

Development and Evaluation of Cinnamon (*Cinnamomum zeylanicum* Blume) Bark Oil-and Cinnamon Powder-Incorporated Pumpkin Cookies

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Abstract—Cinnamon (*Cinnamomum zeylanicum*) is a tropical spice crop belonging to the family Lauraceae. It is used as a spice; there is a lack of value-added cinnamon-incorporated food products in the local market as well as in foreign markets. Pumpkin is an abundant tropical vegetable that contains vitamins, minerals, carotenoids, and fibers. This study aimed to develop cinnamon-incorporated pumpkin cookies with high nutritional qualities, identify physicochemical characteristics, and evaluate the sensory attributes. A 4:1 ratio was selected as the best ratio wheat flour supplementation with pumpkin flour. Cinnamon bark oil was incorporated into cookies in three different concentrations (0.1%, 0.3%, and 0.5%) and the best formulation was selected through sensory analysis with 30 untrained panelists. The cinnamon powder was incorporated into cookies in three different concentrations (2%, 4%, and 6%), and the best formulation was selected through sensory evaluation. For the sensory analysis, seven-point hedonic scales were used. Based on sensory results, 0.1% cinnamon oil and 2% powder-incorporated cookies were selected. Physicochemical characteristics were tested for the best two selected products and control (pumpkin cookie without adding cinnamon) samples. Powder-incorporated cookies contained 3.01% moisture, 3.19% protein, 27.92% fat, and 1.42% ash. Bark oil-incorporated cookies had 2.67% moisture, 3.27% protein, 26.88% fat, and 1.39% ash. The highest antioxidant activity was detected in the powder incorporated pumpkin cookies. The selected two products and control samples were evaluated in shelf-life studies using moisture, water activity, pH, colour, titratable acidity, and yeast and mold count, at two-week intervals, up to two months. Cinnamon bark oil and powder can be incorporated into pumpkin cookies to enhance flavour and physicochemical properties.

Keywords—Cinnamon powder, Cinnamon oil, Cookies, New products, Pumpkin flour

I. INTRODUCTION

Cinnamon is a tropical evergreen spice crop which belongs to the Lauraceae family. Sri Lanka is the origin of Ceylon cinnamon (*Cinnamomum zeylanicum* Blume). The Cinnamon plant's bark, leaves, and roots can be mainly used for a variety of beneficial applications. It contains an abundance of bioactive substances with anti-inflammatory, antimicrobial, and antioxidant properties. The main

components are, respectively, cinnamaldehyde, eugenol, and camphor.

Pumpkins are widely grown in tropical and sub-tropical countries. Pumpkins belong to the Cucurbita genus and Cucurbitaceae. Rich in carotenoids, vitamins, minerals, dietary fibers, phenolics, polysaccharides, and pectins, it contains a high amount of β -carotene.

In Sri Lanka, the bakery industry is considered one of the main parts of the food processing sector. Cookies are a significant, widely consumed bakery product in the food industry. Cookies are prepared from wheat flour, fat, sugar, baking soda, and flavoring agents. Cookies may be further enriched by the incorporation of different ingredients and changing their rations. In this study, cookies were made with wheat flour and pumpkin flour and incorporated with cinnamon bark oil and powder. It enhances the nutritional value, colour, flavour, texture, rheological and sensory properties of cookies.

II. METHODOLOGY

A. Location

This research was carried out at the National Cinnamon Research and Training Centre, Department of Export Agriculture, Palolpitiya.

B. Collection of Raw Materials

All the raw materials were collected from the Matara market. The ground cinnamon, cinnamon bark oil and packaging materials were collected from the Research Institute.

C. Preparation of Pumpkin Powder

Fresh, ripe pumpkin was washed thoroughly and peeled. The pumpkin was cut into two halves and the seeds and stringy bits were removed. Then, the pumpkin was cut into small shreds. The cut shreds were dehydrated at 80°C temperature for about 8 hours using a drying oven. The dried shreds were ground using a grinder and sieved. Finally, pumpkin powder was packaged for further use.

D. Preparation of Cinnamon Powder-Incorporated Pumpkin Cookies

Sugar and Margarine were beaten until they had a creamy and smooth texture. After that, wheat flour, Pumpkin flour, Cinnamon powder, and baking powder were sieved and gradually added to the mixture. All the ingredients were mixed together, and the dough was sheeted on the cutting board using a rolling pin. The dough was cut by using a desired mold cutter and those were transferred into an oil coated aluminum tray. The oven was preheated at about 180°C for 10-20 minutes. The cut cookies were sent to the oven to bake for about 15 minutes. Finally, the baked cookies were kept cool for about 5-7 minutes, and they were packed using polypropylene (PP) packaging material.

E. Preparation of Cinnamon Bark Oil-Incorporated Pumpkin Cookies

Sugar and Margarine were beaten until they had a creamy and smooth texture. Cinnamon oil was added to the mixture and mixed well. After that, wheat flour, Pumpkin flour, and baking powder were sieved and gradually added to the mixture. All the ingredients were mixed, and the dough was sheeted on the cutting board using a rolling pin. The dough was cut using a desired mold cutter, and the pieces were transferred into an oil coated aluminum tray. The oven was preheated at about 180°C for 10-20 minutes. The cut cookies were sent to the oven to bake for about 15 minutes. Finally, the baked cookies were kept cool for about 5-7 minutes and were packed using polypropylene (PP) packaging material.

F. Sensory Evaluation of Cinnamon-Incorporated Pumpkin Cookies

Cookies were evaluated for the sensory attributes, which include colour, taste, odour, texture, appearance, and overall acceptability, using 30 untrained panelists and 7 points hedonic scale.

G. Physico-Chemical Analysis

- Weight, diameter, thickness, spread ratio, volume, density, baking loss, and colour were analyzed as physical properties.
- Moisture content was analyzed using moisture analyzer 3 (OHAUS MB 45)
- Water activity was determined using a water activity meter (LABTOUCH-AWS/N1609009) according to Lerici (1983) method at the 25°C temperature.
- PH was analyzed using a pH meter.
- Titratable acidity was determined according to the SLS 729:2010 method using 0.1% mol/dm³ standard NaOH solution and Phenolphthalein indicator reagents.
- Ash content was determined using a muffle furnace according to the AOAC 2000 method.

- Fat content was determined using the Soxhlet apparatus according to the (AOAC, 2000) method. Petroleum ether was used as the reagent.
- The protein content was determined by the Kjeldahl method. (AOAC, 2000)

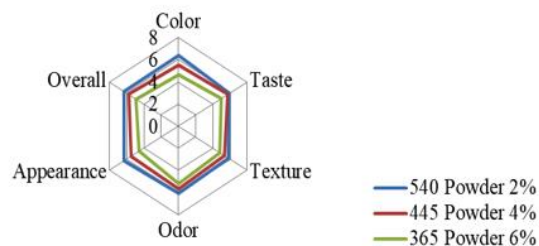


Fig. 1. Sensory evaluation radar chart of cinnamon powder-incorporated pumpkin cookies

H. Shelf-Life Determination

The cookies were packaged on polypropylene (PP) and were used for the shelf-life analysis during storage. The pH, moisture, water activity, colour, titratable acidity, yeast and mold count were analyzed within two weeks intervals for two months.

I. Microbial Analysis

According to SLS 516 book part 2 enumeration of yeast and mold count were enumerated.

J. Statistical Analysis

The data were analyzed by using one-way ANOVA, two-way ANOVA and SAS software. Sensory data were analyzed using one-way ANOVA. The mean separation was carried out by the least significant difference test and were compared at a 5% significant level ($P < 0.05$).

III. RESULTS

A. Sensory Evaluation

TABLE I. SENSORY EVALUATION RESULTS OF CINNAMON POWDER INCORPORATED PUMPKIN COOKIES

Attribute	540 Powder 2%	445 Powder 4%	365 Powder 6%	Probability ($\alpha=0.05$)
Color	6.4 ^a	5.5 ^b	4.6 ^c	<.0001
Taste	5.9 ^a	5.7 ^a	5.0 ^b	0.0036
Texture	5.8 ^a	5.3 ^{ab}	4.8 ^b	0.0113
Odor	6.1 ^a	5.7 ^{ab}	5.2 ^b	0.0136
Appearance	6.3 ^a	5.5 ^b	4.6 ^c	<.0001
Overall	6.3 ^a	5.8 ^b	4.9 ^c	<.0001

^a The different letters mentioned in each value of the identical raw are significantly difference ($p < 0.05$)

TABLE II. SENSORY EVALUATION RESULTS OF CINNAMON BARK OIL- INCORPORATED PUMPKIN COOKIES

Attribute	570 Oil 0.1%	455 Oil 0.3%	375 Oil 0.5%	Probability ($\alpha=0.05$)
Color	6.1	6.0	5.6	0.1021
Taste	6.1 ^a	5.5 ^a	4.7 ^b	0.0002
Texture	5.8	5.5	5.4	0.2807
Odor	6.1 ^a	5.8 ^{ab}	5.3 ^b	0.0171
Appearance	6.1 ^a	5.9 ^{ab}	5.5 ^b	0.0442
Overall	6.1 ^a	5.9 ^{ab}	5.5 ^b	0.0007

^b. The different letters mentioned in each value of the identical raw are significantly difference ($p<0.05$)

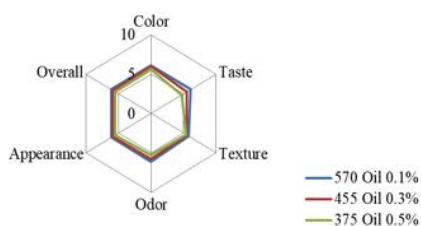


Fig. 2. Sensory evaluation radar chart of cinnamon bark oil-incorporated pumpkin cookies.

TABLE III. PHYSICO-CHEMICAL PROPERTIES OF COOKIES

	Control	Powder 2%	Oil 0.1%	Probability	CV %
Moisture %	4.18	3.01	2.67	0.0742	20.50
pH	5.98 ^c	6.01 ^b	6.07 ^a	<0.0001	0.13
Water activity	0.24	0.28	0.26	0.097	8.11
Titrate acidity %	0.11 ^a	0.09 ^b	0.09 ^b	0.0104	6.98
L* value	45.40 ^c	47.10 ^a	46.70 ^b	<0.0001	0.30
a* value	11.47 ^b	11.50 ^b	12.57 ^a	0.0002	1.26
b* value	15.20 ^b	13.53 ^c	14.60 ^b	<0.0001	0.61
Protein %	3.14	3.19	3.27	0.3077	2.97
Fat %	30.91 ^a	27.92 ^b	26.88 ^b	0.0119	3.99
Ash %	1.32	1.42	1.39	0.1362	3.67
Antioxidant activity %	35.57 ^b	53.99 ^a	36.09 ^b	0.0008	8.01
Weight (g)	8.13	8.16	8.10	0.9929	6.74
Diameter (cm)	3.89	3.84	3.88	0.3312	0.95
Thickness (cm)	0.86	0.86	0.85	0.8382	1.82
Spread ratio	4.52	4.47	4.55	0.5666	1.96
Bake loss %	0.34	0.43	0.41	0.3662	18.08
Volume (cm ³)	10.20	9.96	10.07	0.5962	2.79
Density (g/cm ³)	0.80	0.82	0.80	0.8744	5.91

^cThe different letters mentioned in each value of the identical raw are significantly difference ($p<0.05$)

According to Fig. 1, a cookie incorporated with 2% cinnamon powder obtained the highest score for all the sensory attributes. Figure.2 shows that the cookie incorporating 0.1% cinnamon bark oil obtained the highest score for all the sensory attributes.

B. Physico-Chemical Analysis

According to Tab. 3, There is a significant difference in pH, L* value and b* value among the three treatments. There is a significant difference in titratable acidity between the control and two treatments (oil and powder-incorporated cookies). There is a significant difference ($p<0.05$) in a* value between the oil and powder-incorporated cookies. Fat content is significantly different between control and two treatments (oil and powder-incorporated cookies). There is also a significant difference in antioxidant activity among the treatments. The highest antioxidant activity was detected in the cinnamon powder-incorporated pumpkin cookies. There was no significant difference in the physical properties among the three treatments.

IV. CONCLUSION

According to the sensory evaluation, 0.1% cinnamon bark oil and 2% cinnamon powder were selected as the best formulation for developing the product. It can be concluded that Cinnamon oil and powder can be used as natural flavoring agents in developing this cookie product.

According to the nutrition values, there was no significant difference in the protein and ash content among all three treatments.

The highest antioxidant activity was detected from the cinnamon powder incorporated pumpkin cookies.

According to the results of the shelf-life analysis, adding cinnamon has a positive effect on the shelf life, considering the growth of microbial, moisture, and water activity.

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