Mysore J. Agric. Sci., 57 (4) : 333-343 (2023)

Physical and Sensory Quality Characteristics of Composite Flour Based Cake with Cinnamon Essential Oil

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Received : August 2023
Accepted : September 2023

Abstract

Spices have been used as a food flavoring and food preservative agents for centuries. Spices are huge reservoir of essential oils (EO) and aromatic constituents which are of great demand in pharmaceutical industries both in national and international trade. Cinnamon essential oil derived from the bark of cinnamon trees, is a concentrated aromatic oil known for its distinct fragrance and flavor, it also has an antioxidant, antimicrobial and antimutagenic activity. In the context of cakes, the use of composite flour offers the opportunity to incorporate a variety of flours, resulting in improved nutritional content, texture and sensory attributes. In view of this, the present study aimed to develop and evaluate the physical and sensory quality characteristics of composite flour based cake with cinnamon essential oil. Composite flours were prepared using emmer wheat, little millet, foxtail millet and defatted soya flour with different proportion of combination in the ratio of 40:25:25:10, 30:30:30:10, 20:35:35:10, 10:40:40:10 and 00:45:45:10, respectively. The results found that, there was significant difference in the height (7.0 to 8.3cm), weight (183.1 to 201.5 g), volume (365.7 to 445.7 cm^3) and specific volume (1.86 to 2.40 cm^3/g) of the composite flour based cake. The combination of emmer wheat flour, little millet flour, foxtail millet flour and defatted soya flour with the ratio of 10:40:40:10 were highly acceptable by the sensory panelist. Furthermore, the addition of cinnamon essential oil to the best accepted, composite flour based cake *i.e*., at 0.6, 0.8, 1.0, 1.2, 1.4 per cent had slight decrease in pH (6.52- 6.42), bulk density (2.28 - 22.18 g/cm^3), specific gravity (0.94-0.92) and specific volume (2.09-1.92 cm^3/g), whereas, increase in weight (201.0 - 223.8 g) and baking loss (8.8 to 9.9 %) was observed respectively. Cake prepared with 1.2 per cent cinnamon essential oil was highly accepted which influenced the aroma, taste and overall acceptability scores.

Keywords : Cake, Composite flour, Cinnamon essential oil, Sensory & Physical characteristics

Essential oils are volatile secondary metabolites formed by aromatic plants and can generally be recognized by their characteristic odour. The essential oils can be obtained by the process of steam distillation, hydro distillation and solvent extraction. The large bioactivity of essential oil act as an antibacterial, antiviral, anti-inflammatory, antifungal, antimutagenic, anticarcinogenic and antioxidant as well as other miscellaneous activities. Hence, it is regarded is one of the most functionally important food ingredients (Brodowska *et al*., 2016). Essential oils can inhibit the growth of harmful micro organisms in bakery products, resulting a product with extended shelf-life and enhanced safety. The volatile oils from cinnamon bark portion contains almost 0.4-2.8 per cent of cinnamaldehyde, caryophyllene, cinnamyl acetate, linalool and eugenol (Butt *et al.,* 2013).

Cake is one of the most popular bakery products consumed by all the age groups, that is usually sweet

and often baked, which has a very soft and spongy texture with desired organoleptic characteristics (Matsakidou *et al*., 2010). The onset of lipid peroxidation, mold growth and rancidity are major problems in producing cake, which causes a great influence on texture, color and organoleptic parameters and also loss of the nutritional value in the cake.

Research regarding the commercial production of the cake formulated with essential oils is required as cinnamon essential oil act as a natural preservative and even it act as a functional ingredient in bakery products.

Now a days bakery industry is looking forward for newer options to ingredients having functional and nutraceutical properties as refined wheat flour, major ingredient in bakery industry is a poor source of dietary fibre and protein. The cake available the market are prepared from refined wheat flour or whole wheat flour, lacks in good quality protein as it is deficient in lysine and dietary fiber content. Hence, there is a need for partial or complete substitution of refined wheat flour by fibre and protein rich natural ingredients and also to increase the number of nutritious snacks.

Composite flour is the mixture of flours from tubers rich in starch (e.g. cassava, yam, sweet potato) and/or protein-rich flours (e.g. soy, peanut) and/or cereals (e.g. maize, rice, millet, buckwheat), with or without wheat flour. The main objective of the composite flour is to make the flours more nutritious enriching its deficient components (essential amino acids like lysine, methionine and minerals) by adding the flour of other cereals (Chandra *et al.*, 2015). Therefore, the present study was designed with an objective to develop and evaluate the physical and sensory quality characteristics of composite flour based cake with cinnamon essential oil.

Material and Methods

The raw materials required for the research study was procured from local market of Bengaluru. Raw materials such as emmer wheat, foxtail millet and little millet grains were cleaned to remove dust and other foreign materials. Cleaned grains were grounded in a commercial centrifugal food processing pulverizer (Serial number: CFPM-B44 with RPM of 2800 with 250-µm mesh sieve), flour was sieved using a BS 40 mesh sieve to obtain fine flour and was stored in stainless steel containers.

Formulation of Composite Flours

Composite flours were formulated by including emmer wheat, little millet, foxtail millet and defatted soya flour with different proportion as shown in Table 1. The refined wheat flour was considered as a control.

Table 1

Formulation of composite flours

Treatments	Refined wheat flour (%)	Emmer Wheat flour (%)	Little millet flour (%)	Foxtail millet flour (%)	Defatted soya flour (%)
Control	100	-	-	-	-
T1	-	40	25	25	10
T2	-	30	30	30	10
T3	-	20	35	35	10
T4	-	10	40	40	10
T5	-	-	45	45	10

T : Treatments

Extraction of Cinnamon Essential Oil (CEO)

Cinnamon barks were broken up into smaller bits and put inside the Clevenger device with water submerged. The essential oil was extracted by hydro distillation, using a clevenger-type apparatus. The obtained essential oil was dried over anhydrous sodium sulphate and stored in refrigerator at 4 °C until further use.

Development of Composite Flour Based Cake with Cinnamon Essential Oil

The control cake (refined wheat flour) and experimental cakes were prepared by following the method mentioned by Lakshminarayan *et al*. (2006) slight modification using various combinations of emmer wheat flour, little millet flour, foxtail millet

flour and defatted soya flour at the ratio of 40:25:25:10, 30:30:30:10, 20:35:35:10, 10:40:40:10 and 00:45:45:10 respectively. All the ingredients were weighed as per the formulation. The composite flour and powdered sugar sieved separately to remove the impurities. All other ingredients *i.e*., whey protein concentrate (WPC), sugar, margarine, egg, milk, baking powder, salt, skim milk powder, baking soda, potassium sorbate, glyceryl mono stearate (GMS*),* carboxy methyl cellulose (CMC) and vanilla essence were kept constant. The cake was prepared by creaming method *i.e.,* fat was softened and the powdered sugar was added gradually to fat and creamed till light and fluffy for 2 minutes. Egg was beaten with vanilla essence and added to fat sugar mixture and continued creaming. Salt, baking soda, potassium sorbate*,* glyceryl monostearate, carboxy methyl cellulose was dissolved in water and this suspension was added to the cream mixture, finally composite flour was mixed gently and added sufficient milk to bring the mixture into dropping consistency. Batter was poured into the greased and dusted in and leveled it uniformly and baked at 180 ^{0}C at 20 min.

After the successful standardization of composite flour based cake, the best accepted cake (control) was further used separately for incorporation of cinnamon essential oil at different concentration (Table 2) *i.e.,* 600 ppm (0.6%), 800 ppm (0.8%), 1000 ppm (1%), 1200 ppm (1.2%) and 1400 ppm (1.4%). Essential oil was added at the time of creaming, further method of preparation followed was similar to that of composite flour based cake. Developed cakes were depicted in Plate 1.

TABLE 2

Formulation of composite flour based cake with cinnamon essential oil

Treatments	Emmer Wheat flour (%)	Little millet flour (%)	Foxtail millet flour (%)	Defatted soya flour (%)	Cinnamon essential oil (%)
Control	10	40	40	10	-
CNT1	10	40	40	10	0.6
CNT2	10	40	40	10	0.8
CNT3	10	40	40	10	1.0
CNT4	10	40	40	10	1.2
CNT5	10	40	40	10	1.4

CN: Cinnamon essential oil

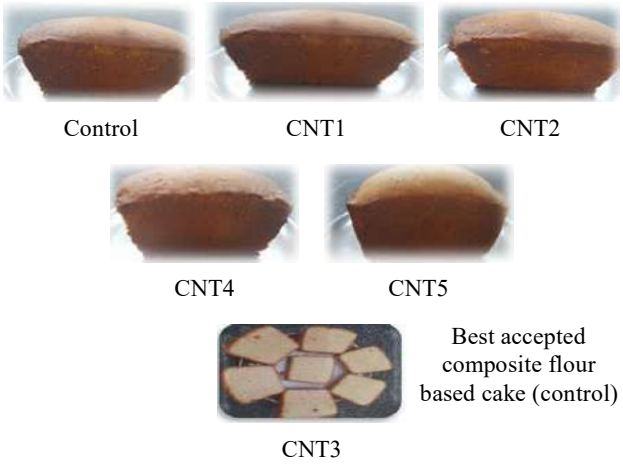

Plate 1 : Development of composite flour based cake with cinnamon essential oil

Physical Parameters of Developed Batter and Cake

The pH of the cake batter was determined using a pH-meter by inserting the electrode directly into a suspension of 10 g batter diluted in 100 ml distilled water. Specific gravity of cake batter (at 28±2 °C) was calculated by dividing the weight of a standard measure of the batter by the weight of an equal volume of water (Ashwini *et al*., 2009).

Physical parameters of cake such as volume (cm^3), specific volume (cm^3/g), density (g/cm^3) and height (cm) were carried out according to Ho *et al*. (2013). Baking loss was calculated according to Hathorn *et al*. (2008). Cake height was calculated as mean value of 3 height measurements comprising middle point height and 2 highest points. The volume was determined according to method used by Mamat *et al*. (2010) using solid replacement technique. Baking loss was calculated by measuring initial batter weight (BW) and final cake weight (CW). Cake density was calculated by measuring cake volume and weight.

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Sensory Evaluation of Developed Product

Developed cake was evaluated for the sensory attributes such as volume (10), appearance (10), crust color (10), crumb color (10), texture (15), aroma (15), grains (20), taste (10) and overall acceptability (100) of the developed cakes by 21 semi trained sensory panelists using composite score method suggested by Khalil *et al*. (2017).

Statistical Analysis

The obtained data were subjected to analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) for testing the significance of variation using OP STAT software (Sheoran *et al*., 1998).

Results and Discussion

Physical Properties of Composite Flour Based Cake Batter

The physical characteristics of the composite flour based cake batter is depicted in Table 3. The pH values of the batter ranged from 6.33 to 6.93. The control group had the highest average pH of 6.97. The composite flour based cake batter exhibited lower pH at all values indicating the decreased wheat flour (gluten) content. The bulk density and specific gravity of the composite flour based cake batter was increased with increase in composite flour percentage varied from 1.90 to 2.37 g/cm^3 and 0.87 to 0.97 g/ml respectively. However, the control group had the lowest average bulk density (1.43 g/cm^3) and specific gravity (0.70 g/ml). This might be due to the increased millets substitution level, in which the air bubbles become more elastic due to non-protein constituents of the flour that disrupt the gluten structure thus decreasing the ability of the batter to hold the air. The statistical analysis revealed that there was a significant difference ($p < 0.05$) among the groups for pH and bulk density. Therefore, it is worth noting that the specific gravity values are higher than the expected range for most cake batters, which typically falls between 0.7 g/ml to 0.8 g/ml (Mudau *et al*., 2021). This may suggest a denser and less aerated batter due to the use of composite flours. The variations in these parameters can affect the texture, moisture content and overall quality of the final baked cake.

Physical Properties of Composite Flour Based Cake

Table 4 provides the physical parameters of cakes prepared using different proportion of composite

Table 3

Physical properties of composite flour based cake batter

	Physical properties of batter		
	pH	Bulk Density (g/cm^3)	Specific gravity (g/ml)
Control	6.97^{a} ± 0.01	1.43^{c} ± 0.01	0.70^{a} ± 0.08
T1	6.93^{a} ± 0.02	1.90^{b} ± 0.02	0.87^{a} ± 0.04
T2	6.53^{ab} ± 0.02	2.03^{ab} ± 0.04	0.93^{a} ± 0.03
T3	6.43^{ab} ± 0.01	2.10^{ab} ± 0.02	0.94^{a} ± 0.06
T4	6.57^{ab} ± 0.11	2.30^{a} ± 0.01	0.96^{a} ± 0.09
T5	6.33^{b} ± 0.02	2.37^{a} ± 0.01	0.97^{a} ± 0.04
F value	*	*	NS
S.Em±	0.090	0.039	0.020
CD @ 5%	0.289	0.124	0.064

Values are expressed as mean ±SD of triplicates determinations. Values having different superscripts are significantly ($p<0.05$) different. *Significant at 5 % NS-Non significant.

TABLE 4
Physical characteristics of composite flour based cake

Treatments	Physical parameters of cake					
	Height (cm)	Volume (cm^3)	Specific volume (cm^3/g)	Weight (g)	Density (g/cm^3)	Baking loss(%)
Control	8.3 ^{a} ± 0.13	445.7 ^{a} ± 0.12	2.40 ^{a} ± 0.03	183.1 ^{e} ± 0.13	0.40 ^{a} ± 0.03	11.67 ^{a} ± 0.11
T1	7.8 ^{ab} ± 0.09	422.9 ^{b} ± 0.13	2.13 ^{ab} ± 0.05	197.1 ^{b} ± 0.11	0.46 ^{a} ± 0.13	11.23 ^{a} ± 0.09
T2	7.5 ^{bc} ± 0.16	400.4 ^{c} ± 0.23	2.06 ^{ab} ± 0.01	193.6 ^{c} ± 0.13	0.50 ^{a} ± 0.23	9.80 ^{b} ± 0.12
T3	7.3 ^{bc} ± 0.16	365.7 ^{e} ± 0.08	1.86 ^{b} ± 0.04	192.7 ^{c} ± 0.12	0.53 ^{a} ± 0.09	9.76 ^{b} ± 0.09
T4	7.0 ^{c} ± 0.09	381.7 ^{d} ± 0.14	2.03 ^{b} ± 0.06	188.9 ^{d} ± 0.18	0.50 ^{a} ± 0.12	8.86 ^{c} ± 0.13
T5	7.0 ^{c} ± 0.08	420.0 ^{b} ± 0.12	2.10 ^{ab} ± 0.07	201.5 ^{a} ± 0.17	0.50 ^{a} ± 0.14	9.00 ^{c} ± 0.07
F value	*	*	*	*	NS	*
S.Em±	0.10	5.50	0.03	2.61	0.02	0.15
CD @ 5%	0.17	17.56	0.10	8.33	0.05	0.46

Values are expressed as mean ±SD of triplicates determinations;
Values having different superscripts are significantly ($p<0.05$) different; *Significant at 5 % NS-Non significant

flours. The height, volume and specific volume of the composite flour based cakes ranged from 7.0 to 7.8 cm, 365.7 to 422.9 cm^3 and 1.86 to 2.13 cm^3/g. The control group had the highest average height, volume and specific volume of 8.3 cm, 445.7 cm^3 and 2.40 cm^3/g, respectively. This might be due to decreased in structure forming proteins (low levels of gluten in the dough) in the composite flour which resulted in less retention of carbon dioxide gas and less dense texture. Therefore, dilution of gluten in the flour blends significantly decreased the volume, specific volume and height of composite four based cake. Mudau *et al*. (2021) observed that, incorporation of millet flour decreased the volume and specific volume of bread from 400 to 256.67 mL and 2.69 to 1.81. ml/g, respectively and observed that, the weight of bread increased from 141.77 to 148.52g, respectively. The weight and density of the composite flour based cakes varied from 188.9 to 201.5 g and 0.46 to 0.53 g/cm^3. The increase in weight and density could be attributed to particle size, increased moisture absorption and decreased air entrapment, resulting in heavy dough. Kayitesi *et al*. (2012) reported that fiber rich flours exhibited higher water absorption capacity and bulk density due to the heaviness and particle size of the flour. The control group had the lowest average weight and density of 183.1 g and 0.40 g/cm^3, while the treatment groups had increased weight and density with increase in composite flour incorporation. The percentage of baking loss of the composite flour based cake had decreased (11.23 to 8.86%) with increased composite flour percentage while compared to control (11.67%). Except density all physical properties of the composite flour based cake had significant difference between the treatments and control. Amandikwa *et al*. (2015) experimented on wheat-yam flour composite bread and David (2015) observed on bread prepared from wheat and unripe plantain composite flours fortified with bambara groundnut protein concentrate. Results from both the study showed that, the loaf weight of composite bread increased significantly ($p < 0.05$) with increased levels of finger millet flour incorporation. Singh *et al*. (2022) prepared the cake with refined wheat flour (50%) and pearl millet flour (50%) was found to be maximum in weight (320 g), reduced volume and uniformity index (0.4 cm).

Sensorial Attributes of Composite Flour Based Cake

Sensorial attributes *viz*., appearance, crust colour, crumb colour, volume, texture, aroma, grains and taste of composite flour based cake are shown in Table 5 and the overall acceptability score was depicted in Fig. 1. The non-significant result was observed in the texture and aroma with mean scores ranging from 12.84 to 13.65 and 11.04 to 12.30 compared to control (14.01 and 12.50), respectively. Significant difference was observed in the appearance, crumb colour, volume, grains, taste and overall acceptability compared with control and between the treatments.

Cake with 10 per cent of emmer wheat flour, 40 per cent each of little millet flour, foxtail millet flour and 10 per cent of defatted soya flour (T4) was best accepted among all the treatments of sensory attributes with mean score of 8.88, 8.73, 8.83, 8.87, 13.65, 12.30, 17.88, 8.72. 87.61 compared to the control 9.00, 9.02, 9.10, 9.20, 14.01, 12.50, 18.69, 9.01, 91.66 respectively. The study revealed that colour scores were desirable with increased composite flour. The desired colour was obtained mainly due to the maillard browning during baking. Millet flour and defatted soya flour has a unique texture and moisture absorbing capacity. When added to cake batter, it contributed to a moist and tender crumb texture, improves the overall mouthfeel of the cake. Also, millet flour can impart a distinct nutty or mildly sweet flavor to the cake, adding depth and complexity to

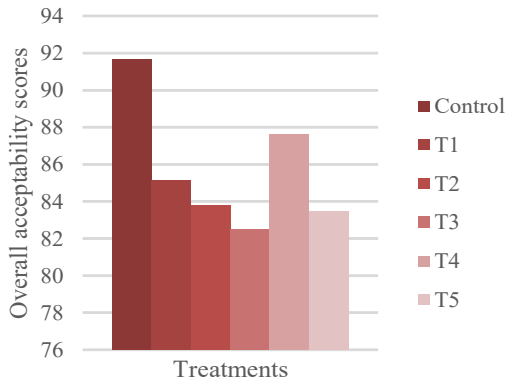

Fig. 1 : Overall acceptability of composite flour based cake

TABLE 5
Sensorial attributes of composite flour cakes

Treatments	Sensory attributes									
	Appearance	Crust color	Crumb color	Volume	Texture	Aroma	Grains	Taste	OAA
Control	9.00 ^{a} ± 0.80	9.02 ^{a} ± 0.13	9.10 ^{a} ± 0.18	9.20 ^{a} ± 0.21	14.01 ^{a} ± 0.32	12.50 ^{a} ± 0.21	18.69 ^{a} ± 0.13	9.01 ^{a} ± 0.21	91.66 ^{a} ± 0.32
T1	8.52 ^{bc} ± 0.24	8.10 ^{c} ± 0.24	8.04 ^{c} ± 0.32	8.28 ^{b} ± 0.23	13.30 ^{ab} ± 0.24	11.04 ^{a} ± 0.22	16.76 ^{bc} ± 0.21	8.35 ^{bcd} ± 0.21	85.14 ^{c} ± 0.16
T2	8.80 ^{ab} ± 0.24	8.03 ^{c} ± 0.13	8.25 ^{c} ± 0.22	8.85 ^{ab} ± 0.18	12.84 ^{b} ± 0.21	11.42 ^{a} ± 0.18	16.41 ^{c} ± 0.16	8.19 ^{cd} ± 0.40	83.8 ^{cd} ± 0.21
T3	8.00 ^{d} ± 0.32	8.34 ^{bc} ± 0.24	8.57 ^{b} ± 0.23	8.29 ^{b} ± 0.19	13.10 ^{ab} ± 0.22	11.14 ^{a} ± 0.15	17.07 ^{bc} ± 0.23	8.00 ^{d} ± 0.23	82.47 ^{d} ± 0.23
T4	8.88 ^{a} ± 0.17	8.73 ^{ab} ± 0.24	8.83 ^{ab} ± 0.21	8.87 ^{ab} ± 0.31	13.65 ^{ab} ± 0.24	12.30 ^{a} ± 0.16	17.88 ^{ab} ± 0.15	8.72 ^{ab} ± 0.31	87.61 ^{b} ± 0.21
T5	8.34 ^{c} ± 0.21	8.20 ^{bc} ± 0.13	8.26 ^{c} ± 0.21	8.10 ^{b} ± 0.15	13.19 ^{ab} ± 0.32	11.05 ^{a} ± 0.33	16.52 ^{bc} ± 0.32	8.50 ^{bc} ± 0.18	83.47 ^{cd} ± 0.16
F value	*	*	*	*	NS	NS	*	*	*
S. Em ±	0.33	0.18	0.18	0.25	0.24	0.64	0.52	0.04	1.29
CD @ 5%	0.22	0.19	0.22	0.23	1.5	1.54	0.65	0.19	2.81

OAA: Over all acceptability, values are expressed as mean ±SD of triplicates determinations. Values having different superscripts are significantly ($p<0.05$) different. * Significant at 5 % NS-Non significant

the taste. Soya flour also acts as a binding agent due to its protein content. It helps to hold the cake batter together, providing structure and stability during baking. Adanse *et al*. (2021) reported a high overall acceptability score of 8.87 for a cake with 40 per cent millet flour incorporation. This suggests that the inclusion of millet flour in cakes can contribute to acceptable sensory attributes and consumer preference. The findings supported the potential use of millet flour as an ingredient in cake formulations to enhance sensory quality and broaden the range of options available to consumers. Similar trend was observed by the Sabbu and Chopra (2013), indicated that cakes standardized with the incorporation of barley and finger millet flours scored highest in sensory attributes such as appearance, taste, colour and volume. Ashoka *et al*., (2021) reported that wheat flour supplemented up to 10 per cent with non-cereal based flour enhanced the aroma, texture and taste of the product.

Physical Properties of Composite Flour Based Cake Batter with Cinnamon Essential Oil

The data presented in Table 6 indicates the mean values of pH, bulk density and specific gravity of the control cake batter were found to be 6.52, 2.28 g/cm^3, and 0.94g/m However, as the concentration of cinnamon essential oil increased from 0.6 to 1.4 per cent, there was a slight decrease in the pH, bulk density and specific gravity were observed *i.e.,* ranged from 6.47 to 6.42, 2.28 to 2.18gm / cm^3 and 0.94 to 0.92g/m, respectively.

Cinnamon essential oil, with its slightly acidic nature contributed to a slight decrease in the pH of the cake batter. This acidity can have an impact on the texture and flavor of the cake. Additionally, cinnamon essential oil is typically lighter than other cake ingredients, which results in a decrease in the overall density of the batter. However, the specific gravity change may not be significant since essential oils are added in relatively small quantities. Statistically non-significant result was observed between the treatments in terms of pH, bulk density and specific gravity of composite flour based cake batter with cinnamon essential oil. A study conducted by Amer (2018) reported similar findings that, with an increased addition of lemon and orange oils level from 1.0 to 1.5 per cent resulted in a slight decrease in bulk density and specific gravity of cakes compared to the control. Gomez *et al*. (2007) reported that essential oils can entrap air bubbles in the batter thus maintaining and allowing the expansion of these bubbles which is caused by the release of gases during baking.

TABLE 6

Physical characteristics of composite flour based cake batter with cinnamon essential oil

Treatments	Physical properties of batter		
	pH	Bulk Density (g/cm^3)	Specific gravity (g/ml)
Control	6.52 ± 0.01	2.28 ± 0.02	0.94 ± 0.02
CNT1	6.47 ± 0.01	2.28 ± 0.01	0.94 ± 0.04
CNT2	6.45 ± 0.02	2.23 ± 0.01	0.93 ± 0.01
CNT3	6.43 ± 0.01	2.24 ± 0.02	0.93 ± 0.01
CNT4	6.42 ± 0.02	2.18 ± 0.01	0.92 ± 0.03
CNT5	6.42 ± 0.01	2.18 ± 0.11	0.92 ± 0.01
F value	NS	NS	NS
SEm±	0.03	0.12	0.02
CD @ 5%	0.25	0.34	0.29

Values are expressed as mean ± SD of triplicates determinations;
Values having different superscripts are significantly ($p<0.05$) different; *Significant at 5 % ; NS-Non significant

TABLE 7
Physical properties of composite flour based cake with cinnamon essential oil

Treatments	Physical parameters of cake					
	Height (cm)	Volume (cm^3)	Specific volume (cm^3/g)	Weight (g)	Density (g/cm^3)	Baking loss(%)
Control	7.3 ± 0.08	420.2 ± 0.12	2.09 ± 0.12	201.0 ^{f} ± 0.13	0.47 ± 0.13	8.8 ^{c} ± 0.07
CNT1	7.5 ± 0.12	422.1 ± 0.11	2.03 ± 0.12	208.2 ^{e} ± 0.21	0.49 ± 0.17	9.2 ^{bc} ± 0.16
CNT2	7.3 ± 0.08	423.4 ± 0.12	1.99 ± 0.12	212.4 ^{d} ± 0.13	0.50 ± 0.08	9.3 ^{abc} ± 0.09
CNT3	7.3 ± 0.12	428.6 ± 0.13	2.00 ± 0.05	213.8 ^{c} ± 0.09	0.50 ± 0.01	9.5 ^{ab} ± 0.03
CNT4	7.4 ± 0.11	430.4 ± 0.21	1.98 ± 0.08	217.9 ^{b} ± 0.19	0.51 ± 0.02	9.9 ^{a} ± 0.12
CNT5	7.3 ± 0.13	429.0 ± 0.21	1.92 ± 0.14	223.8 ^{a} ± 0.14	0.52 ± 0.03	9.9 ^{a} ± 0.13
F value	NS	NS	NS	*	NS	*
S.Em±	0.13	0.12	0.11	0.09	0.12	0.03
CD @ 5%	0.25	0.28	0.36	0.18	0.19	0.27

Values are expressed as mean ± SD of triplicates determinations;
Values having different superscripts are significantly ($p<0.05$) different; *Significant at 5 %; NS-Non significant

Physical Properties of Composite Flour Based Cake with Cinnamon Essential Oil

Table 7 presents the physical characteristics of composite flour based cakes incorporated with cinnamon essential oil. The results showed that, there were no significant differences observed in the height, volume, specific volume and density of the developed cakes among the different variations (Control, CNT1, CNT2, CNT3, CNT4 and CNT5). However, a significant gradual increase was observed across the variations between the control and the treatment group in the weight (201.0 g to 223.8 g) and baking loss (8.8 to 9.9%) of the cakes. The height, volume, specific volume and density of the experimental cakes had minimal differences between the variations *i.e.,* ranged from 7.3 to 7.5 cm, 422.1 to 430.4 cm^3, 1.92 to 2.03 cm^3/g and 0.49 and 0.52 g/cm^3 whereas, control group had 7.3 cm, 420.2 cm^3, 2.09 cm^3/g and 0.47 g/cm^3 respectively.

El Zainy *et al.* (2014) reported that addition of cinnamon oil led to the improvement of weight, density and volume of the cake. These findings suggested that the addition of essential oil can influence the weight of the cakes while maintaining their overall structure and volume.

Sensorial Attributes of Composite Flour Based C cake with Cinnamon Essential Oil

The data in Table 8 represented the mean sensory scores of the different treatments of composite flour based cake with cinnamon essential oil compared to the control. No significant differences could be detected among the treatments containing cinnamon essential oil and control sample in appearance, crust colour, crumb colour, volume, texture and grains but the significant difference was observed in the aroma, taste and overall acceptability. With regard to the overall acceptability, the composite flour based cake sample containing 1200 ppm (1.2%) of cinnamon essential oil was highly accepted with the mean score of 91.86 compared to control (87.61) and other treatments (87.28-90.20), respectively (Fig. 2). Higher the incorporation level of cinnamon essential oil led to intense odor and taste, showed negative effect on overall acceptability. Generally, it is well known that in complex systems like cakes, several ingredients interact with each other and affect the sensory properties.

TABLE 8

Mean sensory scores of composite flour based cake with cinnamon essential oil

Treatments	Sensory attributes									
	Appearance	Crust color	Crumb color	Volume	Texture	Aroma	Grains	Taste	OAA
Control	8.88 ^{a} ± 0.17	8.73 ^{a} ± 0.24	8.83 ^{a} ± 0.21	8.87 ^{a} ± 0.31	13.65 ^{a} ± 0.24	12.30 ^{c} ± 0.16	17.88 ^{a} ± 0.15	8.72 ^{c} ± 0.31	87.61 ^{b} ± 0.21
CNT_1	8.33 ^{a} ± 0.16	8.81 ^{a} ± 0.85	8.43 ^{a} ± 0.20	8.43 ^{a} ± 0.32	12.64 ^{ab} ± 0.21	12.71 ^{bc} ± 0.28	17.30 ^{a} ± 0.18	8.90 ^{bc} ± 0.60	87.28 ^{b} ± 0.12
CNT_2	8.40 ^{a} ± 0.94	8.30 ^{a} ± 0.04	8.43 ^{a} ± 0.12	8.43 ^{a} ± 0.32	12.28 ^{ab} ± 0.15	13.16 ^{abc} ± 0.19	17.91 ^{a} ± 0.11	9.20 ^{abc} ± 0.24	90.20 ^{a} ± 0.12
CNT_3	8.23 ^{a} ± 0.88	8.34 ^{a} ± 0.3	8.67 ^{a} ± 0.36	8.09 ^{a} ± 0.26	13.38 ^{ab} ± 0.22	13.45 ^{ab} ± 0.31	17.19 ^{a} ± 0.32	9.34 ^{ab} ± 0.23	90.19 ^{a} ± 0.21
CNT_4	8.70 ^{a} ± 0.07	8.45 ^{a} ± 0.20	8.90 ^{a} ± 0.32	8.58 ^{a} ± 0.24	13.47 ^{ab} ± 0.32	13.89 ^{a} ± 0.20	18.40 ^{a} ± 0.21	9.54 ^{a} ± 0.12	91.66 ^{a} ± 0.13
CNT_5	8.21 ^{a} ± 0.92	8.10 ^{a} ± 0.04	8.03 ^{a} ± 0.24	8.32 ^{a} ± 0.35	12.04 ^{a} ± 0.16	12.67 ^{bc} ± 0.14	17.09 ^{a} ± 0.23	8.89 ^{bc} ± 0.23	86.00 ^{b} ± 0.22
F-value	NS	NS	NS	NS	NS	*	NS	*	*
SEm±	0.23	0.16	0.23	0.34	0.61	0.19	0.64	0.09	1.70
CD @ 5%	0.61	0.54	0.68	0.63	0.41	0.77	1.29	0.34	1.23

OAA: Over all acceptability, values are expressed as mean ±SD of triplicates determinations. Values having different superscripts are significantly ($p<0.05$) different.
*Significant at 5 % NS-Non significant

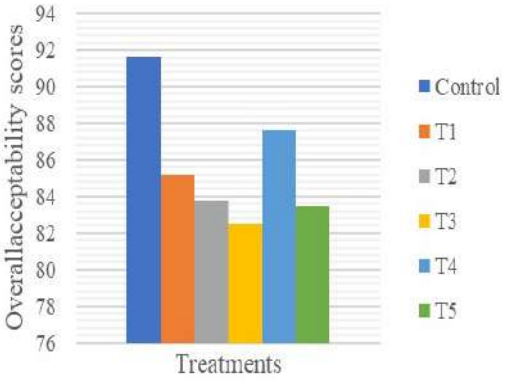

Fig 2: Overall acceptability score of composite flour based cake with cinnamon essential oil

As cinnamon essential oil has a strong, distinct flavor that is characteristic of cinnamon spice hence, by adding it to the cake batter, it enhances the overall flavor profile of the cake, giving it a warm and aromatic taste. Cinnamon essential oil contains natural volatile compound such as cinnamaldehyde that contribute to its spicy and slightly warming sensation. Incorporating cinnamon essential oil can add a subtle level of heat and spiciness to the cake's flavor profile.

In a study by Ibrahium *et al*. (2013) on the incorporation of different concentrations of clove essential oil (CEO) in cakes, no significant effects were observed in most of the sensorial qualities up to 800 ppm of CEO and were generally acceptable. However, samples with more than 800 ppm CEO showed reduced scores for taste, aroma and overall acceptability. Similarly, Alrefaie and Bostan (2017) reported that a cake with 600 ppm of lemon essential oil (LEO) significantly differed in taste and aroma, likely due to the desirable lemon odor of LEO, which was preferred by the panelists in terms of overall acceptability. Amer (2018) indicated that very good sensory characteristics were obtained by panelists with increased levels of lemon essential oil from 0.5 to 1.5 per cent along with control. Hence, essential oils often have obvious effect on acceptance of consumers with a pleasant odor and sometimes a distinctive taste is used in significant amounts in the flavoring.

The study highlights the functional properties and sensory attributes of composite flour and the effects

of cinnamon essential oil on composite flour based cakes. The findings suggest that the incorporation of millet flour and other flour enhanced the nutritional quality of the cake. Cinnamon essential oil can enhance the sensory quality and acts as natural preservative by extending the shelf life of the product and broaden the range of options available to consumers, providing potential for the development of nutritious and flavorful bakery products.

Acknowledgement : I would like to express my heartfelt gratitude to the Indian Council of Social Science Research (ICSSR) for their invaluable support and financial assistance throughout the course of this research project. Their funding played a crucial role in enabling me to conduct this study and achieve the research objectives.

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