Physico-Chemical Properties of Biscuits Influenced by Different Ratios of Hydrogenated Fat (vanaspati) and Peanut Butter

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Biscuits prepared with different ratios of hydrogenated fat (vanaspati) and peanut (Arachis hypogaea L.) butter (PB) i.e. (50:00, 40:10, 30:20, 25:25) were evaluated for their physico-chemical properties. Diameter was maximum in biscuits (100% vanaspati), which decreased with increasing proportion of PB. Fat content showed a decreasing trend upon increasing proportion of PB and was lowest in biscuits (50% PB). Overall sensory parameters of biscuits improved when 50% vanaspati replaced by PB in the standard biscuits recipe. Biscuits prepared with 50% incorporation of PB had better physico-chemical properties and also a greater overall acceptability.

Keywords: Biscuit, Vanaspati, peanut butter ratios, Sensory evaluation.

Introduction

The term biscuit was derived from the Latin word biscocutus, meaning twice cooked (Macrace et al., 1993). Biscuits are popular foodstuff, consumed by a large number of people today, due to their pleasant taste, prolonged shelf life and easy availability at fairly low cost (Gandhi et al., 2001). Fat is necessary part of diet and it imparts flavor, texture and appearance of the baked product (Pyler, 1988). On the other hand, excess intake of fat in diet may lead to higher risk of diseases like obesity, coronary heart disease and cancer (Akoh, 1998). As biscuits generally have higher fat content, it becomes difficult to prepare biscuits by reducing fat contents in their formulation to lower the risk of such diseases. To reduce the quantity of fat in bakery products fat replacers like peanut butter are used (Sanchez et al., 1995). Peanut is an important legume which has attracted researchers in recent times (Azeket et al., 2005), food having peanut are highly accepted by consumers because of their divine flavour. Peanut butter is a dispersion of peanut oil in peanut solids which results, when roasted peanuts are ground. Peanut butter is a good source of protein and fiber, and low in fat. It is continually applied for the preparation of low calorie improved food products (Woodroof, 1983). The confectionery
formulations contain hydrogenated fat (vanaspati), which lowers the nutritional value due to presence of large amount of saturated fatty acids (SFA). The biscuits can be used as a source of desirable and essential fatty acid supplementation by utilizing part of peanut butter in place of vanaspati (Gajera et al., 2010). Keeping in view all the above facts this research was designed to study the effect of incorporation of peanut butter on physico-chemical and sensory properties of biscuits.

Materials and Methods

Materials

Refined wheat flour, sugar, hydrogenated fat (vanaspati), peanut (Arachis hypogaea L.) butter (PB), eggs and baking powder were procured from local market of Allahabad and experiment was conducted in the Department of Food Process Engineering, Vaugh Institute of Agricultural Engineering and Technology (SHUATS), Allahabad (Uttar Pradesh) India.

Biscuits preparation

The biscuits were prepared as per standard recipe (AACC, 2000) the process flow chart of biscuits is given below: The treatment plan used in the preparation of biscuits is given in Table 1.

Methods

Physical analysis

The diameter and thickness were measured using Vernier caliper at two and four different places, respectively in each biscuit and the average value was calculated. The average of 6 biscuits was recorded for each batch. Spread ratio was calculated by dividing the average value of diameter by average value of thickness of biscuits according to AACC (2000).

Chemical analysis

The proximate analysis i.e. moisture, crude fat and ash contents of biscuits were determined as per (AACC, 2000).

Moisture content of biscuits was measured by the hot air oven (Scientronic Instruments, New Delhi) method. 5gm of the sample which has been thoroughly grounded and uniformly mixed was weighed in the dry dish.

After removing the lid of the dish it was heated in an oven at 130°C for 2 hour. After 2 hours the dish was removed from desiccator and allowed to cool and weighed. Again the dish was kept in the oven for another 1 hour and was cooled and weighed again. The process was repeated until change in weight between two successive observations could not exceed 1 mg. The difference in weights was determined for the determination of the moisture per cent by using following formula:

\[
\text{Moisture } \% = \frac{W_1 - W_2}{W} \times 100
\]

Where,

\[
W_1 = \text{Weight in gm of the dish with the material before drying,}
\]

\[
W_2 = \text{Weight in gm of the dish with the material after drying and}
\]

\[
W = \text{Weight in gm of the empty dish}
\]

The crude fat is extracted by using Soxhlet apparatus (EIE Instruments Pvt. Ltd., Ahmedabad). The fat was calculated by the following formula:
\[(\text{Weight of flask + oil}) - (\text{Weight of flask}) \times 100\]
\[\% \text{ Fat} = \frac{\text{Weight}}{\text{of sample}}\]

The ash content was measured using muffle furnace. 5gm of the ground sample was weighed into a silica dish. The material was kept at 550°C for 4 hours in a muffle furnace (Meta Instruments, Mumbai). The dish was cooled and weighed. The process was repeated till constant weight was obtained. The total ash content was calculated by difference in weights and was expressed as percent.

\[\text{Weight of ash} \times 100\]
\[\% \text{ Ash} = \frac{\text{Weight of the sample}}{\text{}}\]

**Sensory evaluation**

The samples were subjected to sensory evaluation to determine consumer preferences for colour, taste, aroma, flavour and overall acceptability (OAA) by the method described by (Rangana, 2008). A panel of 9 judges was involved in the sensory evaluation exercise. The samples were offered in coded in identical transparent polyethylene bags and were tested individually.

The order of presentation of samples was completely randomized. The panelists rinsed their mouth thoroughly with water after testing each sample and waited for a minute before proceeding to test the next sample. The sensory evaluation was based on a 9-point hedonic scale, where (9) represented “like very much” and (1) is “disliked very much”.

**Statistical analysis**

The analytical data of samples with equal number of replications (nos.3) for individual parameters were subjected to analysis of variance of completely randomised design (CRD) following the procedure described by (IASRI, 2011).

**Results and Discussion**

**Effect of peanut butter incorporation on physical properties of biscuits**

Significant \(P \leq 0.05\) variations were recorded among biscuits prepared with different ratios of *vanaspati* and peanut butter with respect to diameter and thickness.

The minimum diameter and maximum thickness were recorded in treatment \(T_3\) (25:25) in which 50% quantity of *vanaspati* was replaced by PB (Table 2). These changes in diameter and thickness are reflected in their spread ratio which decreased for increasing levels of PB. Spread ratio is considered most important quality parameter of biscuits as it correlates with texture and overall mouth feel of the biscuits (Bose *et al.*, 2010). Two main factors affect the spread ratio: expansion of dough by leavening and gravitational flow as the thickness of the biscuits prepared with PB were higher than prepared with 100% *vanaspati* \(T_0\) biscuits. Therefore the reduced spread-ratios of PB biscuits can be attributed to PB containing more water absorbing constituents like protein and fibre. Several reports (Patel *et al.*, 1996; Hooda *et al.*, 2005) showed that reduced spread ratio was observed when wheat flour was substituted by high protein and /high fibre ingredients. These constituents form aggregates with available hydrophilic sites thus reducing free water in biscuit dough (McWatters, 1978). Rapid partitioning of free water of these hydrophilic sites occurs during dough mixing and increases dough viscosity, thereby limiting biscuit spread. A reduced spread ratio seen in PB biscuits increases their suitability for rotary mould preparation in which a lower spread is desirable to keep the embossing intact (Hooda *et al.*, 2005).
Effect of peanut butter incorporation on chemical properties of biscuits

Fat content

Fat content was higher (21.10%) in treatment $T_0$ (50: 00) which gradually decreased with increasing proportion of PB, which was statistically different ($P < 0.05$) from other treatments (Table 3). The lowest fat content (16.20%) was recorded in treatment $T_3$.

This was due to the high content of SFA in vanaspati and low content in PB. These findings are in accordance with the findings of (Wekwete et al., 2009), who observed that peanut butter, had lower fat content than hydrogenated vegetable shortening. Hence, with increasing levels of peanut butter as a substitute for hydrogenated vegetable shortening the fat content of biscuit decreased, which is good for health. There was a significant negative correlation between PB and fat content (Fig. 1). The fat content decreased by 0.18 per cent with unit increase in PB. At 25 gm of PB, the fat content was minimum, which could be considered as the optimum level of PB for biscuit making.

Moisture and ash content

There was a change in moisture and ash content in biscuits with the incorporation of peanut butter (Table 3). The highest moisture and ash content (3.30 and 2.41% respectively) were recorded in treatment $T_1$, which was statistically different with all the other treatments and showed a decreased trend among the treatments, but, on an average the content of both was higher than the control treatment $T_0$. The increase in moisture content might be attributed to higher amount of fiber in peanut butter and fiber has strong affinity for water and products containing fiber. (Yadav et al., 2012) also reported that with the addition of partially de-oiled peanut meal flour ash content of biscuits increased slightly.

Table 1 Treatment plan: Hydrogenated fat (vanaspati) to peanut butter ratios in standard recipe of biscuits

| Treatment | Hydrogenated fat (vanaspati): peanut butter ratios |
|-----------|---------------------------------------------------|
| $T_0$     | 50: 00 (100% Vanaspati)                           |
| $T_1$     | 40: 10                                            |
| $T_2$     | 30: 20                                            |
| $T_3$     | 25: 25                                            |

Table 2 Effect of hydrogenated fat (vanaspati) substitution with peanut butter on physical characteristics of biscuits

| Treatment | Diameter (cm) | Thickness (cm) | Spread ratio |
|-----------|---------------|----------------|--------------|
| $T_0$     | 4.51a         | 0.71a          | 6.35a        |
| $T_1$     | 4.01b         | 0.72a          | 5.56b        |
| $T_2$     | 4.02b         | 0.71a          | 5.66b        |
| $T_3$     | 3.53c         | 0.90a          | 3.92c        |
| CV (%)    | 10.05         | 12.29          | 19.17        |
Table 3: Effect of hydrogenated fat (vanaspati) substitution with peanut butter on chemical characteristics of biscuits

| Treatment | Fat content (%) | Moisture content (%) | Ash content (%) |
|-----------|----------------|----------------------|-----------------|
| T₀        | 21.10a         | 3.12ab               | 1.82d           |
| T₁        | 18.50b         | 3.30a                | 2.41a           |
| T₂        | 17.36c         | 2.94c                | 2.21b           |
| T₃        | 16.20d         | 2.80d                | 1.89c           |
| CV (%)    | 2.98           | 6.18                 | 11.50           |

Biscuits preparation

Mixing the peanut butter, hydrogenated fat and sugar

Blending of wheat flour and baking powder
(At slow speed for 12 minutes and mixed with other ingredients at high speed for 20 minutes)

Dough formed into a sheet

Cut the dough into small size pieces of required size
(Round shaped)

Place in baking tray (1 cm apart)

Press gently

Baked for 10 to 15 minutes at 180°C

Cooling

Packing (LDPE)

Fig.1: Relationship between peanut butter and fat content

\[ Y = 20.85 - 0.18X, \quad r = -0.986 \]
Fig. 2 Effect of hydrogenated fat (vanaspati) substitution with peanut butter on sensory parameters

![Sensory score chart with color, taste, aroma, flavour, and OAA as parameters.]

**Effect of peanut butter incorporation on organoleptic characteristics of biscuits**

Significant (P ≤ 0.05) variations were found among biscuits prepared with different ratios of vanaspati and peanut butter with respect to their color, taste, aroma, flavour and overall acceptability (Fig. 2).

**Color**

The results showed that the biscuits became darker with incorporation of peanut butter. Highest score (8.3) was recorded for T₃ among the treatments. Lowest score (6.70) was recorded in T₁ where 80% vanaspati and 20% peanut butter were used as raw materials to prepare biscuits. The reason of darker color of the biscuits might be due to high level of protein present in the peanut butter. The colour development is contributed by the maillard reaction *i.e.* reaction between sugars and proteins of product that results in brown colour (Singh *et al.*, 1993). Other factors that may be responsible for colour development are time and temperature of baking, composition, humidity in oven *etc.* (Lingnert, 1990) and (Wade, 1988).

**Flavour and aroma**

Flavour and aroma of biscuits progressively increased with increasing levels of peanut butter (Fig. 2). The highest score was recorded for T₃, while lowest score was recorded for treatment T₁. Similar results were observed by (Yadav *et al.*, 2012) who found that the typical peanut flavour and aroma was highly acceptable by the panel members.

**Over All Acceptability (OAA)**

Biscuits’ acceptability was in acceptable range (Fig. 2) with maximum score of (8.40) for biscuits prepared with 50% PB in place of hydrogenated fat (vanaspati) T₃ while minimum score (7.00) for biscuits prepared with 40% PB in place of vanaspati (T₂).

(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.

It is concluded that biscuits prepared with the incorporation of PB to reduce the quantity of vanaspati had shown maximum overall acceptability, this substitution of PB for vanaspati of the biscuits also decreased spread ratio and fat content. The most acceptable formulation was vanaspati: peanut butter (25:25). PB also imparted better taste, aroma and flavour to biscuits.

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