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Effect of Cinnamon Powder Addition on Nutritional Composition, Physical Properties and Sensory Acceptability of Butter Biscuits

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ABSTRACT

Introduction: Demand for dietary fibre-enriched and low sugar bakery products is rapidly increasing due to the current high incidence of Type 2 diabetes mellitus. Cinnamon, a spice which acts as a natural sweetener and insulin mimetic is believed to have health benefits. The objective of this study was to determine the properties of butter biscuits containing cinnamon powder (CP) that partially replaced sucrose at levels of 0 (control), 2, 4 or 6%. **Methods**: Nutritional composition, physical properties and sensory acceptability of the biscuits were analysed using AOAC methods, texture profile analyser and 7-point hedonic scaling method, respectively. **Results**: Protein, ash and dietary fibre contents of the biscuits increased significantly ($P < 0.05$) whereas the moisture and sucrose contents were reduced significantly, proportionately to the increasing levels of CP. In texture profile analyses, increment of firmness and reduction of crispiness of the biscuits were detected with increasing levels of CP, but not significantly. The sensory scores for control and 2% CP biscuits were not significantly different for all the sensory attributes. Biscuits with 4% CP received lower scores only for aroma and appearance whereas the scores for colour, crispiness and flavour showed no significant differences compared to the control and 2% CP biscuit. **Conclusion**: The addition of 4% CP in biscuit could be an effective way to produce nutritious butter biscuits without any apparent change to its desirable physical properties and sensory acceptability.

Key words*:* Butter biscuits, cinnamon powder, nutritional composition, physical properties, sensory acceptability

INTRODUCTION

Type 2 diabetes mellitus is a debilitating chronic metabolic disorder characterised by high blood glucose levels due to insulin insensitivity. It is related to multiple serious complications including blindness, ischemic heart disease, stroke, kidney failure and ultimately death (ADA, 2007). It affects approximately 4% of the population worldwide and is expected to increase by 5.4% (about 300 million) in 2025 (King, Aubert & Herman, 1998; Kim, Hyun & Choung, 2006). Based on the National Health and Morbidity Survey (NHMS, 2011), 2.6 million (15.2%) Malaysians are suffering from diabetes. The rising trend may be due to obesity, high- intake of alcoholic beverages, physical inactivity as well as unhealthy

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dietary practices such as low dietary fibre and high sugar consumption (Habib & Saha, 2011).

Dietary fibre is an indigestible portion of plant foods which consists of the structural and storage polysaccharides and lignin in plants (Marlett, McBurney & Slavin, 2002). Dietary fibre has its beneficial effects in preventing obesity, cardiovascular disease, type 2 diabetes, colon cancer, colonic diverticulosis and constipation (Timm & Slavin, 2008). Recommended intakes of dietary fibre for adults are 20-35g/day (ADA, 2001). Nevertheless, the usual intake for dietary fibre among populations is low, only 16g/day (Timm & Slavin, 2008). Therefore, intake of other sources of dietary fibre such as fibre-enriched food products should be encouraged.

Sucrose is the main form of sugar in the biscuit industry (Lin *et al.*, 2010). It is one of the components in biscuit formulation; it affects flavour, colour, dimensions, hardness and surface finish (Gallagher *et al.*, 2003). It can inhibit gluten development during dough mixing by competing with the flour for recipe water. However, according to the USDA Food Guide Pyramid, sucrose should be consumed only in moderation. Long-term consumption of sucrose-rich diets is associated with Type 2 diabetes mellitus (Emily *et al.*, 2012).

Hence, it is recommended that reducing the amount of added sucrose in bakery products is the best solution for obtaining a healthier product. Artificial sweeteners (non-nutritive sweeteners) such as aspartame, saccharin and neotame could be used to replace traditional sugars and are widely used in bakery products currently. Nevertheless, numerous studies report that consuming artificial sweeteners may bring side effects to human health (Christina, Joseph & Linda, 2008).

Cinnamon, one of the most commonly used spices worldwide next to black pepper for centuries, is primarily grown in South Asia and Southeast Asia (Singletary, 2008). It is obtained from the dried inner brown bark of trees from the genus *Cinnamomum* and known to have high dietary fibre content. Furthermore, there is some evidence suggesting that cinnamon has antioxidant (Suganthi *et al.*, 2007), antitumor (Ka *et al.*, 2003), blood pressure-lowering (Akilen *et al.*, 2010), cholesterol-lowering (Khan *et al.*, 2003), and hypoglycemic effects (Anderson, 2008).

Among all the medicinal uses, cinnamon has been mainly used as anti-diabetic medicine in many countries for thousands of years. Results from several *in vitro* experiments have demonstrated that cinnamon may act as an insulin mimetic which potentiates insulin activity and stimulates cellular glucose metabolism (Jarvill-Taylor, Anderson & Graves, 2001; Anderson *et al.*, 2004). In foods, it conveys a sense of warmth and sweetness and thus has been used as flavouring agent in various products such as baked goods, meat dishes, fruit preparations and beverages such as tea and coffee (Singletary, 2008).

Based on findings from the Malaysian Adult Nutrition Survey (MANS), biscuits are among the top 10 food items popularly consumed by Malaysians (Norimah *et al.*, 2008). A wide variety of sweeteners such as erythritol (Lin *et al.*, 2010) and Raftilose® (Gallagher *et al.*, 2003) which are partially employed as sucrose replacers in biscuits has been reported previously. However, there is lack of scientific data recording the use of CP as a sucrose replacer in biscuits.

Due to the fact that commercially available biscuits are generally low in dietary fibre and high in sucrose content, biscuits formulated with CP as partial replacement for sucrose have been developed. By partially replacing sucrose with CP in biscuit formulation, we expected to see an improvement in nutritional composition, especially dietary fibre, without compromising physical and sensorial properties.

Therefore, the objectives of this paper are to determine the nutritional composition, physical properties and sensory acceptability of butter biscuits formulated with different levels of CP. Further, the nutritional composition of CP was also determined.

METHODS

Study design

The control sample in this study were the butter biscuits without the addition of CP whereas the experimental samples were the butter biscuits formulated with 2%, 4% and 6% CP to partially replace the sucrose content. The proximate composition, dietary fibre composition (total dietary fibre, insoluble dietary fibre and soluble dietary fibre), physical properties and sensory acceptability parameters of control butter biscuits and butter biscuits formulated with different levels of CP were compared. Four independent variables of 0%, 2%, 4% and 6% CP butter biscuits were formulated.

Sample preparation

Cinnamon powder (CP) was purchased directly from a hypermarket at Kota Bahru, Kelantan, Peninsular Malaysia. It was sifted by using a siever with a mesh of 125µm. The CP was kept in a screw cap bottle at 4°C before further use.

The biscuits were formulated by using various commercially available raw ingredients such as butter, sucrose, egg white, wheat flour, corn flour and baking powder as listed in Table 1. CP partially replaced sucrose at levels of 2, 4 and 6%. In a mixing bowl, butter, white egg, sucrose and vanilla essence were mixed together and beaten by Hobart mixer for 5 minutes or until creamy texture was achieved. After all flours were added, the mixture was beaten again for 5 minutes to obtain the desired consistency. The dough was then manually shaped into 5-mm thick round mounds and put on lightly greased baking sheet and baked at 180°C for 18 minutes. The biscuits were then cooled at room temperature for 1 hour before being ground into powder form and kept in screw cap bottle at 4°C until further analyses.

Nutritional analyses

Proximate analyses were conducted using AOAC (1996) for moisture (air-oven method), total ash (dry-ashing method), crude protein by nitrogen conversion factor of 6.25 (Kjeldahl method), crude fat using the semi-continuous extraction (Soxhlet method) and sucrose (HPLC-ELSD method). Carbohydrate (CHO) was calculated by difference: Total CHO = 100 – g (moisture + protein + fat + ash).

Total dietary fibre (TDF) of biscuits formulated with various levels of CP was determined by enzymatic gravimetric

Table 1. Raw ingredients used in the preparation of butter biscuits formulated with CP

Items	*Ingredients*	*Quantities*			
		**Control (0% CP)*	*2% CP*	*4% CP*	*6% CP*
1	Butter (g)	140	140	140	140
2	Sucrose (g)	90	88.2	86.4	84.6
3	Beaten egg white	1	1	1	1
4	Vanilla essence (tsp)	½	½	½	½
5	Sifted wheat flour (g)	270	270	270	270
6	Corn flour (g)	50	50	50	50
7	Baking powder (g)	2	2	2	2
8	Biscuit softener (g)	2	2	2	2
9	CP (g)	0	1.8	3.6	5.4

*The recipe was adopted from Brown (2008) with a slight modification.
CP: cinnamon powder

method, based on the method of AOAC 985.29 and AACC 32-05. Insoluble dietary fibre (IDF) and soluble dietary fibre (SDF) of the samples were determined according to AOAC 991.42, 993.19 and AACC 32-21.

Physical analyses

One hour after final baking, biscuit diameter (*W*) was measured by placing 10 biscuits edge-to-edge. The biscuit thickness (*T*) was measured by stacking 10 biscuits. Biscuits were rearranged to obtain accuracy. Measurements were expressed in mm as the mean value of mm/10 of three different trials. The spread ratio (*W*/ *T*) was calculated as the diameter to thickness ratio. Weight (g) of biscuits was measured by using an analytical balance.

Texture profile analyses (TPA) of biscuits incorporated with different levels of CP was performed by using a Texture Analyser TA.XTplus (Stable Micro Systems, Surrey, UK) with a 3D extensibility method. The TA.XTplus texture analyser was coupled with Texture Exponent Software. Pieces of biscuits approximately 35 mm in diameter and 5 mm in thickness were placed on the base of a heavy duty platform equipped with a 3-point bend rig. The operating conditions included pre-test speed (1.0mm/s), test speed (3.0mm/s), post-test speed (10.0mm/s), trigger force (50g), distance between probe and biscuit (10mm), compression distance (3mm) and option (return to start). Firmness (kg) and crispiness (mm) attributes were calculated from the curves.

Sensory evaluation

Sensory evaluation of butter biscuits was carried out by 60 untrained consumers consisting of students and staff of the School of Health Sciences, Universiti Sains Malaysia Health Campus. Consumers received four different formulations of CP butter biscuits for the sensory test. The tested samples were coded with a 3-digit permuted number. All samples were evaluated according to the 7-point hedonic scaling method outlined by Piggott (1988). Sensory parameters evaluated were aroma, colour, appearance, crispiness, flavour and overall acceptance on a 7-point scale (1 = dislike the most and 7 = like the most).

Statistical analysis

Data obtained were tested for significance using ANOVA and Duncan Multiple Range Test by SPSS, Version 18.0. (SPSS Inc, Chicago, lllinois). Results were expressed as mean ± standard deviation. All measurements were conducted in triplicate (n=3) except for dietary fibre compositions analysis (n=4). The experiments were replicated twice. Significance level was established at $P < 0.05$.

RESULTS AND DISCUSSION

Nutritional composition

The proximate composition of butter biscuits formulated with CP as partial replacement for sucrose at four different levels are presented in Table 3. The results show an improvement in protein, ash, fat and dietary fibre content but a reduction in moisture, carbohydrate and sucrose content in biscuits prepared with increasing amounts of CP.

Biscuits added with 6% CP had the highest protein content (6.69%), significant at $P< 0.05$, followed by biscuits added with 4% CP (6.50%). However, the protein content (6.38%) of 2% CP biscuit formulation was significantly ($P < 0.05$) lower compared with 4% and 6% CP biscuits, but was not significantly different compared with the control (6.30%). The biscuit formulated with 6% CP had the highest ash content (0.91%) which was significantly higher than in the other formulations (0.75-0.86%). Meanwhile, fat content was found to increase in line with CP level in all biscuit formulations, but was not significant ($P > 0.05$). The higher the CP content in the biscuit, the higher the content of protein and ash. This is because CP possesses appreciable amounts of protein (6.31%) and ash (2.13%) (Table 2). It could

Table 2. Nutritional composition of cinnamon powder

*Chemical composition**	*Concentration (%)*
Protein	6.31 ± 0.05
Ash	2.13 ± 0.03
Fat	1.36 ± 0.02
Moisture	5.22 ± 0.20
Carbohydrate	84.98 ± 0.24
Sucrose	0.1 ± 0.00
Soluble dietary fibre	10.88 ± 0.53
Insoluble dietary fibre	37.50 ± 1.90
Total dietary fibre	48.38 ± 2.42

* The analysis was replicated thrice (n = 3).

Table 3. Nutritional composition of butter biscuits formulated with cinnamon powder

Nutritional omposition	*Concentration (%)*			
	Control (0%)	*2%*	*4%*	*6%*
Protein	6.30 ± 0.00^c	6.38 ± 0.01^c	6.50 ± 0.06^b	6.69 ± 0.10^a
Ash	0.75 ± 0.03^c	0.86 ± 0.02^b	0.86 ± 0.02^b	0.91 ± 0.01^a
Fat	22.28 ± 0.08^a	22.57 ± 0.03^a	22.68 ± 0.06^a	22.80 ± 0.05^a
Moisture	1.94 ± 0.04^a	1.71 ± 0.07^b	1.37 ± 0.05^c	1.16 ± 0.00^d
Carbohydrate	68.72 ± 0.07^a	68.48 ± 0.06^a	68.59 ± 0.08^a	68.44 ± 0.08^a
Sucrose	17.4 ± 0.08^a	14.8 ± 0.05^b	12.8 ± 0.06^c	9.2 ± 0.03^d
Total dietary fibre	1.16 ± 0.12^d	2.43 ± 0.20^c	3.37 ± 0.19^b	4.21 ± 0.35^a
Insoluble dietary fibre	0.93 ± 0.10^d	1.95 ± 0.18^c	2.63 ± 0.16^b	3.34 ± 0.32^a
Soluble dietary fibre	0.23 ± 0.02^d	0.48 ± 0.04^c	0.74 ± 0.04^b	0.87 ± 0.03^a

$^{a-d}$ Mean values within the same row bearing different superscripts differ significantly (P<0.05).

be concluded that CP improves the nutritional contents of biscuits.

Table 3 lists the dietary fibre composition of biscuits formulated with CP. The data shows that the percentage of total dietary fibre increases proportionally with the level of CP added, ranging from 1.16 to 4.21%. Significantly ($P < 0.05$), 6% CP biscuits reported the highest total dietary fibre (4.21%), soluble dietary fibre (0.87%) and insoluble dietary fibre (3.34%). Collectively, the dietary fibre composition of biscuits showed that CP could be used for enriching the dietary fibre content of biscuits. This is because CP itself contains a high level of total dietary fibre (48.38%), including its soluble form (10.88%) and insoluble form (37.50%). The same trends of increased total dietary fibre content were documented in biscuits formulated with increasing levels of mango peel powder (Ajila, Leelavathi & Prasada, 2008) and oyster mushroom powder (Wan Rosli, Nurhanan & Aishah, 2012).

On the other hand, there was an inverse relationship between moisture, carbohydrate and sucrose content with the level of CP incorporated in the biscuit formulations. Biscuits are very low moisture content products. Thermal processing reduces the final moisture content from 5 to 1% in the final product. Biscuits added with 6% CP had the lowest moisture content (1.16%) which was significantly ($P < 0.05$) lower than the other treatments (1.37-1.94%). This trend is due to the low moisture content of CP (5.22%). Moreover, dietary fibre content in CP may absorb a large amount of water, consequently resulting in decreased moisture content. The findings are in line with Wan Rosli *et al.* (2012) who incorporated mushroom powder to replace wheat flour in biscuits. The moisture content of biscuits is usually used as an indicator of biscuit quality. It is crucial to measure it because of its potential impact on the sensory, textural and microbial properties of the final product (Ahlborn *et al.*, 2005). This low moisture content ensures that biscuits are basically free from microbiological spoilage and the product enjoys a long shelf life.

Carbohydrates are among the predominant macronutrients in biscuits. In general, carbohydrate content of biscuits was found to be inversely proportional to the level of CP added, ranging from 68.44 to 68.72%. The values were not significant ($P > 0.05$) among all CP-based biscuits and the control. Our data are within the range of values of the study by Tiwari *et al.* (2011). In addition, the results show a reduction in sucrose content for biscuits prepared with increasing amounts of CP. All biscuits formulated with CP had significantly ($P < 0.05$) lower sucrose content ranging from 9.2 to 14.8% compared to the control (17.4%); the 6% CP biscuits recorded the lowest, due to the lesser amount of sugar introduced into the biscuits. This trend is attributed to negligible amount of sucrose content in CP (0.1%). The finding is in agreement with a previous study conducted by Lin *et al.* (2010) on the incorporation of erythritol to partially substitute for sucrose in the preparation of Danish cookies. Many bakery products contain large amounts of sucrose. It is necessary to reduce sucrose utilisation in products to improve carbohydrate metabolism in the body. Nevertheless, the amount of sucrose to be replaced needs to be taken into consideration because sucrose can play an essential role in maintaining desirable colour and the textural and sensory acceptability of biscuits (Gallagher *et al.*, 2003).

Physical properties

The TPA permits bakers to consistently and objectively check and determine the quality of bakery products (Hathorn *et al.*, 2008). Table 4 shows the effect of CP addition on the physical properties of the biscuits. Basically, all properties investigated were influenced by CP incorporation, except thickness properties. The results for thickness of biscuits did not show any changes (5 mm) for all formulations.

Further, the weight, diameter, spread ratio and crispiness of biscuits decreased proportionally with the level of CP added, with no significant difference for all biscuit formulations ($P > 0.05$). Sucrose plays a leading role in developing a crispier biscuit. A high sucrose content increases spread because the sucrose liquefies at baking temperature. As a result, the control biscuits

Table 4. Physical properties of butter biscuits formulated with cinnamon powder.

Properties	*Control (0%)*	*2%*	*4%*	*6%*
Weight (g)	5.42 ± 0.07[a]	5.38 ± 0.07[a]	5.35 ± 0.05[a]	5.35 ± 0.07[a]
Diameter (*W*, mm)	36.00± 1.00[a]	35.67 ± 0.58[a]	35.33 ± 0.58[a]	35.33 ± 0.58[a]
Thickness (*T*, mm)	5.00 ± 0.00[a]	5.00 ± 0.00[a]	5.00 ± 0.00[a]	5.00 ± 0.00[a]
Spread ratio (*W/T*)	7.20 ± 0.20[a]	7.13 ± 0.12[a]	7.00 ± 0.00[a]	7.00 ± 0.00[a]
Firmness (kg)	2.31 ± 0.08[a]	2.35 ± 0.21[a]	2.50 ± 0.15[a]	2.53 ± 0.12[a]
Crispiness (mm)	0.39 ± 0.01[a]	0.37 ± 0.02[a]	0.36 ± 0.03[a]	0.36 ± 0.02[a]

[a] Mean values within the same column bearing different superscripts differ significantly ($P<0.05$).

where the sucrose was not replaced by CP received the highest weight, diameter, spread ratio and crispiness rates (Pareyt *et al.*, 2009).

Nevertheless, the firmness of biscuits increased in line with the level of CP added with firmness ranging from 2.31 to 2.53 kg but was not significantly different (P > 0.05). Increasing firmness may be attributed to dietary fibre content in CP. Dietary fibre components tend to tightly bind appreciable amounts of water, making it less available for dough inflation and gas cell stability during baking, hence leading to a more compact texture and a higher degree of firmness (Symons & Brennan, 2004).

Sensory acceptability

The development of healthier high-fibre and low-sucrose products with acceptable sensory characteristics is of major industrial concern so as to fulfill consumer expectations. To produce biscuits that match consumer expectations, it is necessary to understand the making of good quality biscuits. Sensory evaluation scores for biscuits added with four different levels of CP are shown in Table 5. Generally, the scores of all attributes for all formulations were from 4.10 to 5.80 which can still be considered as acceptable values. This result is in agreement with a previous study done by Wan Rosli, Nurhanan & Aishah (2012) who replaced wheat flour with oyster mushroom powder in butter biscuit development. The sensory scores of all attributes from the study were from 4.07 to 5.51, similar to the findings of this study.

Apparently, the scores of all attributes decreased with increasing levels of CP added in biscuit formulations. Among all CP-based biscuits, biscuits with 2% CP recorded the highest score for all attributes, not significantly different from the control (P > 0.05). In terms of aroma, flavour and overall acceptance, 2% CP biscuits showed the highest scores among all formulations, with 5.25, 5.48 and 5.58, respectively. Biscuits with 4% CP were not significantly different (P > 0.05) in sensorial scores compared with 2% and control in terms of colour, crispiness, flavour and overall acceptance. However, 6% CP biscuit saw the greatest changes in sensory acceptability for all attributes when compared with other formulations (P < 0.05). Ng & Wan Rosli (2013) also documented similar results, in which 6% cornsilk yeast bread obtained the lowest sensory scores. It could be stated that the addition of small amounts of CP can aid in a more desirable flavour and aroma compared with the control. However, the addition of higher amounts of CP led to lower scores for sensory attributes possibly due to its brownish colour and strong flavor

In summary, these results indicate that consumers prefer biscuits with 2% CP incorporated into the formulation. The present study also demonstrates that incorporation of 4% CP into biscuit formulations is preferred if the focus of the attention is colour, crispiness and flavour of

Table 5. Sensory acceptability of butter biscuits formulated with cinnamon powder

Properties	*Control (0%)*	*2%*	*4%*	*6%*
Aroma	5.18 ± 1.16[a]	5.25 ± 1.19[a]	4.67 ± 1.07[b]	4.1 ± 1.37[c]
Colour	5.12 ± 1.30[a]	5.1 ± 1.34[a]	4.72 ± 0.94[a]	4.18 ± 0.95[b]
Appearance	5.27 ± 1.13[a]	4.97 ± 1.12[ab]	4.68 ± 1.02[b]	4.12 ± 0.90[c]
Crispiness	5.80 ± 1.07[a]	5.68 ± 0.90[a]	5.48 ± 1.07[ab]	5.13 ± 1.08[b]
Flavour	5.35 ± 1.10[ab]	5.48 ± 1.08[a]	5.22 ± 1.07[ab]	4.15 ± 1.36[c]
Overall acceptance	5.45 ± 1.01[ab]	5.58 ± 1.00[a]	5.32 ± 0.99[ab]	4.37 ± 1.13[c]

[a-c] Mean values within the same column bearing different superscripts differ significantly (P<0.05) (Score 1 = dislike extremely and score 7 = like extremely).

the finished product. Therefore, it could be suggested that replacement of 4% CP for sucrose could be an effective way to produce a functional biscuit with high dietary fibre but low sucrose content without any apparent change to desirable sensory properties.

CONCLUSION

The study results show that incorporation of CP into biscuits resulted in increased dietary fibre, protein and ash content but reduced moisture and sucrose content as well as lower sensory scores. Biscuits containing 6% CP were higher in certain nutrient contents but scored lower for sensory acceptability than the control, 2% and 4% CP biscuits. This could be due to the original strong aroma and brownish colour of CP. The sensory evaluation results indicate that colour, crispiness and flavour did not differ significantly between control, and biscuits added with 4% CP. Also there were no significant differences in the physical properties of the biscuits for control or 2, 4 and 6% incorporation of CP. In summary, this study established that the incorporation of CP up to 4% to replace sucrose results in a more nutritious biscuit with acceptable physical and sensory characteristics.

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Conflict of Interest

The authors have no potential conflict of interest to declare.

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