as fat sources in comminuted meat products.

Conclusions

This study shows the potential for substituting animal fat with palm fat and red palm fat in beef burgers. Carotenes and vitamin E provide benefits from palm fat/red palm fat usage in meat products. Substitution of animal fat with palm based fat did not change the overall acceptability of beef burgers significantly.

Acknowledgement

The authors appreciated the funding from the Malaysian Palm Oil Board (MPOB), Universiti Kebangsaan Malaysia and the assistance of Carotino Sdn. Bhd. towards the research and findings of this paper.

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Table 1: Beef burger formulations

Ingredient	Percent
Beef	49.0
Fat (beef, palm fat or red palm fat)	15.0
Water	22.5
Textured vegetable protein	5.0
Potato starch	3.0
Isolated soy protein	3.0
Salt	1.1
Sodium tripolyphosphate	0.3
Spices and seasoning	1.1
Total	100

Table 2: Nutritional content of beef burgers containing beef fat (C), palm fat (PF) or Carotino® Red Palm Fat (RF) before and after cooking

		FAT		
		Control (C)	**Palm fat (PF)**	**Carotino® (RF)**
Vitamin E(μg/g)				
α-tocopherol	Raw	4	$^{x}130^{a}$	$^{x}62^{b}$
	Cooked	0	$^{y}107^{a}$	$^{x}54^{b}$
α-tocotrienol	Raw	0	$^{x}133^{a}$	$^{x}83^{b}$
	Cooked	0	$^{y}109^{a}$	$^{x}74^{b}$
γ-tocotrienol	Raw	0	$^{x}201^{a}$	$^{x}221^{a}$
	Cooked	0	$^{x}184^{a}$	$^{y}186^{a}$
δ-tocotrienol	Raw	0	$^{x}29^{b}$	$^{x}64^{a}$
	Cooked	0	$^{x}25^{b}$	$^{x}54^{a}$
Vitamin E (average)	Raw	4	$^{x}487^{a}$	$^{x}429^{b}$
	Cooked	0	$^{y}428^{a}$	$^{y}367^{b}$
Carotene (ppm)	Raw	$^{x}8^{b}$	$^{x}10^{b}$	$^{x}275^{a}$
	Cooked	$^{x}7^{b}$	$^{x}9^{b}$	$^{y}256^{a}$
Cholesterol (mg/100g)	Raw	$^{y}103^{a}$	$^{x}87^{b}$	$^{x}87^{b}$
	Cooked	$^{x}121^{a}$	$^{x}93^{b}$	$^{x}92^{b}$

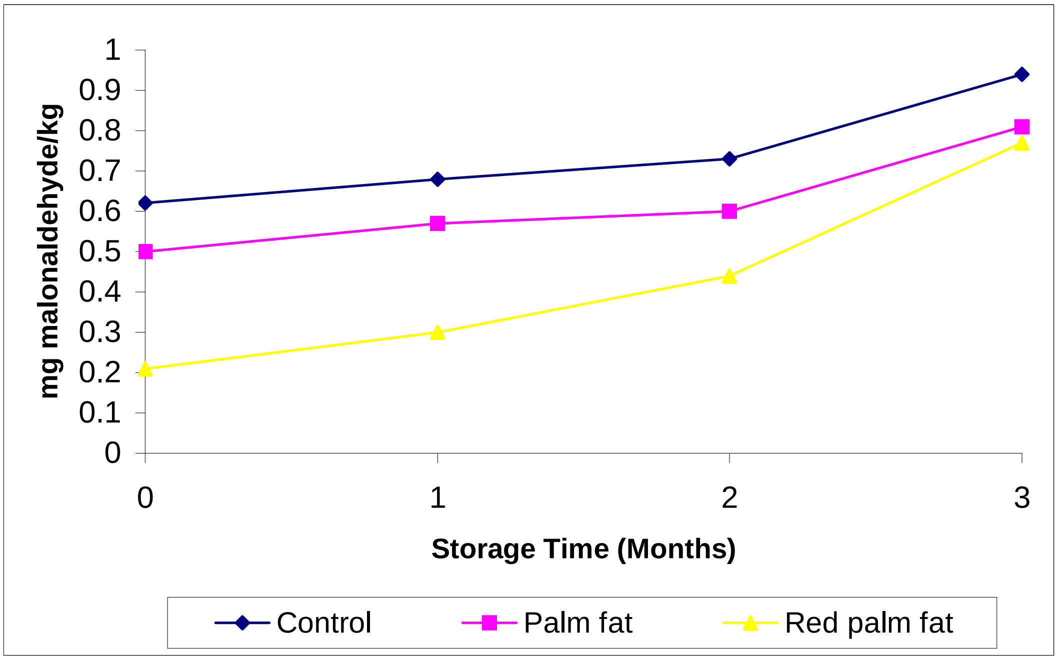
$^{a-c}$ Mean values within the same row bearing different superscripts differ significantly ($P \leq 0.05$)
$^{x-y}$ Mean values within the same column bearing different superscripts differ significantly ($P \leq 0.05$)

Table 3: Sensory attributes of cooked beef burgers containing beef fat (Control), palm fat or red palm fat (n=100)

	FAT		
Sensory attribute	**Control**	**Palm Fat**	**Red Palm Fat**
Colour	4.28[a]	4.39[a]	4.51[a]
Springiness	4.86[a]	4.74[a]	4.57[a]
Juiciness	4.32[a]	4.46[a]	4.44[a]
Meaty taste	4.98[a]	4.87[a]	4.56[a]
Oiliness	4.38[a]	4.55[a]	4.29[a]
Overall acceptance	4.79[a]	4.94[a]	4.57[a]

[a-b] mean values within the same row bearing different superscripts differ significantly ($P \leq 0.05$)

Figure 1: TBA values of beef burgers containing 15% beef fat (Control), palm fat or red palm fat.



Treatment	Storage time (months)			
	0	1	2	3
Control	$^{X}0.62 \pm 0.10^{b}$	$^{X}0.68 \pm 0.05^{b}$	$^{X}0.73 \pm 0.10^{b}$	$^{X}0.94 \pm 0.10^{a}$
Palm fat	$^{X}0.50 \pm 0.05^{c}$	$^{Y}0.57 \pm 0.05^{b}$	$^{Y}0.60 \pm 0.05^{b}$	$^{Y}0.81 \pm 0.05^{a}$
Red palm fat	$^{Y}0.21 \pm 0.10^{d}$	$^{Z}0.30 \pm 0.05^{c}$	$^{z}0.44 \pm 0.05^{b}$	$^{y}0.77 \pm 0.05^{a}$

$^{a\text{-}c}$ Mean values within the same row bearing different superscripts differ significantly ($P \leq 0.05$)
$^{x\text{-}y}$ Mean values within the same column bearing different superscripts differ significantly ($P \leq 0.05$)