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ORIGINAL ARTICLE

# Application of peanut butter to improve fatty acid composition of biscuits

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**Abstract** Biscuits prepared with different levels of hydrogenated fat (vanaspati) and peanut (*Arachis hypogaea* L.) butter (PB) (100:00, 75:25, 50;50, 25;75, 00:100) were evaluated for their fatty acid composition and textural property. Saturated fatty acids like myristic, palmitic, stearic acids were higher in control biscuits (100% vanaspati), which decreased with increasing proportion of PB in the experimental biscuits. Oleic acid and linoleic acid were lowest in control biscuits and it gradually increased upon incorporation of PB. The hardness of biscuits also increased with increasing proportion of PB. Overall sensory quality of experimental biscuits improved when 50% vanaspati replaced by PB in the standard biscuits recipe. Biscuits prepared with 50% supplementation of PB had better fatty acid composition with balanced oil quality and also had a greater acceptability by sensory evaluation panel.

**Keywords** Biscuits · Peanut butter · Vanaspati · Fatty acid composition · Hardness · Sensory acceptability

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## Introduction

Peanut (*Arachis hypogaea* L.) is probably the most important oil bearing seed in the world, and is rapidly becoming a valuable source of plant protein. It has 47-50% oil and 26% protein (Nagaraj 1995). The requirements of edible oil are increasing every year (Rajendran and Chaya Devi 2004) and peanut is used not only for oil extraction but also for formulation of various fortified food products (Krishnaswamy 1970). Generally, the fatty acid composition of peanut oil comprises about 10% palmitic acid and 80% oleic and linoleic acids combined, and these three acids account for ~90% of the total fatty acid content in the peanut oil (Moore and Knauft 1989). The confectionery formulations contain vanaspati (hydrogenated fat), which lowers the nutritional status due to presence of large amount of saturated fatty acids (SFA). The biscuits can be used as a vehicle for desirable and essential fatty acid supplementation by utilizing part of peanut butter (PB) in place of vanaspati. The present study was carried out to utilize PB as a source of desirable and essential fatty acids, in biscuits.

## Materials and methods

*Preparation of peanut butter (PB)*: The PB was prepared according to Woodroof (1983) with some modifications: 100 g peanut (variety 'GG-13') were mixed with fine sand, heated at 160°C in electrical oven for 4–5 min, cooled to obtain uniform roasted product, blanched, red skins removed, light nuts, discoloured nuts or other undesirable parts were removed and whitened peanut kernels were subjected to coarse grinding at medium speed in domestic mixer for 2 min. To this, 1 g powder salt was added followed by fine grinding for 2–3 min. The ground product was spread on aluminum tray and kept for 4 h followed by de-oiling, when oil separation was noticed on the surface of PB. The PB was packed in airtight container and stored in refrigerator (14°C) to prevent rancidity.

*Preparation of biscuits*: Biscuits, having vanaspati to PB ratios of 100:00 ($T_1$), 75:25 ($T_2$), 50:50 ($T_3$), 25:75 ($T_4$), 00:100 ($T_5$), were prepared as per standard recipe (AACC 1994). Refined wheat flour (*maida*) (100%) and skimmed milk powder (2%) were mixed and sieved twice to ensure homogenous blending. Sugar powder (30%), dextrose monohydrate (2%) and different ratios of vanaspati/ PB were creamed for 3–4 min in Hobart mixer (Model N-50, Troy, OH, 45374, USA). Salt (1%), ammonium bicarbonate (1%) and sodium bicarbonate (0.5%) were dissolved in 20 ml distilled water and added to the cream in the mixing bowl. The contents were mixed further for 1–2 min. The flour containing skim milk powder was added and mixed for 3 min. The dough obtained was sheeted on a metal platform to a thickness of 3 mm using wooden rolling pin. The dough was cut into circular shape using a metallic cutter and arranged on a baking sheet and baked in the oven preheated to 204°C for 8 min. The cooled biscuits were packed in polypropylene (40 µ thickness) pouches and quality evaluated after 24 h.

*Fatty acid composition:* Oil from experimental biscuits and raw materials (PB, *maida*) were first extracted by Soxhlet method. Methyl esters of different oil samples were prepared by AOAC (1984) method and modified by Misra and Mathur (1998) to determine the fatty acid composition. The oil (0.250 g) of experimental biscuits and raw materials (PB, vanaspati, *maida*) were methylated in 6 ml of 0.5 M methanolic sodium methoxide at 70°C. The fatty acid methyl esters (FAME) were extracted and analyzed by capillary gas chromatograph (GS- Auto system XL, Perkin Elmer) equipped with flame ionization detector and a capillary column (BP-225, L-25M, ID-250 µM). The carrier gas was helium, and the total gas flow rate was 45 ml/min. The injector and detector temperatures were kept at 250 and 300°C, respectively. The column was initially held at 40°C for 3 min and programmed to increase to 130°C at the rate of 10°C/min. After holding at 130°C for 3 min, the column was programmed to increase to 215°C at the rate of 20°C/min.

The FAME were identified according to retention times using reference standards, and their relative contents were calculated as per cent distribution of areas (peak height x base width) under each peak of fatty acids. The fatty acids quantified as per cent distribution were myristic ($C_{14:0}$), palmitic ($C_{16:0}$), palmitolic ($C_{16:1}$), stearic ($C_{18:0}$), oleic ($C_{18:1}$), linoleic ($C_{18:2}$), linolenic ($C_{18:3}$), arachidic ($C_{20:0}$), ecosenoic ($C_{20:1}$), arachidonic ($C_{20:4}$) acids. Heptadecanoic acid ($C_{17:0}$) was used as the internal standard.

*Hardness of biscuits:* The hardness of biscuits was measured using texture analyzer (Stable Micro System Ltd., London, UK). Blade set with knife penetrated into biscuits samples at 0.5 mm/sec to a depth of 5 mm from the sample surface and then was withdrawn with post test speed 10 mm/sec. The reading of maximum force (i.e. highest peak) was recorded as hardness, when the biscuit fractured into 2 major pieces. Force following this point was substantially reduced as the knife continued to penetrate through smaller broken pieces.

*Sensory evaluation:* The overall sensory quality of biscuits was recorded as mean of colour, surface characteristics, crumb colour, crumb texture, taste, mouth feel (CFTRI 1991) by a panel of 10 judges on a 7-point scale (1 very poor quality and 7 excellent quality).

*Statistical analysis:* The analytical data of 4 replicated samples for individual parameters were subjected to analysis of variance (completely randomized design) following Snedecor and Cochran (1967) method.

## Results and discussion

*Fatty acid composition of raw materials:* Total saturated fatty acids (SFA) were highest (40.1%) in vanaspati followed by 36.6% total monounsaturated fatty acids (MUFA) and 21.7% total polyunsaturated fatty acids (PUFA) (Table 1). Oleic acid (36.2%) was highest in vanaspati as followed by palmitic acid (31.8%) as SFA and linoleic acid (20.8%) as PUFA, while other fatty acids were found in lower concentrations (Table 1). Paul and Southgate (1978) reported 36.9% oleic acid, 23.7% palmitic acid and 21.1% linoleic acid in vanaspati. Fatty acid composition of vanaspati varies depending on the vegetable fats used in its production.

Peanut butter contained highest proportion of total MUFA (49.0%), total PUFA (30.4%) and total SFA (19.5%) (Table 1). Oleic acid was highest (48.1%) in PB followed by linoleic acid (30.4%) and palmitic acid (11.6%). SFA (palmitic and stearic acids) were found significantly ($p<0.01$) higher in vanaspati than PB, while oleic acid and linoleic acid contents were significantly ($p < 0.01$) higher in PB than in vanaspati. However, contribution of fatty acid of *maida* to the experimental biscuits has not much importance as it contained only about 1% fat. Paul and Southgate (1978) stated that nutritive value of PB was higher as it contained higher oleic acid (51.6%) followed by linoleic acid (26.2%) than other fats and butter. Peanut and its product did not always exhibit same fatty acid composition as it varies with variety and location (Nagaraj 1995).

*Fatty acid composition of biscuits:* Total SFA was highest (49.3%) in control biscuits which gradually decreased with increasing proportion of PB biscuits (Table 2). The lowest SFA (26.5%) were found in $T_5$ treatment wherein entire quantity of vanaspati was replaced by PB. This was due to the high content of SFA in vanaspati and low content in PB. Total MUFA was 41.8% in $T_3$ where 50% vanaspati and 50% PB were used as raw materials to prepare biscuits. Highest MUFA (44.7%) was in $T_5$ biscuits. Total PUFA was highest in $T_5$ (31.2%) where 100% vanaspati was substituted by PB (Table 2). This was probably due to the high content of PUFA (30.4%) in PB, which was 100% used to prepare $T_5$ biscuits instead of vanaspati. The nutritional quality index (as ratio of linoleic acid to total SFA) of $T_3$ type biscuits was 0.32 against 0.19 in control

**Table 1** Fatty acid composition (%) of raw materials

| Fatty acid (% distribution) | Vanaspati | Peanut butter | *Maida* | S Em | CD | CV % |
|---|---|---|---|---|---|---|
| **SFA** | | | | | | |
| Myristic acid, $C_{14:0}$ | 0.77 | - | - | - | - | - |
| Palmitic acid, $C_{16:0}$ | 31.8 | 11.6 | 10.1 | 0.49 | 1.59 | 5.34 |
| Stearic acid, $C_{18:0}$ | 6.74 | 2.90 | 4.25 | 0.23 | 0.75 | 9.40 |
| Arachidic acid, $C_{20:0}$ | 0.61 | 1.00 | - | 0.07 | 0.24 | 10.5 |
| Behenic acid, $C_{22:0}$ | 0.16 | 3.96 | - | 0.05 | 0.18 | 4.96 |
| **MUFA** | | | | | | |
| Oleic acid, $C_{18:1}$ | 36.2 | 48.1 | 31.7 | 0.37 | 1.20 | 2.12 |
| Eicosenoic acid, $C_{20:1}$ | 0.36 | 0.85 | - | 0.02 | 0.08 | 7.14 |
| **PUFA** | | | | | | |
| Linoleic acid, $C_{18:2}$ | 20.8 | 30.4 | 42.1 | 0.60 | 1.92 | 3.61 |
| Linolenic acid, $C_{18:3}$ | 0.48 | - | 2.93 | 0.16 | 0.55 | 18.3 |
| Arachidonic acid, $C_{20:4}$ | 0.39 | - | - | - | - | - |
| **Others** | 1.69 | 1.19 | 8.92 | 0.73 | 2.34 | 6.43 |

SFA: Saturated fatty acids, MUFA: Monounsaturated fatty acids, PUFA : Polyunsaturated fatty acids, CD: CD at 5%. n = 4

**Table 2** Influence of peanut butter (PB) on the fatty acid composition (%) of biscuits

| Fatty acid (% distribution) | Treatments | | | | | S Em | CD | CV% |
|---|---|---|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ | | | |
| **SFA** | | | | | | | | |
| Myristic acid, $C_{14:0}$ | 0.98 | 0.83 | 0.51 | 0.32 | - | 0.03 | 0.08 | 10.3 |
| Palmitic acid, $C_{16:0}$ | 40.3 | 35.6 | 32.3 | 22.8 | 16.8 | 0.62 | 1.88 | 3.88 |
| Stearic acid, $C_{18:0}$ | 7.28 | 6.20 | 5.06 | 4.32 | 4.18 | 0.23 | 0.69 | 8.50 |
| Arachidic acid, $C_{20:0}$ | 0.60 | 1.22 | 1.26 | 1.58 | 2.09 | 0.06 | 0.19 | 9.56 |
| Behenic acid, $C_{22:0}$ | 0.11 | 1.40 | 1.57 | 2.52 | 3.46 | 0.04 | 0.13 | 4.58 |
| Total | 49.3 | 45.2 | 40.7 | 31.6 | 26.5 | | | |
| **MUFA** | | | | | | | | |
| Oleic acid, $C_{18:1}$ | 35.8 | 40.3 | 41.2 | 42.5 | 43.9 | 0.91 | 2.74 | 4.36 |
| Eicosenoic acid, $C_{20:1}$ | 0.28 | 0.37 | 0.56 | 0.72 | 0.84 | 0.02 | 0.07 | 8.88 |
| Total | 36.1 | 40.7 | 41.8 | 43.2 | 44.7 | | | |
| **PUFA** | | | | | | | | |
| Linoleic acid, $C_{18:2}$ | 9.67 | 11.2 | 13.2 | 24.4 | 31.2 | 0.65 | 1.97 | 9.03 |
| Arachidonic acid, $C_{20:4}$ | 0.45 | 0.35 | 0.24 | 0.12 | - | 0.03 | 0.10 | 8.10 |
| Total | 10.1 | 11.6 | 13.4 | 24.5 | 31.2 | | | |
| **Others** | 4.53 | 2.55 | 1.40 | 0.72 | 0.23 | 1.08 | 3.26 | 10.7 |

SFA, MUFA, PUFA: See Table 1. $T_1$ = Control, V 100 : PB 0; $T_2$ = V 75 : PB 25; $T_3$ = V 50 : PB 50; $T_4$ = V 25 : PB 75; $T_5$ = V 0 : PB 100; V = vanaspati; PB = Peanut butter; n = 4, CD: CD at 5%. n=4

biscuits.The major fatty acids in the Turkish biscuit samples were palmitic, stearic, oleic and linoleic acids (Daglioglu *et al*. 2000) which support the present investigation.

Peanut butter supplemented biscuits contained beneficial MUFA and PUFA. These fatty acids have been shown to lower blood cholesterol level and thereby reduced risk of coronary heart diseases (Arlington 2002). Besides, it also contained many other heart healthy nutrients such as protein, vitamin E, folic acid, soluble fiber, arginine, plant sterols, copper, zinc, selenium and magnesium (Albany 2003). Diet with PB reduced risk of heart disease by 21% while low fat diet reduced it by 12% (Albany 2002). Kris-etherton et al. (1999) also found that PB diets had high MUFA which lowered total cholesterol level by 10% and LDL cholesterol by 14%.

*Biscuit hardness:* The hardness of biscuits increased upon substitution of PB for vanaspati (Fig. 1). This could be due to reduction in total fat in the biscuits with gradual

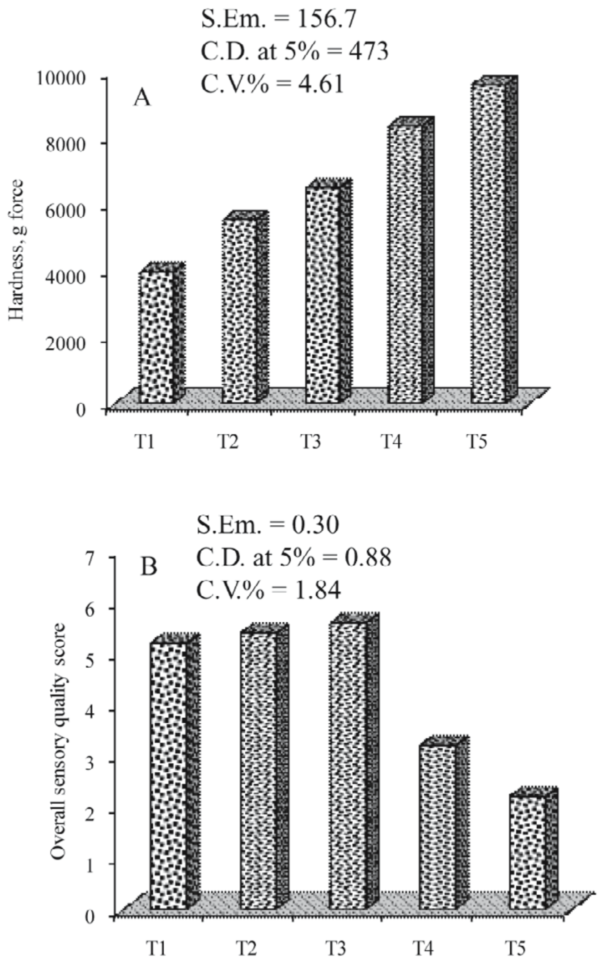


**Fig. 1** Influence of treatments peanut butter on hardness (A) and overall all sensory (B) quality of biscuits (n = 4). $T_1$–$T_5$ = As in Table 2

increasing proportion of PB. Similar pattern of increasing the cutting hardness was found by Gandhi et al. (2001) where wheat flour up to 40% was replaced with defatted soy flour in sweet biscuits. Texture was found harder in cookies by Ory and Conkerton (1983) when 10, 15 and 50% wheat flour were replaced by defatted white skin peanuts. Swanson et al. (1999) reported that carbohydrate based fat substitute- *oatrim* replaced 75 and 100% of the butter in PB cookies increased water activity, colour and reduced cookie spread and decreased hardness. They also reported that use of 0.1% sodium stearoyl lactylate moderated the brittleness but resulted in a hard cookie.

*Sensory acceptability:* Overall sensory quality expressed improved upon addition of 50% PB in place of vanaspati ($T_3$) (Fig. 1). However, biscuit with 100% PB was found soggy with irregular puffing. Spread ratio was not affected up to 50% replacement of vanaspati with PB but decreased when 75 and 100% PB was incorporated (Gajera et al. 2008). However, Weight of biscuit increased with increasing proportion of PB. Adair et al. (2001) reported that product acceptability was declined when fat was substituted by more than 50% with mung bean paste. Shrestha et al. (2002) found greater acceptance of kinema- supplemented (which was prepared from natural fermentation of soybean) biscuits in comparison with full-fat soyabean flour supplemented biscuits.

## Conclusion

Vanaspati (50%) and PB (50%) in the standard biscuits recipe are optimum for preparing biscuits which have better fatty acid composition with balanced oil quality. Such biscuits have higher oleic acid (41.2%, MUFA) and linoleic acid (13.2%, essential fatty acids, PUFA), with higher (3.12) oil stability index (as ratio of oleic acid to linoleic acid). The hardness of biscuits increased with increasing proportion of PB. Biscuit with 50% vanaspati and 50% PB had greater sensory acceptability. Further addition of PB showed detrimental effect on sensory characteristics.

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