USE OF PALM OIL AND BUTTERFAT AS SHORTENINGS FOR SHORT-DOUGH BISCUITS: SENSORY AND INSTRUMENTAL ANALYSIS

Keywords: Palm oil, Butterfat, Shortenings, Biscuits, Texture, Flavour

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The purpose of this study was to evaluate the quality of short-dough biscuits made with shortenings based on palm oil and butterfat. A commercial biscuit sample was included in the study for comparison. Evaluations were carried out using a panel of judges, and attempts were made to relate panel evaluation with instrumental measurements on texture. Hedonic Rating, Texture Profiling, Flavour Profiling and Quantitative Descriptive Analysis were the sensory methods used, while the J.J. Lloyd Texture Testing Machine Model T5K was the instrument used for measurements of breaking strength. Differences in texture between experimental and commercial biscuit samples could be detected by the trained panels ($p < 0.05$). The amount of force required to break the experimental biscuits ranged from 4.2 to 5.8 Newton while a higher force (13.2 Newton) was required to break the commercial biscuit sample. There was a good correlation between trained panel evaluation and instrumental measurements. The experimental biscuits were judged to be more crispy, more crunchy, more crumbly and more gritty as compared with the commercial sample. Products

made with shortenings containing palm oil and butterfat were not significantly different in flavour from those made with 100% butterfat. However, there was a significant difference in flavour ($p<0.05$) between experimental and commercial short-dough biscuits.

INTRODUCTION

The word 'biscuit' as used in Malaysia and the United Kingdom, refers to what are called 'cookies' in the USA. Biscuits are a very popular snack food. They contain basic ingredients such as flour, fat, sugar, egg, and flavouring and leavening agents — similar to those of cakes, but in different proportions (Gates, 1976). In biscuits, fat or shortening may be selected to aid in producing the most desirable spread, to produce volume or to furnish other textural attributes (Andres, 1985). Biscuit doughs prepared without the inclusion of fat have a hard, cohesive texture (Greethead, 1969). The inclusion of fat in the dough produces biscuits which break easily and are described as 'short'. Greethead (1969) adds that the breaking strength of baked biscuits is indicative of their shortness, and breaking strength has been used to measure the shortening power of fats.

Important characteristics for biscuits are their texture and flavour. Texture is the composite of those properties which arise from the physical structural elements and the manner in which these register with the physiological senses. The term therefore encompasses all properties of foods which are perceived by the kinesthetic and tactile senses (Jellineck, 1985). According to Szczesniak (1963) texture can be grouped into three major classifications namely: 1) mechanical, 2) geometrical and 3) other characteristics, related mainly to the moisture and fat contents of foods. Textural considerations are essential with most food products as texture plays a significant role in determining product quality, and is considered an attribute predictive of changes that will occur in food products during processing, storage or distribution (Gatchalian, 1981). Flavour is defined as a complex combination of the olfactory and gustatory attributes perceived during tasting, which may be influenced by tactile, thermal, pain and even kinesthetic effects (Jellineck, 1985).

In the study reported here the textural and flavour attributes of short-dough biscuits made using palm oil and butterfat shortenings were examined. Correlations between instrumental measurement and sensory evaluation of biscuit texture were investigated. The study also included investigations of the effect of storage on the quality of short-dough biscuits.

MATERIALS AND METHODS

Materials

Samples used in the study consisted of experimental short-dough biscuits made with different shortenings and a commercial short-dough biscuit obtained from a local supermarket. The samples were :

A) Biscuit made with a commercial (control) shortening based on palm oil.
B) Biscuit made with a shortening containing palm oil and butterfat at a ratio of 3:1.
C) Biscuit made with a shortening containing palm oil and butterfat at a ratio of 1:1.
D) Biscuit made with 100% butterfat.
E) Commercially produced biscuit.

Production of Shortening

Palm oil and butterfat were melted separately in an oven. Blends were prepared by mixing the palm oil and butterfat in the appropriate proportions in a stainless steel vessel of 100 kg capacity, to give a total of 30 kg of each blend. The feedstocks were held at 50°C and were processed on a pilot plant scale on the Schröder Kombinator type VUK B 01/60-400 (Lübeck, Germany). The products were run at an average pump speed of 345 rev/min and a back pressure of 1 kg/cm^2. Refrigeration was adjusted to obtain a standard filling temperature (18°C). The shortenings were filled into cans and stored at ambient temperature (23°C) until used.

Preparation of Biscuits

Biscuit samples A,B,C and D were made with the recipe shown in *Table 1*, following the procedure of Nor Aini (1990).

TABLE 1. SHORT-DOUGH BISCUIT RECIPE

Ingredients	Weight (g)
Wheat flour	400
Shortening	170
Castor sugar	200
Egg	50
Vanilla	2.5
Baking powder	3

The commercial biscuit contained the following ingredients: wheat flour, palm oil shortening, sugar, butterfat, glucose, skim milk powder, leavening agent, egg, salt, permitted food conditioner, flavour and colouring.

Sensory Evaluation

Four types of sensory tests were conducted. The first was Hedonic Rating, to provide information on how well the biscuits were liked. The second and third were profiling techniques to provide appropriate descriptive terms for the textural and flavour characteristics of the biscuits. The fourth test was an analytical test designed to determine the intensity of the textural and flavour attributes associated with biscuits. Judges consisted of 15 staff of PORIM with previous experience in sensory evaluation. Only trained panels (n=10) were used for the fourth test.

Facilities: Sensory tests were conducted in an air-conditioned sensory evaluation laboratory equipped with 10 individual panel booths. The lighting system consisted of white fluorescent lights and coloured lights, namely red and blue, which served to mask colour differences among the samples if necessary.

Sample preparation and presentation: Each biscuit sample was coded with a 3-digit random number and five different samples were presented together on a white polystyrene plate. A glass of warm water was provided for each judge for cleansing the palate between tastings.

Hedonic Rating: Panels were asked to evaluate the texture and flavour of the five samples using a five-point scale, where 1 = dislike very much, and 5 = like very much.

Texture Profiling: Panelists were individually asked to describe the texture attributes of the samples. A list of terms was provided as a guide. The textural attributes of the given samples were discussed in order to come up with a terminology agreed by all panel members.

Flavour Profiling: Relevant flavourings obtained from Robertet & Cie, Grasse, France — vanilla flavour, creamy flavour, condensed milk flavour and buttery flavour were provided as reference samples. Very old biscuit samples were included as reference for stale and rancid flavours. Each panel was asked to describe the flavours of the samples presented to them. In flavour profiling, descriptive terms for flavour relevant to biscuits were discussed until agreement was reached among all panel members.

Quantitative Descriptive Analysis (QDA): Quantitative Descriptive Analysis was conducted using various terms developed during the Texture and Flavour Profiling sessions (see *Appendix I*). The terms for textural attributes included crispy, crunchy, crumbly, gritty, dense, mealy, dry and greasy. For flavour attributes, the terms included sweet, vanilla, creamy buttery, milky and fresh. Panels were presented with samples similar to those used in the previous tests. They were asked to quantify each textural attribute relevant to the samples. After they had finished, they were asked to proceed with the assessment of flavour attributes.

In another set of tests, panelists were given samples of experimental biscuits which had been stored for three months. The aim was to see the effect of storage on the textural and flavour characteristics of the biscuits. The test was conducted in the same manner as before.

Instrumental Measurement of Texture

A texture testing machine (J.J. Lloyd, Model T5K, Southampton, England) was used for measuring the breaking strengths of the biscuits. The attachment used was a stainless steel probe 0.75 cm in diameter with a rounded end. The biscuit sample was placed under the probe on a hollow plastic cylinder with an

internal diameter of 3.1 cm, a wall thickness of 0.1 cm and a height of 3.0 cm. The 'load cell' used was 10 Newton and the speed was set at 100 mm/min. The texture of biscuits was measured in terms of the force required to break them.

Statistical Analysis

The data from sensory evaluation were subjected to analysis of variance. Stepwise multiple regressions were done to find relationships between various texture attributes.

RESULTS AND DISCUSSION

The results of Hedonic Scoring are shown in *Figures 1* and *2*. There was little difference among the samples in texture score; however, there was a significant difference in flavour score ($p < 0.05$) between experimental short-dough biscuits (samples B, C and D) and the commercial short-dough biscuits (Sample A) (*Figure 2*). There was also a significant difference in flavour ($p < 0.05$) between the biscuits made with the commercial shortening (Sample A) and those made with 100% butterfat (Sample D). This was as expected, because sample A did not have any buttery flavour. Although the mean scores of biscuits made with combinations of palm oil and butterfat shortenings indicated that the biscuits were not significantly different from those made with 100% butterfat, the all butter biscuits were liked the best. It is possible to add flavour components (diacetyl) to 100% palm oil shortening to give the desirable buttery flavour instead of adding butterfat.

In Texture Profiling, descriptive terms for texture attributes of short-dough biscuits given by the panel members included crispy, crunchy,

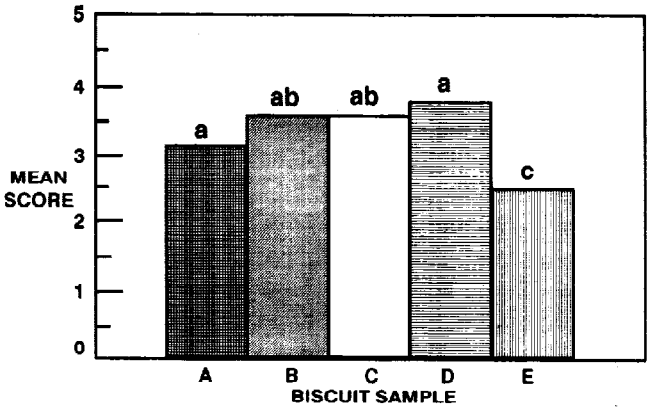

Figure 2. Mean (n = 15) hedonic score for flavour of biscuits made with different shortenings. The scale was from 1 (dislike very much) to 5 (like very much). There were significant differences ($p < 0.05$) between the mean scores for samples labelled with different small letters (a, b, c).

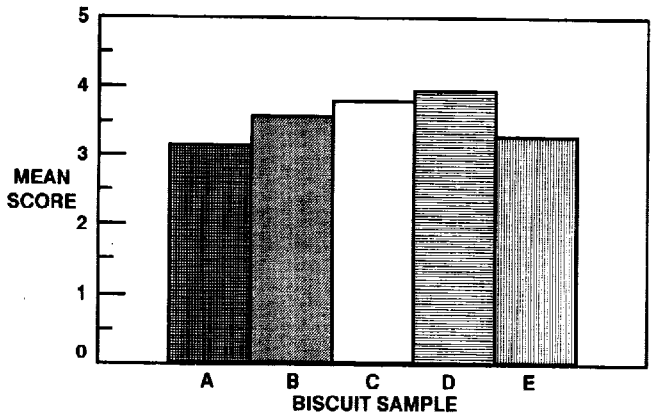

Figure 1. Mean (n = 15) hedonic score for texture of biscuits made with different shortenings: The scale was from 1 (dislike very much) to 5 (like very much). None of the differences between mean scores for the samples was significant ($p < 0.05$).

A = commercial shortening, B = palm oil:butter fat 3:1, C = palm oil : butterfat 1:1, D = butterfat and E = commercial biscuit.

crumbly, gritty, dense, mealy, dry and greasy. A round table discussion was held after the evaluation session and each descriptive term was discussed. All panel members agreed that 'crispiness' relates to the sound produced when the biscuit is first bitten with the front teeth. They also agreed that 'crunchiness' is associated with the perception of sound and the presence of solid fragments during mastication in the mouth. Agreement was reached to describe a biscuit that breaks down easily into small fragments as 'crumbly'. Each panel member agreed to use the term 'gritty' when referring to a sharp and sandy feeling in the mouth when the samples were chewed. 'Dense' refers to the compactness of the structure of a biscuit, while 'mealy' is associated with a powdery feeling in the mouth due to breakdown of the biscuit structure into tiny fragments.

In Flavour Profiling, descriptions were associated with the aroma, taste or flavour of the particular item. 'Sweet' is associated with the taste of sugar, 'vanilla' is associated with the aroma or fragrance of vanilla essence, 'creamy' is reminiscent of sweetened condensed milk, 'buttery' is reminiscent of butter, 'milky' is reminiscent of the aroma perceived when biscuits are being baked, and 'stale' is associated with a product that has lost its freshness due to long storage.

Descriptive terms agreed by all members during the panel discussion were used for the subsequent test, which was Quantitative Descriptive Analysis (QDA). In this test, the intensity of the textural and flavour attributes was quantified using a given scale. The scale ranged from 0 to 9. The results of Quantitative Descriptive Analysis indicated that there was not much difference in texture attributes among the experimental short-dough biscuits, but the commercial short biscuit was very different (*Table 2*). It was less crispy, less crunchy, less crumbly and less gritty than the experimental biscuits. On the other hand, the commercial biscuit was more dense or compact and it had a mealy texture during mastication, unlike the experimental biscuits.

TABLE 2. QUANTITATIVE DESCRIPTIVE ANALYSIS: MEAN (N = 10) SCORE FOR TEXTURE ATTRIBUTES

Texture Attribute	Sample				
	A	B	C	D	E
Crispy	7.0[a]	7.0[a]	7.6[a]	7.8[a]	4.0[b]
Crunchy	7.2[a]	7.2[a]	6.8[a]	7.4[a]	4.2[b]
Crumbly	7.0[a]	7.0[a]	6.6[a]	7.2[a]	5.0[b]
Gritty	6.8[a]	6.4[a]	6.6[a]	6.4[a]	3.8[b]
Dense	1.4[a]	1.8[a]	1.8[a]	1.4[a]	6.2[b]
Mealy	0.4[a]	0.4[a]	0.2[a]	0.4[a]	6.6[b]
Dry	6.2[a]	6.0[a]	5.8[a]	6.2[a]	6.2[a]
Greasy	1.0[a]	1.0[a]	1.0[a]	1.0[a]	1.8[b]

a, b Values in the same row followed by different letter are significantly different ($p < 0.05$).

In terms of flavour attributes, there was again not much difference among the experimental biscuits except that those made with 100% butterfat were judged as being slightly sweeter and having a more creamy flavour (*Table 3*). There was a significant flavour difference ($p < 0.05$) between the commercial and the experimental biscuits. The commercial biscuit was less sweet, and had less vanilla, less creamy and less buttery flavours. On the other hand, it had a milky flavour due to the skim milk powder added as one of the ingredients in its formulation. Skim milk powder was not added to the experimental biscuits, so there were no scores for this attribute.

Instrumental texture measurements showed obvious differences between experimental biscuits and the commercial product. The amount of force required to break the experimental biscuits was 4.2, 4.7, 5.8 and 5.0 Newton for samples A,B,C, and D respectively. Higher force (13.2 Newton) was required to break the commercial biscuit (Sample E).

Stepwise multiple regression on texture attributes showed a good correlation between trained panel evaluation and instrumental measurements. There were positive as well as negative correlations. A positive correlation ($r = 0.99$) existed between the force required to break the samples and the dense characteristic. Higher force was required to break the sample that was more dense. Negative correlations were found between the force required to break the samples and the attributes crispiness ($r = -0.95$), crunchiness ($r = -0.99$), crumbliness ($r = -0.98$) and grittiness ($r = -0.99$).

Figure 3 shows the comparison of textural characteristics of biscuit samples (A, B, C and D) when fresh and after three months of storage. During storage the biscuits tended to lose some crispiness, became less crunchy, less crumbly, less gritty and less dry owing to moisture absorption. Although changes in denseness were less pronounced, the biscuit samples became slightly more greasy. It was noted that there were slight flavour changes during storage (*Figure 4*). The intensity of all the flavour attributes was reduced and the fresh aroma of the biscuits was almost completely lost upon storage .

TABLE 3. QUANTITATIVE DESCRIPTIVE ANALYSIS: MEAN (N = 10) SCORE FOR FLAVOUR ATTRIBUTES

Flavour Description	Sample				
	A	B	C	D	E
Sweet	6.4^a	6.6^a	6.2^a	7.6^a	4.4^b
Vanilla	6.4^a	6.4^a	6.4^a	6.4^a	0.4^b
Creamy	5.6^a	5.4^a	5.4^a	6.0^a	2.0^b
Buttery	4.8^a	4.8^a	5.0^a	5.0^a	1.8^b
Milky	–	–	–	–	5.8^a
Fresh	7.8^a	7.8^a	7.8^a	8.0^a	5.8^b

a, b Values in the same row followed by different letter are significantly different ($p < 0.05$).

CONCLUSIONS

Differences in texture attributes between experimental and commercial short-dough biscuits could be detected by sensory means. The experimental biscuits were found to be more crispy, more crunchy, more crumbly and more gritty than the commercial product. Although biscuits made with 100% butterfat were not significantly different from other experimental biscuits, they were liked the best.

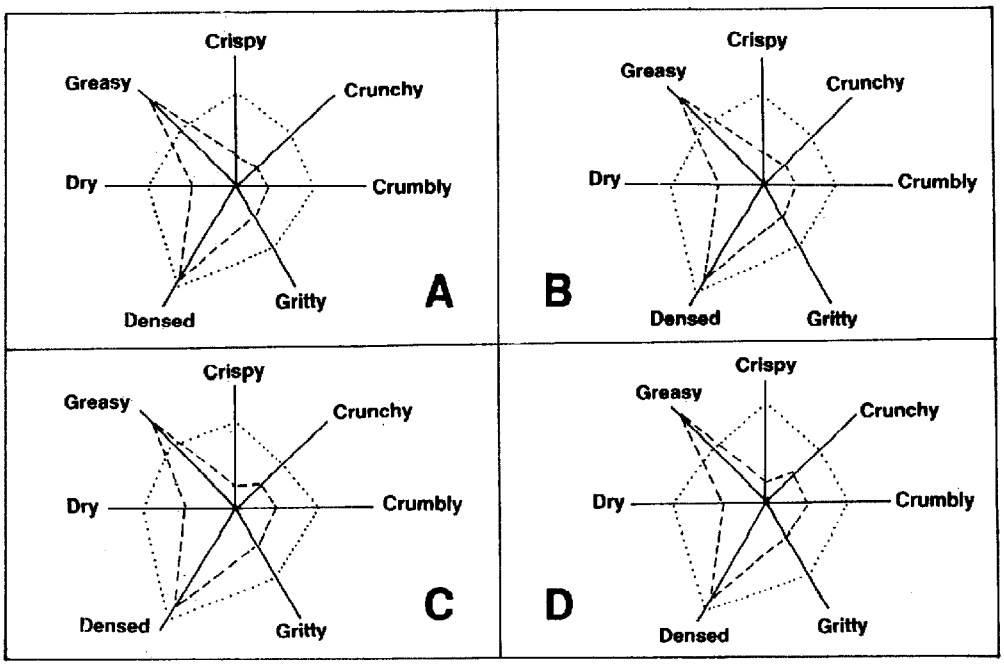

Figure 3. Textural characteristic of biscuit samples A, B, C, and D when fresh(---) and after 3 months of storage(···). Range of scores: 0 to 9, 0 at the outer end, 9 at the centre.

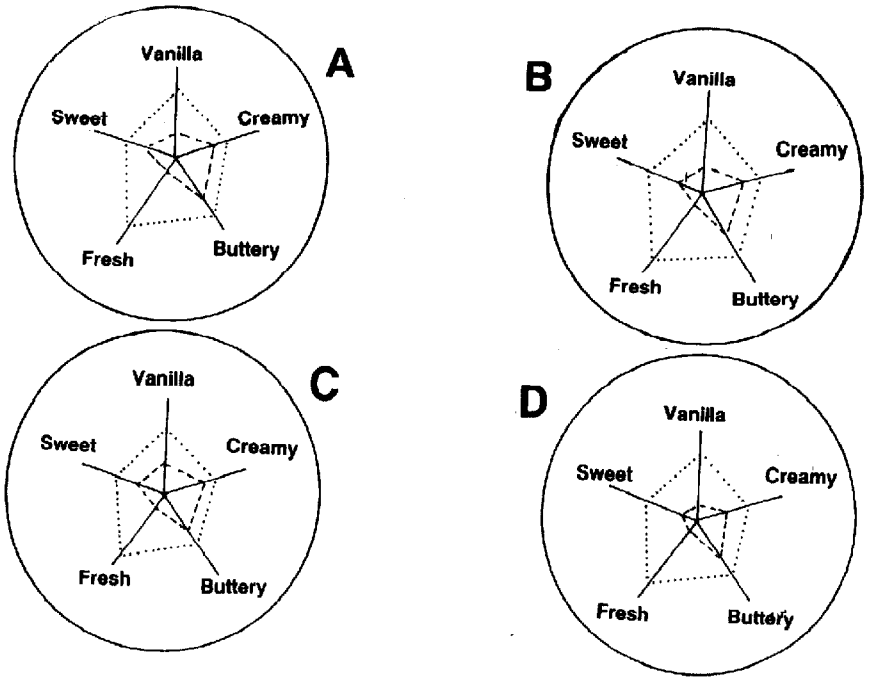

Figure 4. Flavour characteristics of biscuit samples A, B, C and D when fresh(---) and after 3 months of storage(···). Range of scores: 0 to 9, 0 at the outer end, 9 at the centre.

There was a significant ($p < 0.05$) correlation between panel evaluation and instrumental measurements on texture. During storage there were changes in the texture and flavour characteristics of the biscuits.

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REFERENCES

ANDRES C (1985). Fat and oils in food: Furnish desired texture, mouthfeel, volume, nutrition, operating function. *Food Processing. 54*, 60–61.

GATCHALIAN MM (1981). *Sensory Evaluation Methods with Statistical Analysis.* College of Home Economics, University of the Philippines, Quezon City.

GATES JC (1976). *Basic Foods.* Holt, Rinehart and Winston. U.S.A., pp. 287-305.

GREETHEAD GF (1969). The role of fats in bakery products. *Food Technology in Australia.* May, 228-230.

JELLINECK G (1985). *Sensory Evaluation of Food.* Ellis Horwood Ltd., England.

NOR AINI IDRIS (1990). Utilization of palm oil and milkfat in shortening formulations for Madeira Cake and short-dough biscuits. (In preparation).

SZCZESNIAK AS (1963). Classification of textural characteristics. *J. Food Sci., 28*, 385.

Appendix I. Score sheet used for evaluation of texture and flavour attributes of biscuits.

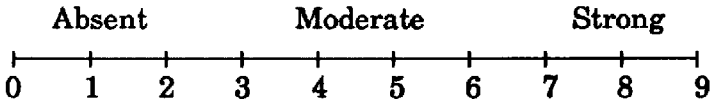
QUANTITATIVE DESCRIPTIVE ANALYSIS

Product: Biscuit

Judge :_____

Date :_____

Rating Scale



Instruction: Using the vocabulary below, please evaluate texture and flavour of the given samples using the above scale :

Texture attribute	Sample Code				
	984	687	039	176	432
Crispy					
Crunchy					
Crumbly					
Gritty					
Dry					
Greasy					
Dense					
Flavour Attribute					
Sweet					
Vanilla					
Creamy					
Buttery					
Milky					
Fresh					