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ORIGINAL ARTICLE

Preparation and quality evaluation of peanut *chikki* incorporated with flaxseeds

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Abstract In an attempt to achieve correct ratio of n-3 to n-6 fatty acids for health benefits, flaxseeds (*Linum usitatissimum*), a good source of n-3 fatty acids, were incorporated with optimized 20% replacement of peanuts in the formulation for the preparation of *chikki*. Tertiarybutylhydroquinone (TBHQ) at 200 ppm level used as an antioxidant. Results showed that there were no differences in texture or sensory quality among the samples with and without addition of antioxidant. The peroxide value of oil in *chikki* increased gradually at 37 °C on storage. At the end of 60 days at 37 °C, rancidity developed in samples without antioxidant but not in that with added antioxidant. Thus, TBHQ increased the shelf-life of the product. Addition of flaxseeds to *chikki* increased PUFA content, especially n-3 fatty acids, up to 9%, which were not present in *chikki* prepared only with peanuts. Thus the ratio of 18:2 to 18:3 increased with addition of flaxseed, which has significant health benefits.

Keywords *Chikki* · Flaxseeds · Omega 3 fatty acids · Rancidity

Introduction

India with divergent food habits is having a number of traditional foods, including sweet products. *Chikki* is one of the popular Indian traditional sweet snack. *Chikki* is mainly prepared using jaggery as sweetener and roasted peanuts (*Arachis hypogaea*). Sweets or confections with jaggery are gaining popularity due to the awareness of its health benefits. Jaggery is obtained by concentrating sugar cane juice to solid or semi solid state. It is a natural sweetener having a sweet winy flavour (Shahi 1999) and contains protein, minerals and vitamins and is a potent source of iron and copper (Manay and Swamy 2001). There are several different varieties of *chikki* in addition to the most common peanut *chikki*. Usually ingredients such as puffed Bengal gram, sesame, puffed rice, beaten rice and copra (desiccated coconut) are used and some *chikkis* are made using a combination of these ingredients. Special *chikkis* are made out of cashew nuts, almonds and pistachio.

It has been reported that *chikki* prepared with added sodium bicarbonate were lighter, more yellow than other products (McKee et al. 2003). Process of making *chikki* with added soda was patented (Shelesky and Anderson 2000). Peanut *chikki,* peanut and sesame seed *chikki* and peanuts and spices mixed with Bengal gram meal were developed and evaluated for sensory and nutritional properties with regard to their use as nutritional supplements for school children (Chahal and Sehgal 1996). Since the product is popular among all sections of population in the country, an attempt was made to further enrich with nutraceuticals by incorporating flax seeds. Flax seed (*Linum usitatissimum*) is one of the richest sources of n-3 fatty acids, mainly consisting of alpha linolenic acid in addition to 18:2 (linoleic acid). Unlike fish oil, flaxseed provides one of the non-animal sources of n-3 making it ideal for vegetarians. Flax seed contains approximately 40% oil, 30% dietary fiber, 20% protein, 6% moisture and 4% ash (Oomah and Mazza 1998, Bathena Ali et al. 2003). In the present work flaxseeds

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were incorporated in *chikki* formulation to increase the essential fatty acids and the effect of incorporation of flax seeds on physico-chemical properties of *chikki* was studied.

Material and methods

Peanuts (*Arachis hypogaea*), linseed/flaxseeds (*Linum usitatissimum*) and jaggery were procured from local market. Peanut seeds were roasted to golden brown colour (120–130°C), dehusked, de-germed and crushed into small bits of about 2.8 mm. Flaxseeds were roasted at 120°C, coarsely ground in a domestic mixer, sieved through 850 micron mesh size to remove husk.

Preparation of chikki Chikki control (A) was prepared by taking jaggery and peanuts in equal proportions. Jaggery was crushed and made into syrup with addition of water and warming and filtered through a nylon mesh of ~ 30 mesh to remove extraneous matter. The clear jaggery syrup was heated until the temperature reached 145 °C and immediately pre-weighed, roasted and dehusked peanuts were added and mixed thoroughly till the nuts get coated with jaggery syrup. Hot mass was then transferred on to a wooden board or clean platform, which was smeared with oil. The product was then spread uniformly by rolling it with the help of a roller. Vertical and horizontal lines were marked with a cutter to make individual slabs then cooled to room temperature (27 ± 2 °C) and were packed in polythene pouches.

Preparation of chikki with flaxseeds Toasted and sieved flaxseeds were added at 20% level replacing peanuts in *chikki* formulation (B). Replacement of 20% was found to be optimum based on sensory evaluation and was chosen for further studies. The antioxidant TBHQ at 200 ppm (on the basis of total fat content) was added to formulation (B) and labeled as formulation (C).

Moisture estimation Moisture was estimated by oven method (AOCS 1995).

Texture The breaking strength or snap of *chikki* was measured using Universal Texture Measuring system (Model LR-5K, Lloyds, UK). The uniform size 7 × 3 × 1 cm of *chikki* was taken and 3-point bending/breaking test was performed using a load cell of 100 N with 6 replicates with a cross head speed of 50 mm/min. The force required to break the *chikki* into 2 pieces was recorded as the breaking strength (snap) and expressed in Newton (N).

Instrumental colour measurements The colour was measured using CIELAB measuring system (model Lab scan, USA). Colour was determined using the 10°/D 65 setting and expressed according to Commission Internationale de L'Eclairaige (CIE) system and reported as L*, (lightness), a* (redness) and b* (yellowness) (Wiegand and Waloszek 2003). ΔE represents the total colour difference of the samples.

Fatty acid composition The fatty acid composition of oil in *chikki* was determined by extracting the oil from C*hikki* with chloroform and converting into fatty acid methyl esters (FAME) using 14% boron triflouride/methanol as per AOCS (1995) method. The FAME were analyzed by GC-15A (M/s Shimadza Corporation Kyoto, Japan) equipped with flame ionization detector operating under the following conditions: Column, 2.4 m × 0.3 cm S-S packed with 15% DEGS; column temperature 180 °C. Injection temperature 220 °C, detector temperature 230 °C and carrier gas nitrogen at 15 ml/min. The peaks were identified by comparing retention time with those of authentic standards and represented as relative %.

Peroxide value Oil from C*hikki* was extracted with chloroform, the solvent was removed under vacuum and peroxide value (PV) was determined as per AOCS (1995) procedure.

Sensory evaluation The desirable characteristics of *chikki* were evaluated sensorily by a panel of 12 judges using a 10-point linear rating scale ranging from 0 (Lowest intensity on left) to 10 (Highest intensity on right end) (Amerine et al. 1965). The judges were asked to perceive the attributes such as colour, snap, hardness, crunchiness, chewiness, sweetness, peanut flavour, rancidity, off taste and overall quality and to mark on scale. *Chikki* samples with code number were served one at a time for evaluation. Sensory evaluation was carried out for freshly prepared *Chikki* products and those stored for 30 days at 37 ± 2 °C.

Storage studies C*hikki* (100 g) were packed in 150 guage polypropylene pouches and kept at accelerated (37 °C) and at ambient (27 °C) temperatures. The stability of the products was evaluated by texture, peroxide value and sensory quality. Storage studies were carried out for 90 days.

Statistical analysis All analyses were carried out in triplicate. Duncan's Multiple Range Test was applied to differentiate among the means of different samples ($p \leq 0.05$) (Harter 1960).

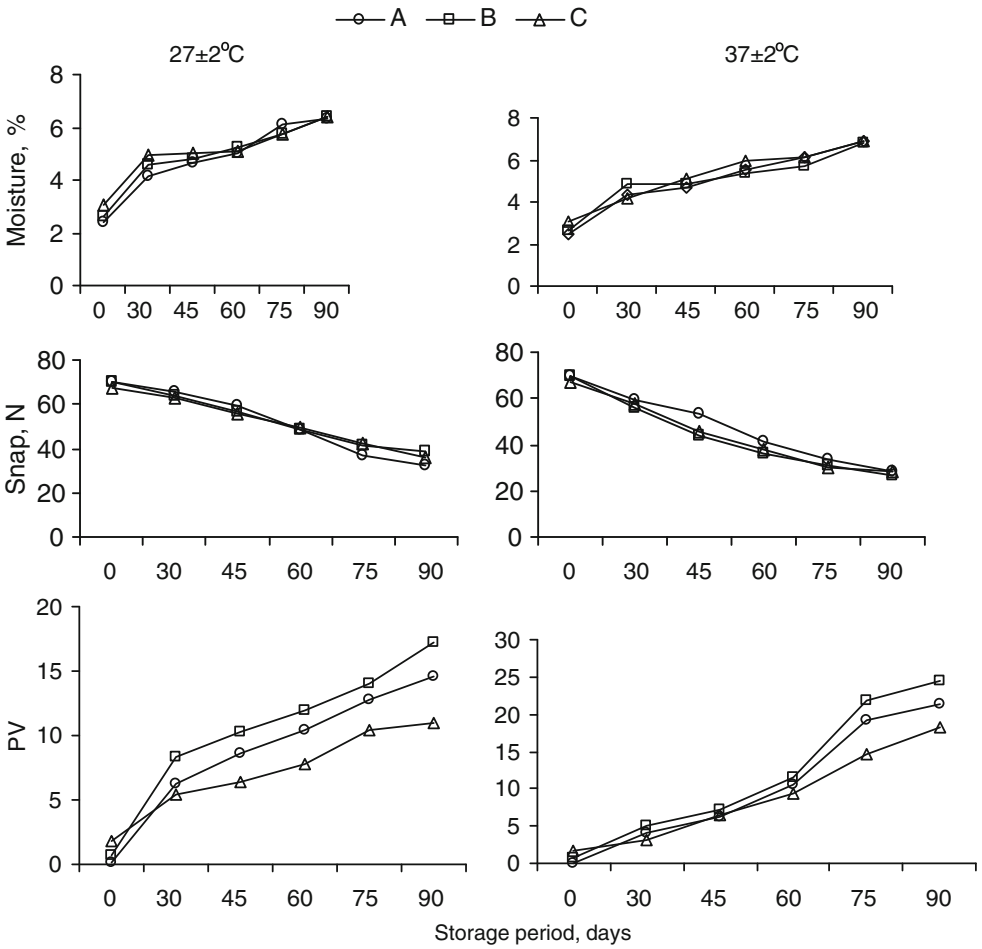
Results and discussion

Moisture Moisture of *chikki* is very critical as it determines the quality and stability of the product. All the products had a moisture content of 2.4 to 3% (Fig. 1). No significant differences were observed between control c*hikki* (A) and *chikki* with added flaxseeds (A and C) with respect to moisture. The moisture content of *Chikki* samples gradually increased in all the samples during storage. Crisp texture was observed up to 45 days under accelerated conditions and up to 60 days under ambient conditions, after which the *Chikkis* lost their crisp and crunchy texture. Moisture content of 5.5% rendered the product soft and at moisture content of >5.5%, *Chikki* became soggy and lost its characteristic crunchy texture.

Texture (Snap) Chikki had a characteristic or desirable crunchy texture and was brittle on the first bite. The snap of C*hikki*, which ranged from 68.5 to 71.5 N initially decreased gradually during storage (Fig. 1). This could be due to the absorption of moisture in all the samples at ambient and accelerated conditions. Addition of flaxseeds did not affect the texture of *Chikki*.

Peroxide value Adding flaxseeds to improve the PUFA content made the C*hikki* prone to rancidity, as revealed by higher PV compared to those of control as expected (Fig. 1). However, addition of antioxidant improved oxidative stability especially of C*hikki* with flaxseeds as shown by lower peroxide values (Fig. 1) both at ambient and accelerated conditions. *Chikki* with flaxseed and antioxidant (C) showed PV similar to those of control (A). Beyond 60 days of storage at accelerated conditions, a rancid odour was prominent due to higher PV.

Colour The results (Table 1) showed that L*, which represents the lightness or brightness of the C*hikki,* decreased significantly with addition of flaxseeds, indicat-



PV: peroxide Value, meqO_2 / kg fat
A, B, C: As in Table 1.

Fig. 1 Changes in moisture, texture and peroxide values of *chikki* during storage

Table 1 Hunter color and fatty acid composition of fresh *Chikki* products

	A	B	C
Hunter color			
L*	59.4 ± 2.62^{c}	49.1 ± 2.31^{b}	45.6 ± 2.18^{a}
a*	11.1 ± 2.18^{b}	9.3 ± 2.67^{a}	8.2 ± 2.01^{a}
b*	38.8 ± 1.83^{d}	28.8 ± 1.87^{b}	25.5 ± 2.13^{a}
Δ E*	52.0 ± 0.63^{a}	53.9 ± 0.93^{ab}	54.5 ± 1.13^{ab}
Fatty acids,%			
16:0	14.0^{c}	11.9^{a}	13.9^{b}
18:0	4.2^{a}	4.5^{a}	5.8^{b}
18:1	44.6^{b}	41.7^{a}	40.7^{a}
18:2	29.2^{c}	27.8^{c}	26.0^{c}
18:3	0.7^{b}	8.85^{b}	9.2^{a}
22:0	3.1^{c}	3.0^{b}	2.6^{a}
24:0	1.3^{b}	1.4^{b}	0.9^{a}

Values in the same row with different superscripts differ significantly ($p < 0.05$)

A = Control *chikki* with 100% peanuts; B = *chikki* with 20% flax seeds; C = *chikki* with 20% flax seeds + antioxidant

ing that control samples were lighter in colour compared to others. Addition of 20% flaxseeds showed significant difference in a* and b* values compared to those of control *Chikki*.

Sensory quality of chikki with flaxseeds Addition of flaxseeds showed an increase in the colour scores of the products (Table 2), which was also observed in the instrumental colour values (Table 1). Snap values showed no significant difference with increasing levels of flaxseeds. The hardness of the product decreased thereby increasing the chewiness of C*hikki*. Addition of flaxseeds did not show any significant difference in peanut flavor. Addition of antioxidant did not significant by affect the overall acceptability of C*hikki.*

Sensory scores of all desirable attributes decreased slightly at both ambient and accelerated conditions at the end of 30 days when compared to the initial values (Table 2) but were still acceptable. Slight off taste and rancidity was evident in C*hikki* without added antioxidant at the end of 30 days of storage at accelerated temperature, compared to that with antioxidant thus increasing the shelf life of the product.

Fatty acid composition of Chikki with added flaxseed n-3 fatty acids were present to the extent of about 9% in chikki with added flax seeds, whereas they were traces in the control C*hikki* prepared with peanuts alone (Table 1). No difference in fatty acid composition was observed on storage (data not shown). Thus the nutraceutical quality of *Chikki* was improved by increasing the n-3 fatty acid content with addition of flaxseeds.

Conclusion

Chikki, a popular sweet snack, was chosen as a vehicle for enrichment with nutraceuticals. Flaxseeds rich in n-3 fatty acids were added at 20% levels replacing peanuts in *Chikki* formulation. Addition of flaxseed did not show any differences on the textural qualities. Peroxide values increased on storage, addition of antioxidant was advantageous in increasing the shelf life of the product up to 90 days. There was an increase in PUFA content especially 18:3 in C*hikki*

Table 2 Sensory quality of *chikki* with added flaxseeds stored for 30 days at 27 °C and 37 °C

Sample	Colour	Snap	Hardness	Crunchy	Chewiness	Sweetness	Mouthfeel	Peanut flavour	Rancidity	Off-taste	OQ
Initial											
A	5.2^{a}	7.5^{a}	7.7^{b}	6.7^{b}	4.1^{b}	6.0^{a}	7.6^{c}	7.3^{b}	–	–	8.8^{b}
B	7.4^{b}	7.4^{a}	6.9^{a}	6.3^{a}	5.3^{a}	6.3^{b}	6.4^{a}	5.8^{a}	–	–	7.1^{a}
C	7.5^{b}	7.5^{a}	7.0^{a}	6.4^{a}	5.3^{a}	6.1^{a}	6.8^{b}	6.3^{ab}	–	–	7.6^{a}
At 27 °C, 30 days											
A	5.2^{a}	6.8^{a}	7.0^{b}	5.8^{b}	3.6^{b}	6.0^{a}	6.8^{c}	7.2^{b}	1.0^{a}	–	8.2^{b}
B	7.1^{b}	6.6^{a}	6.6^{a}	5.3^{a}	4.3^{a}	6.0^{b}	6.3^{a}	6.8^{a}	1.0^{a}	–	6.7^{a}
C	7.3^{b}	6.5^{a}	6.6^{a}	5.2^{a}	4.3^{a}	6.1^{a}	6.3^{b}	6.6a^{b}	–	–	6.9^{a}
At 37 °C, 30 days											
A	5.0^{a}	7.0^{b}	7.0^{b}	6.6^{b}	4.0^{b}	6.0^{b}	6.0^{a}	7.0^{b}	2.0^{a}	–	8.0^{b}
B	7.0^{b}	6.7^{a}	6.3^{a}	5.3^{a}	6.2^{a}	6.3^{a}	6.4^{b}	6.2^{a}	3.0^{b}	2.5^{a}	6.0^{a}
C	6.2^{b}	6.8^{a}	6.5^{a}	5.5^{a}	6.5^{a}	6.4^{a}	6.2^{a}	6.1^{a}	1.0^{a}	4.2^{b}	6.3^{a}

A, B, C: As in Table 1. OQ: Overall quality ($n = 12$ panelists), 10 – Point linear scale

Values in the same row with different superscripts differ significantly ($p < 0.05$)

with addition of flax seed. Flaxseeds imparted a slight darkening to the product and the product was comparable in all quality attributes with control C*hikki*, containing only peanuts.

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References

Amerine AM, Pangborn RM, Roessler BE (1965) Principles of sensory evaluation of food. Academic, New York, pp 356–358

AOCS (1995) Official methods and recommended practice, 16th edn. American Oil Chemists Society, Washington DC

Bathena Ali AA, Haudenschild P, Latham Ranien T, Mohammed AF (2003) Dietary flaxseed meal is more protective than soya protein concentrate against hyper triglyceridemia and steatosis of liver. J Am Coll Nutr 22:157–164

Chahal S, Sehgal S (1996) Development, acceptability and nutritional evaluation of home made supplements for school children. Nahrung 40(6):345–347

Harter HL (1960) Critical values for Duncan's New Multiple range test. Biometrics 16:671–678

Manay N, Swamy S (2001) In: Food facts and principles 2nd edn, New Age International Pvt. Ltd, pp 410–424

McKee LH, Christopher J, Remmenga M (2003) Sensory and physical properties of peanut brittle prepared in different types of cookware and with different levels of sodium bicarbonate. Plant Foods Hum Nutr 58:165–177

Oomah BD, Mazza G (1998) Compositional changes during commercial processing of flaxseeds. Ind Crop Prod 9:29–37

Shahi HN (1999) Sustainability of jaggery and khandasari industry in India, Souvenir. Proc- National Seminar on Status problems and prospects of jaggery and Khandasari industry, Lucknow, Dec 2–3, pp 15–20

Shelesky ST, Anderson LS (2000) Process of making nut brittle. US Patent 6 074 684

Wiegand C, Waloszek G (2003) Color glossary A-C. http://www.sapdesignguitd.org/resources/glossary-color/index1.html (Accessed on 18 Aug 2010)