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EFFECT OF INCORPORATION OF MINT ON TEXTURE, COLOUR AND SENSORY PARAMETERS OF BISCUITS

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In recent years, there has been a general trend towards replacing the use of synthetic antioxidant by natural antioxidant, derived from various plants, spices and oil seeds, in processed food. The present study deals in the use of mint (Mentha spicta L) as a source of natural antioxidant in different forms viz, powder, extract, and pure menthol for its application in biscuits. Formulation of mint component was designed based on preliminary studies using various parameters such as instrumental assessment for texture and color measurement and sensory evaluation. The selected levels were as follows 1% mint powder (MNT-P), 500 mg mint extract (MNT-E), and 100 ppm pure menthol (MNT-M) for incorporation in biscuits. The biscuits with different mint forms were packed in unit pouches of metallized polyester/poly laminate and stored at room temperature for five months. The texture value of biscuits with mint powder (MNT-P) received higher scores, comparable with the control (CNT) and BHA (BNT) biscuit indicating their crisp nature. However, color measurement (ΔE) values in MNT-P biscuits were higher followed by MNT-E biscuit due to their green color, whereas the values of MNT-M biscuit were comparable with the CNT and BHA biscuit indicating MNT-M did not impart any change in the color of the biscuit. The sensory scores of MNT-M were higher ($P \leq 0.05$) than MNT-P and MNT-E biscuits. MNT-P variation received significantly higher ($P \leq 0.05$) scores in terms of texture, taste and mouth feel. The results indicate that MNT-P biscuits were highly acceptable compared to MNT-E and MNT-M biscuits.

Keywords: ***Mint, Biscuit, Sensory, Color, Textural analyzer.***

INTRODUCTION

The keeping quality of biscuit is of great economic importance since these products are often stored for extended periods before they are consumed. The onset of rancidity in baked goods affects the texture, color, and sensory parameters of biscuits. If the biscuit texture, color, and sensory parameters fail to meet consumer expectations, the product probably will not be consumed and repeat sales will be lost.

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Instrumental assessment of biscuit texture and color has evolved from new application and combination of principle of material testing. The texture analyzer measures the hardness, crunchiness, and crumbliness of the biscuit, whereas as the color measuring system measures the change in color of the biscuits during storage.[1–3]

Recently, natural plants have received much attention as a source of biologically active substances including antioxidants, antimutagens, and anticarcinogens.[4] Natural aromatic plants, spices, fruit powder, and fruit kernel powder have been widely used in food products such as meat and meat product, dairy, and bakery products.[5–9]

Mint is the third largest popular flavor worldwide; it appeals to all people irrespective of age, gender, and ethnic background. Mint flavor was well-known in Asia about 2000 years ago.[10] It is regarded as one of the most important spices throughout the world. Mint belongs to a small genus of aromatic perennial herbs distributed mainly in the temperate regions of the world.

Today, mint is considered the most important commercial essential oil-bearing plant from the standpoint of worldwide production with Spearmint, (*Mentha spicata L*), Peppermint (*Mentha piperita L*), and Vornmint (*Mentha arvenisi L*) essence being the most valuable for their use in food, confectioneries, cosmetic, and pharmaceutical industries.[11] Several species have been introduced into various countries and are cultivated for their aromatic leaves and flowers. In India about six species are recorded to be used widely.[12] It provides a rich source of natural antioxidants.

This article addresses the utilization of plant material such as mint, incorporated in biscuits in various forms (powder, extract, and Menthol crystals) at different levels as an antioxidant. The effect of incorporation on the quality characteristics (texture and color) and acceptability of biscuits was also studied during the storage period.

MATERIALS AND METHODS

Fresh mint leaves were washed repeatedly in Luke warm water (3–4 times), drained, and dehydrated in a Semco hot air oven (Scientific Equipments Manufactures, Chennai, India) (overnight at ≤ 60°C). The dried leaves were finely powdered, passed through 60-mesh screen (Geologists Syndicate Private limited, Kolkatta, India) and stored in airtight packages, until further use.

Preparation of Mint Extract

About 25 g of the mint powder was taken in a stopper flask; ethanol (50–60 ml) was added and kept for 6 hours in a mechanical shaker at room temperature. It was filtered, and the residue was treated again with the solvent and filtered. The combined filtrates were stored in amber colored bottle at −4°C. The extract was concentrated by evaporating under vacuum (50°C) the solvent in rotary evaporator (Buchi Rotavapor, Flawil, Switzerland). The concentrated extract was stored in the refrigerator until further use.

Preparation of Biscuits

Biscuits incorporated with mint powder, extract and pure menthol were prepared with varying levels and were subjected to acceptability studies. Based on these results biscuits were selected for further studies. They were prepared by the following method.[13] Sugar (90 g) and fat (60 g) were creamed for 3 to 4 minutes in a Hobart mixer. The mint extracts/powder/

Table 1 Different levels and selected level of mint constituents incorporated in biscuits.

Sl. no.	Forms of mint	CODE	Level of incorporation				Selected levels
1.	Mint powder	MNT-P	0.5 %	1 %	2.5 %	5 %	1 %
2.	Mint extract*	MNT-E	200 mg	400 mg	600 mg	800 mg	500 mg
3.	Pure Menthol	MNT-M	100 ppm	150 ppm	200 ppm	–	100 ppm
4.	Control	CNT					
5.	BHA	BNT	As per standard				200 ppm

*Mint extract — incorporated at 500 mg. Since biscuits with 400 & 600 mg were found to be acceptable intermediate levels, i.e., 500 mg was selected.

menthol were blended with the fat and the emulsion was mixed with sugar. The water containing sodium and ammonium bicarbonate (1.5 and 3 g), and sodium chloride (3 g) was added to the above cream and mixed for 5 minutes to obtain a homogenous dough. Wheat flour (300 g) sieved twice with baking powder (0.9 g) was added and mixed for 3 minutes. The dough was sheeted to a thickness of 3.5 mm and cut into circular shapes using 45-mm cutter and placed on an aluminum tray, baked at 160°C for 10 minutes, and then allowed to cool. The biscuits packed in unit pouches of metallized polyester/poly and stored at room temperature.

In a preliminary study, biscuits were prepared to provide three variations at four levels of incorporation of mint and were subjected to sensory acceptability. The data indicated that the threshold level of mint powder (MNT-P) was 1%, mint extract (MNT-E) was 500mg, while that for pure menthol (MNT-M) was 100 ppm. Hence, for further studies biscuits were prepared accordingly. Control biscuits were prepared without the addition of mint/synthetic antioxidant. The standard variation was prepared with BHA at 200 ppm (BNT). The selected levels of mint incorporation is shown in Table 1.

Instrumental Assessment

Texture measurement. The breaking strength of biscuits was measured by following the triple beam snap method (also called three point break) using Texture Analyzer (Model Tahdi, Stable Microsystems, Surrey, UK). The samples were rested on two supporting beams spread at a distance of 2.5 cm. Another beam connected to moving part was brought down to break the biscuits at a crosshead speed at 10mm/min and load cell of 10 kg. Care was taken to see that the point of contact was equivalent from both the supporting beams (Fig. 1). The peak force (kg) at break, representing breaking strength was recorded and average values were calculated.[2]

Color measurement. The values of surface color of biscuits in terms of color difference (ΔE) and percent whiteness (w) were measured using U.V visible recording Minolta spectrophotometer, (M-3500d, Konica Minolta, Osaka, Japan). A standard white board made from barium sulphate (100% whiteness) was used as a perfectly white object for setting the instrument with illuminant. Biscuit was placed in the sample holder and the reflectance was auto-recorded for the wavelength ranging from 360–800 nm. The color difference value (ΔE) for biscuit, in comparison with the standard and also the percent whiteness (w) were recorded.

Figure 1 Photograph of placement of biscuit on the beam for the textural measurement.

Sensory Quality Assessment

Sensory evaluation of biscuit (freshly prepared and stored) was conducted to determine the acceptability of the product prepared by mint. Ten panelists were selected from among the scientists in the Flour Milling Baking and Confectionery Technology Department, Central Food Technological Research Institute, Mysore, India.

Five differently coded samples i.e. CNT, MNT-P, MNT-M, MNT-E, and BNT were given to the 10 panelists for sensory evaluation The panelists were asked to give the scores for each sample, for different quality attributes like color, surface character, crumb color, texture, taste, mouth feel and overall quality by assigning scores as follows. Color: 1 = brownish/whitish, non-uniform and 10 = golden brown, uniform; surface character: 1 = rough and 10 = smooth; crumb color: 1 = dull white/dark brown and 10 = creamy white; texture: 1 = hard/brittle/grittiness and 20 = crisp; taste: 1 = off-flavor/dislike and 20 = pleasant to mouth; Mouthfeel: 1 = residual taste/formation of lump in mouth and 10 = easy break down/clean mouthfeel. The overall quality score (80) was taken as the combined score of all previous attributes. Incorporation of mint powder and mint extract in biscuits contributed a green color; hence this variation was presented for sensory evaluation on a separate occasion along with control product. This was done to prevent bias in the evaluation.[13–14]

Statistical Analysis

Statistical analysis of data was done by using ANOVA on five experimental groups with the average of six sample readings. The experimental groups were then separated statistically by using Duncan's multiple range test.[15]

RESULTS

Instrumental Texture Measurement

Texture is an important parameter in assessing quality of bakery products with research focusing on the use of fat replacers and plant materials.[6,16–18] The data on the texture of the control and experimental biscuits as influenced by the different forms of mint incorporation during storage is presented in Table 2. The typical curve for the texture measurement of biscuit is shown in Fig. 2. The control, MNT-P and BNT biscuits had similar breaking strength values when fresh indicating crisp texture. On the other hand, the MNT-M and MNT-E had higher breaking strength of 1612 and 1520 g, respectively, which was higher than the control value (1445 g), biscuits containing menthol showed an increase in texture values from 1612 to 2004 g. The harder texture of MNT-M could be attributed to the stronger interaction of menthol with flour components and the ingredients used in biscuit preparation.

The changes in texture of biscuits during five months of storage showed that there was not much change in the breaking strength of control and biscuits with BHA. Biscuits with MNT-P and MNT-E exhibited increased breaking strength from 1475 to 1817 g and 1520 to 1901 g respectively indicating slightly harder texture than the control & BHA biscuits.

Brennan and Samyue[7] in their study on evaluation of textural characteristics of dietary fiber enriched biscuits reported that the biscuit firmness was reduced with addition of potato fibers. The breaking strength of biscuits with mint powder and BHA are almost comparable with each other, which indicate that biscuit containing Mint powder did not show significant changes in texture during storage period.

Color Measurement

Color is also one of important quality attributes for consumer acceptance of bakery products. Color Measurement (ΔE) of biscuits during storage period was studied. Biscuits prepared with the incorporation of natural antioxidant (Mint powder, Mint extract and pure menthol), synthetic antioxidant (BHA) and control were packed in metallized polyester/poly and stored at room temperature, were analyzed for instrumental color measurement at monthly interval during five month storage period.

The color measurement of biscuit during their storage is presented in Table 3. As observed in fresh biscuit, the sample containing mint powder had maximum value of ΔE 47.7 followed with biscuits containing mint extract with values of 45.55. Biscuits containing other mint forms had color values similar to control biscuit.

Table 2 Changes in textural quality* of biscuits during storage (g).

	Period in months					
Samples	0	1	2	3	4	5
CNT	1445^{a}	1480^{a}	1537^{a}	1598^{a}	1679^{a}	1761^{a}
MNT-P	1475^{ab}	1518^{ab}	1578^{ab}	1638^{ab}	1705^{ab}	1817^{ab}
MNT-M	1612^{d}	1655^{d}	1773^{d}	1892^{d}	1956^{d}	2004^{d}
MNT-E	1520^{c}	1566^{c}	1635^{c}	1704^{c}	1832^{c}	1901^{c}
BNT	1450^{a}	1470^{a}	1527^{a}	1585^{a}	1656^{a}	1728^{a}

*Means followed by column by different letters differ significantly at 25 df. CNT = Control Biscuit; MNT-P = Mint powder Biscuit; MNT-M = Pure menthol Biscuit; MNT-E = Mint extract Biscuit and BNT = BHA Biscuit.

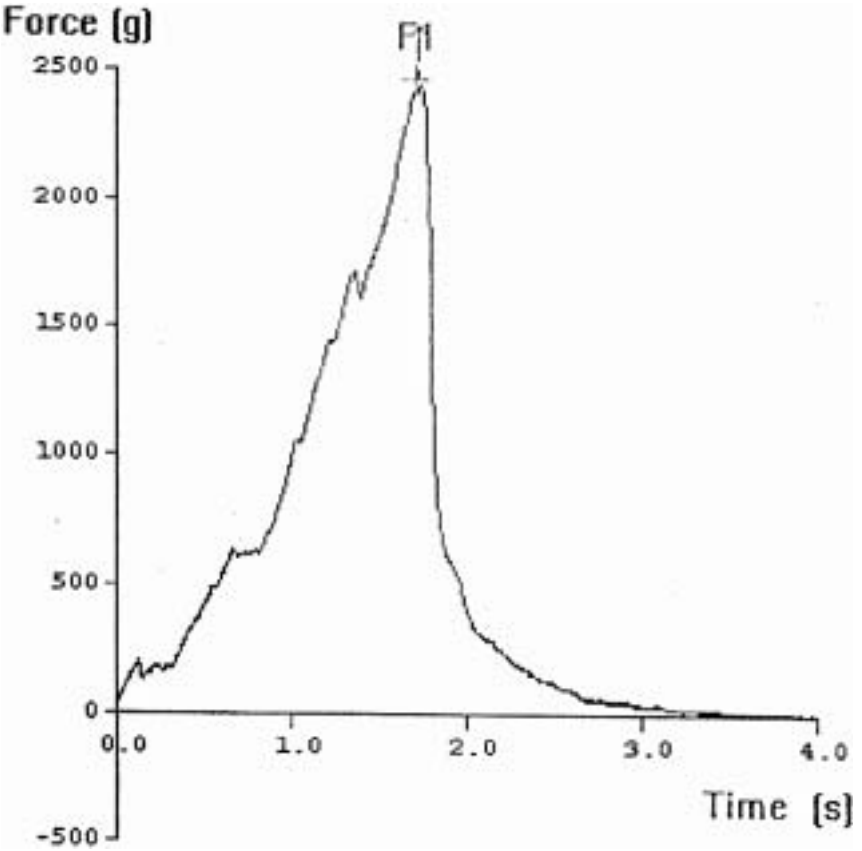

Figure 2 Typical curve for measurement of breaking strength of biscuit using Texture analyzer (P1 — Peak of the curve).

Table 3 Changes in color analysis* of biscuits during storage (g).

	Period in months					
Samples	0	1	2	3	4	5
CNT	41.98[a]	41.64[a]	41.48[a]	41.11[a]	40.83[a]	40.56[a]
MNT-P	47.72[c]	47.51[c]	47.23[c]	46.83[c]	46.62[c]	46.23[c]
MNT-M	42.63[a]	42.12[a]	41.92[a]	41.78[a]	41.46[a]	41.08[a]
MNT-E	45.55[b]	45.27[b]	44.98[b]	44.61[b]	44.19[b]	43.99[b]
BNT	42.00[a]	41.86[a]	41.53[a]	41.23[a]	40.95[a]	40.68[a]

CNT = Control Biscuit; MNT-P = Mint powder Biscuit; MNT-M = Pure menthol Biscuit; MNT-E = Mint extract Biscuit, and BNT = BHA Biscuit. *Means followed by column by different letters differ significantly at 25 df.

Although the color value (ΔE) of all these experimental biscuit reduced marginally during five month storage period, the decrease was uniform in all the experimental samples, as the biscuit were packed in metallized polyester poly, having good barrier properties for light, moisture oxygen. The observed marginal reduction in color during storage could be due to internal changes in the packet caused by available headspace oxygen.

Sensory Evaluation

Sensory evaluation of biscuit is very crucial in assessing acceptance of consumer. Hence systematic sensory analysis was carried out using the above variations by a trained panel. The products were packed in pouches made out of metallized polyester/polyethylene (LDPE) laminate. Evaluation was conducted on five occasions during the storage period i.e. 0, 1, 2, 3, 4, and 5 months. The mean scores before and after storage, assigned to the five variations are given in Tables 4 and 5.

In the fresh samples in Table 4, it was observed that MNT-M and MNT-E prepared with menthol and extract, respectively, were well accepted in terms of color, surface character, and crumb color compared to the biscuits prepared with synthetic antioxidant–BHA. In terms of texture and taste, the mean scores did not differ significantly ($p < 0.05$) between MNT-P, MNT-M, MNT-E, and BNT. In terms of overall quality, CNT and BNT were rated significantly higher scores ($P \leq 0.05$) followed by MNT-M, MNT-E, and MNT-P.

The sensory scores of the products evaluated at the end of the study period are given in Table 5. It was interesting to note that, in terms of color, surface character, crumb color, and texture, MNT-M and MNT-E biscuits were comparable with BNT biscuits, with no significant differences (Fig. 3). Similar results were observed for the plant extract incorporated biscuits in an earlier study.[6] Biscuits treated with natural antioxidants extracted from *Vitis vinifera* and Moringa *oleifera* received higher scores during storage period of 6 weeks than control and BHA treated biscuits.[6]

A cumulative comparison of overall acceptability scores between biscuit variations is given in Table 6. In CNT sample, which did not contain any antioxidant, the mean scores assigned by the panelists did not differ up to two months. A similar trend was also

Table 4 Mean sensory scores of biscuit variations before storage.

Biscuits	Colour (10)	Surface Character (10)	Crumb Colour (10)	Texture (20)	Taste (20)	Mouth feel (10)	Over all quality (80)
CNT	$8.1^{c,d}$	$8.3^{c,d}$	$7.9^{b,c}$	$17.7^{a,b}$	$17.7^{b,c}$	7.7^{b}	67.4^{d}
MNT-P	6.0^{a}	6.7^{a}	6.1^{a}	17.0^{a}	17.1^{a}	6.8^{a}	59.7^{a}
MNT-M	7.8^{c}	8.0^{c}	7.5^{b}	16.7^{a}	16.5^{a}	6.5^{a}	63.7^{b}
MNT-E	7.0^{b}	7.4^{b}	6.6^{a}	17.0^{a}	16.9^{a}	6.5^{a}	61.4^{c}
BNT	7.9^{c}	8.1^{c}	7.7^{b}	17.2^{a}	17.5^{ab}	7.8^{b}	66.5^{d}
SEM (+/–) Df	0.17	0.15	0.19	0.20	0.17	0.16	0.26

*Means followed by column by different letters differ significantly at 25 df. **Values carrying different superscripts a, b, c, — in columns differ significantly ($P < 0.05$).

Table 5 Mean sensory scores of biscuit variations after five months storage.

Biscuits	Colour (10)	Surface character (10)	Crumb colour (10)	Texture (20)	Taste (20)	Mouth feel (10)	Over all quality (80)
CNT	$7.6^{c,d}$	$7.7^{c,d}$	$7.4^{c,d}$	16.7^{d}	16.8^{d}	$7.2^{b,c}$	63.5^{c}
MNT-P	5.8^{a}	6.3^{a}	5.9^{a}	$16.2^{a,b,c}$	$16.7^{c,d}$	6.0^{a}	57.0^{a}
MNT-M	$7.4^{b,c,d}$	$7.4^{b,c}$	$7.0^{b,c,d}$	$16.0^{a,b}$	16.0^{b}	$6.3^{b,c}$	60.1^{b}
MNT-E	$6.6^{b,c,d}$	$6.6^{b,c}$	$6.0^{b,c}$	16.4^{a}	16.4^{a}	6.0^{a}	$58.0^{a,b}$
BNT	7.7^{d}	8.0^{d}	7.5^{d}	16.7^{d}	$16.5^{c,d}$	7.4^{c}	63.9^{c}
SEM (+/–) Df	0.18	0.16	0.20	0.30	0.25	0.17	0.36

*Means followed by column by different letters differ significantly at 25 df. **Values carrying different superscripts a, b, c, — in columns differ significantly ($P < 0.05$).

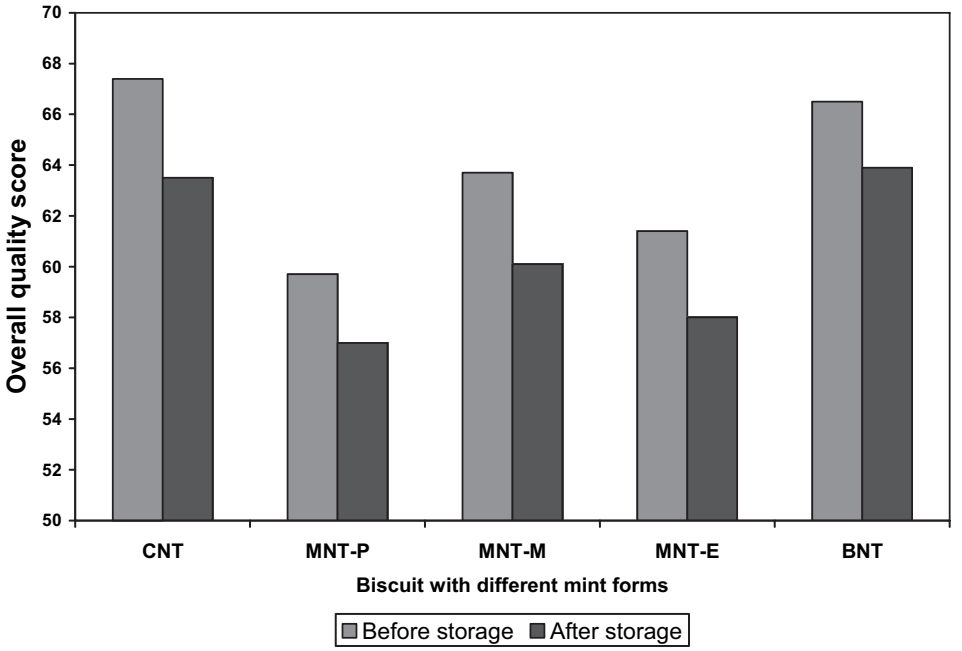

Figure 3 Comparison of overall quality scores of biscuits incorporated with different mint forms (Before and after storage).

Table 6 Comparison of over all acceptability of biscuits variations over storage period.

	Period in months					
Samples	0	1	2	3	4	5
CNT	$67.4^{e,p}$	$66.8^{c,o,p}$	$66.5^{d,n,o,p}$	$66.0^{d,n}$	$64.8^{d,m}$	$63.5^{d,l}$
MNT-P	$59.7^{a,q}$	$59.4^{a,o,p}$	$59.2^{a,n,o,p}$	$59.0^{a,m,n}$	$58.3^{a,m}$	$57.0^{a,l}$
MNT-M	$63.7^{c,p}$	$63.5^{c,o}$	$63.0^{c,o}$	$62.5^{c,n}$	$61.7^{c,m}$	$60.1^{c,l}$
MNT-E	$61.4^{b,p}$	$61.0^{b,o,p}$	$60.8^{b,n,o,p}$	$60.5^{b,m,n}$	$59.5^{b,m}$	$58.0^{b,l}$
BNT	$66.5^{d,o}$	$66.3^{c,n}$	$66.2^{d,o}$	$66.0^{d,o}$	$65.8^{e,p}$	$63.9^{d,l}$
SEM* (+/–) Df	0.27	0.27	0.24	0.22	0.21	0.20

Values carrying different superscripts a,b,c… ., in columns (comparison between samples) and l.m… ., in rows (comparison between storage period), differ significantly ($P \leq 0.05$). * Standard error of the mean at 25 degrees of freedom.

seen in the other variations. The mean scores at the end of the storage period were found to be significantly lower ($P \leq 0.05$) than the initial scores in all the five variations. In MNT-P and MNT-E samples, the scores assigned by the panelists at the end of third and fourth month were comparable, which indicate their acceptability. The overall acceptability on fresh basis differed significantly ($P \leq 0.05$) between the variations. However, MNT-M was rated significantly higher ($P \leq 0.05$) scores among the three mint incorporated variations through out the storage period. This could be due to MNT-M does not contain any plant pigments whereas MNT-P and MNT-E contained chlorophyll and other plant pigments which in turn affected the overall quality score of MNT-P and MNT-E biscuits.

CONCLUSIONS

Effect of incorporation of different forms of mint on different quality attributes such as texture, color and sensory characteristics of biscuits were studied. The texture of biscuits with mint powder (MNT-P) was comparable with the control (CNT) and BHA (BNT) biscuit indicating their crisp nature. However, color measurement (ΔE) values in MNT-P biscuits were higher followed by MNT-E biscuit whereas the values of MNT-M biscuit were comparable with the CNT and BHA biscuit indicating MNT-M did not impart any change in the color of the biscuit. The present study indicates that MNT-P biscuits were highly acceptable compared to MNT-E and MNT-M biscuits.

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