Biological Forum – An International Journal 16(7): 260-265(2024)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Sensory Attributes of Bread as Influenced by Hydrocolloids, Frozen Storage of Bread Dough and Thawing Temperature

Ishita Rajput[1]*, Pratibha Parihar[2], Rajendra Singh Thakur[3] and Shiv Shanker Shukla[4]
[1]Ph.D. Scholar, Department of Food Science and Technology, College of Agriculture, JNKVV, Jabalpur (Madhya Pradesh), India.
[2]Professor, Department of Food Science and Technology, College of Agriculture, JNKVV, Jabalpur (Madhya Pradesh), India.
[3]Subject Matter Specialist, KVK, Seoni, JNKVV, Jabalpur (Madhya Pradesh), India.
[4]Professor and Head, Department of Food Science and Technology, College of Agriculture, JNKVV (Madhya Pradesh), India.

(Corresponding author: Ishita Rajput)*
(Received: 24 April 2024; Revised: 21 May 2024; Accepted: 15 June 2024; Published: 15 July 2024)
(Published by Research Trend)

ABSTRACT: This study examines the sensory attributes of frozen dough bread, focusing on the influence of thawing temperature and storage duration. Taste, appearance, aroma, colour, texture, and overall acceptability were evaluated. Taste scores ranged from 4.5 to 9, with higher scores associated with the best thawing conditions. Appearance scores ranged from 5 to 9, favouring specific hydrocolloid concentrations. Aroma scores varied from 4.5 to 9, depending on storage conditions. Colour scores ranged from 4 to 8.5, showing the effect of additives on crust appearance. Texture scores ranged from 4.5 to 8.5, highlighting the role of hydrocolloids in improving bread texture. Overall acceptability scores ranged from 4.5 to 8.5, indicating the positive impact of guar gum and hydroxypropyl methyl cellulose (HPMC) on the quality of the bread. The findings suggest that hydrocolloids positively influence sensory attributes, with controlled thawing processes preserving crust and crumb characteristics. These results contribute to understanding how addition of hydrocolloids and storage conditions affect the sensory quality of frozen dough bread, offering insights for optimizing product development and consumer satisfaction.

Keywords: Frozen, dough, sensory, thawing, hydrocolloid, crust, crumb.

INTRODUCTION

Bread is a universally consumed staple food with a rich history and cultural significance. In recent years, the popularity of frozen dough bread has surged, driven by its convenience, extended shelf life, and consistent quality. The process of freezing dough allows for the preservation of freshly prepared bread dough, enabling storage and subsequent baking at a later time. However, the quality of frozen dough bread is influenced by various factors, including the incorporation of hydrocolloids, thawing temperature, and storage time. Hydrocolloids, such as guar gum and hydroxypropyl methylcellulose (HPMC), are commonly used additives in bread-making processes. These hydrophilic polymers interact with water molecules, forming a network that enhances dough texture, moisture retention, and overall quality. Addition of hydrocolloids can improve the rheological properties of dough, resulting in better handling characteristics and enhanced volume and crumb structure in the final baked product (Lazaridou *et al.,* 2007).

Additionally, the duration of storage after freezing can influence the quality of frozen dough bread. During storage, frozen dough undergoes physical and biochemical changes that can affect its baking performance and final product attributes. Extended storage periods may lead to flavour deterioration, staling, and textural changes in the baked bread (Ahmed *et al.,* 2013). Understanding the combined effects of hydrocolloids, thawing temperature, and storage time is essential for optimizing the production process and ensuring consistent product quality. Thawing temperature is another critical factor affecting the quality of frozen dough bread. The rate and method of thawing can significantly impact the dough's texture, volume, and other attributes. Rapid thawing may lead to uneven heating and moisture loss, potentially compromising the bread's structure and mouthfeel. Conversely, slow thawing at controlled temperatures can help preserve the dough's integrity and minimize quality defects (Baik *et al.,* 1997).

The sensory characteristics of frozen dough bread are vital indicators of bread quality and directly influence consumer perception and acceptance. These aspects encompass a wide range of attributes that influence the bread's flavour, texture, appearance and taste. Sensory characteristics refer to the attributes perceived by the senses, including taste, aroma, texture, and appearance. Taste and aroma are influenced by factors such as ingredient composition, fermentation process, and baking conditions, contributing to the bread's overall flavour profile. Appearance, encompassing factors such as crust colour, shape, and surface uniformity, influences visual appeal and first impressions (Sahar & Ali 2019). As the human sensory organs firstly contact food items and decide that food is attractive and palatable or not, so in the development of frozen dough bread with hydrocolloids, it is important to analyse the effect of hydrocolloids, frozen storage duration and different thawing temperature on the sensory characteristics of developed bread.

MATERIAL AND METHODS

Materials. The raw materials required for the experiment *i.e.,* common salt (Sodium chloride), instant dry yeast (Saccharomyces Cerevisiae), powdered sugar, and oil were obtained from Vipin Trading, Napier Town, Jabalpur, while refined wheat flour was procured from Priyadarshani Suvidha Sahaseva Kendra, Civic Centre Jabalpur. The food grade hydrocolloids *i.e*., HPMC (Hydroxy propyl methyl cellulose) and Guar gum for the preparation of dough were ordered online from amazon. The potable water in the department was used to make the dough from refined wheat flour, hydrocolloids and other materials for bread development.

Preparation of Frozen Dough Bread. Frozen bread dough was prepared using a method adapted from Asghar *et al.* (2006). Briefly, frozen bread dough was prepared using the formulation shown in Table 2. For each formulation (1 kg), the ingredients were mixed in a laboratory dough mixer for 8 minutes, low speed to obtained optimal dough development. The dough was cut, kneaded and moulded which were frozen in the ultra-low temperature freezer with temperature of -30° C, until the temperature at the centre of the dough, measured by thermometer was -18°C. The frozen dough was taken out of the ultra-low freezer and transferred to polyethylene bags, then stored in a domestic freezer at -18°C for 60 days. Immediately after dough preparation, samples were collected to represent the unfrozen (zero time) dough. Further samples were removed after 15, 30, 45 and 60 days of frozen storage, thawed at five different temperatures *i.e.,* 20, 30, 40, 50 and 60° C for 1 hour, fermented and proofed at 30° C for 1 hour and 35 minutes and finally baked at 200° C for 20 minutes. The breads obtained frozen dough were cooled at room temperature for at least one hour and evaluated with respect to specific loaf volume and shelf life study of bread by measuring its moisture contents at 3, 24, 48,72 and 96 hrs after baking.

Table 1: Standard recipe for preparation of bread.

Ingredients	Refined Wheat flour	Sugar	Salt	Dry Yeast	Bread improver	Oil	Water
Quantity	100 g	10 g	1 g	3 g	0.1 g	5 ml	20 ml

Sensory Characteristics of developed bread. Developed frozen dough breads were evaluated for sensory parameters like colour, taste, texture, aroma, and overall acceptability at different intervals of 0, 15, 30, 45 and 60 days by the panel of 20 selected judges. A panel consisting of 20 people evaluated the product for individual characters like colour, taste, texture, aroma and overall acceptability. The 9 point hedonic scale was used to assess the degree of liking that ranged from 'Like very much' to 'Dislike very much' with 'Neither like Nor Dislike'(NLND) as midpoint. Data were analysed and expressed the number of responses, as percentage (Amerine *et al.,* 1965).

Statistical Analysis. In this study, a central composite rotatable design was employed, comprising four independent variables across 30 experimental runs. The ranges of variables were selected taking into consideration the maximum and minimum values used for control samples of preparation. Responses surface methodology (Myers, 1976) was used to reduce the number of experiments, without affecting the accuracy of result. Six central point experiments were conducted to assess method repeatability. The variables included guar gum, HPMC, thawing temperature, and frozen storage time. The analysis of variance (ANOVA table) revealed at significance at $P < 0.05$ level.

Table 2: Experimental plan detail.

Sr. No.	Name of Variables	Unit	-2	-1	0	+1	+2
1.	Guar gum	g	0.5	1	1.5	2	2.5
2.	HPMC (Hydroxypropyl methyl cellulose)	g	0.5	1	1.5	2	2.5
3.	Thawing Temperature	°C	20	30	40	50	60
4.	Storage time	days	0	15	30	45	60

RESULTS AND DISCUSSION

Taste. The sensory scores for the taste of the developed breads ranged from 4.5 to 9 as shown in Table 3. The highest score of 9 was achieved by Experiment 23, which utilized 1.5 grams of Guar Gum and 1.5 grams of HPMC at 0 days (fresh). In contrast, the lowest score of 4.5 was assigned to Experiment 24, which used the same hydrocolloids but had a thawing temperature of 40°C after 60 days of frozen storage. The Model F-value of 14.92, as shown in ANOVA table 4, indicates that the model is statistically significant, with terms A and D being significant ($p < 0.05$). The model's R^2 value of 0.7047 suggests it explains 70.47% of the variability in the experiments. Table 5 presents the probability values of coefficients for the linear model, demonstrating that the levels of Guar Gum and HPMC had a significant positive linear effect at the 1% and 10% confidence levels, respectively. Conversely, storage time had a significant negative linear effect at the 1% confidence level, while increased thawing temperature had no significant impact on the taste of the developed frozen dough bread. These findings align with those of Rosell*et al.,*(2001), who noted that freezing can affect bread taste by disrupting the dough's fermentation process and moisture content. However, the inclusion of hydrocolloids like Guar Gum and HPMC can mitigate these effects by enhancing moisture retention and stabilizing the dough matrix, resulting in a more consistent and pleasing taste in the final product.

Appearance. The sensory score for the appearance of the developed breads ranged from 5 to 9. The highest score of 9 was achieved by Experiment 23, which involved 1.5 grams of Guar Gum and 1.5 grams of HPMC at 0 days (fresh). In contrast, the lowest score of 5 was given to Experiment 24, which used the same hydrocolloids but with a thawing temperature of 40°C after 60 days of frozen storage as provided in Table 3. The Model F-value of 21.58 indicates that the model is statistically significant, with terms A, B, C, and D being significant ($p < 0.05$). The model's R^2 value of 0.7754 suggests it explains 77.54% of the variability in the experiments. Table 5 also shows the probability values of coefficients for the linear model, indicating that the levels of Guar Gum and HPMC had a significant positive linear effect at the 1% confidence level. Conversely, increased thawing temperature and storage time had a significant negative linear effect at the same confidence level on the appearance of the developed frozen dough bread. These findings align with those of Maleki and Milani (2013), who found that HPMC at a mid-concentration of 0.5% yielded the highest scores in appearance and upper surface attributes of developed bread.

Aroma. Table 3 provides the sensory score for the aroma of the developed breads which ranged from 4.5 to 9. The highest score of 9 was achieved by Experiment 23, which used 1.5 grams of Guar Gum and 1.5 grams of HPMC at 0 days (fresh). In contrast, the lowest score of 4.5 was given to Experiment 24, which used the same hydrocolloids but with a thawing temperature of 40°C after 60 days of frozen storage. The Model F-value of 14.82 from ANOVA Table 4 indicates statistical significance, with terms A, B, and D being significant ($p < 0.05$). The model's R^2 value of 0.7034 suggests it explains 70.34% of the variability in the experiments. Table 5 also shows the probability values of coefficients for the linear model, indicating that the levels of Guar Gum and HPMC had a significant positive linear effect at the 1% confidence level. Conversely, storage time had a significant negative linear effect at the same confidence level, while increased thawing temperature had no significant effect on the aroma of the developed frozen dough bread. Similar findings were reported by Piga *et al.* (2005), who noted that hydrocolloids in bread formulations help preserve flavour and aroma compounds, enhancing the sensory profile.

Colour. The sensory score for the colour of the developed breads ranged from 4 to 8.5. Experiment 23 achieved the highest score of 8.5 with a combination of 1.5 grams of Guar Gum and 1.5 grams of HPMC at 0 days (fresh). In contrast, Experiment 24 received the lowest score of 4 with the same hydrocolloid combination but a thawing temperature of 40°C after 60 days of frozen storage as given in table 3. The Model F-value of 22.48 indicates statistical significance, with terms A and D being significant ($p < 0.05$). The R^2 value of 0.7824 shows that the model explains only 78.24% of the variability in the experiments as provided in ANOVA Table 4. Table 5 presents the probability values of coefficients for the linear model, demonstrating that the levels of Guar Gum and HPMC had a significant positive linear effect at the 1% and 10% confidence levels, respectively. Conversely, increased thawing temperature and storage time had a significant negative linear effect on the colour of the developed frozen dough bread at the 10% and 1% confidence levels, respectively. Research indicates that bread produced from frozen dough often exhibits a paler crust compared to that from fresh dough, due to reduced enzymatic activity and modified starch gelatinization during baking, as reported by Wang *et al.* (2017). HPMC has been noted to enhance the maillard reaction, contributing to a more desirable crust colour, according to Rosell *et al.* (2001). However, Asghar and Zia (2016) found that the hedonic scores decreased with increasing levels of gums, due to the lightening of colour, increased hardness, and aftertaste in gluten-free bread compared to wheat bread.

Texture. The sensory score for the texture of the developed breads ranged from 4.5 to 8.5. Experiment 23 achieved the highest score of 8.5 with a combination of 1.5 grams of Guar Gum and 1.5 grams of HPMC at 0 days (fresh). In contrast, Experiment 24 received the lowest score of 4.5, with the same hydrocolloid combination but a thawing temperature of 40°C after 60 days of frozen storage. The Model F-value of 29.56 indicates statistical significance, with terms A, B, C, and D being significant ($p < 0.05$). The R^2 value of 0.8254 shows that, the model explains 82.54% of the variability in the experiments as provided in ANOVA Table 4. Table 5 provides the probability values of coefficients for the linear model, demonstrating that the levels of Guar Gum and HPMC had a significant positive linear effect at the 1% confidence level. Conversely, increased thawing temperature and storage time had a significant negative linear effect at the same confidence level on the appearance of the developed frozen dough bread. Research by Kohajdová and Karovičová (2009) highlighted similar results, reporting that combinations of HPMC or CMC with α-amylase can enhance the overall quality and texture of fresh bread.

Overall acceptability. The sensory score for overall acceptability of the developed breads ranged from 4.5 to 8.5 (Table 3). Experiment 23 achieved the highest score of 8.5 with a combination of 1.5 grams of Guar Gum and 1.5 grams of HPMC at 0 days (fresh). Conversely, Experiment 24 received the lowest score of 4.5, with the same hydrocolloid combination, a thawing temperature of 40°C, and 60 days of frozen storage. The Model F-value of 13.71 indicates statistical significance, with terms A, B, and D being significant ($p < 0.05$). The R^2 value of 0.6868 shows that the model explains only 68.68% of the variability in the experiments as provided in ANOVA Table 4. Table 5 also presents the probability values of coefficients for the linear model, highlighting that the levels of Guar Gum and HPMC had a significant positive linear effect at the 1% confidence level. In contrast, storage time had a significant negative linear effect at the same confidence level, while increased thawing temperature showed no significant effect on overall acceptability. Hydrocolloids like guar gum and hydroxypropyl methylcellulose (HPMC) enhance the dough's viscoelastic properties, ensuring optimal gas retention and volume, thus improving the texture and appearance of the bread, as reported by Guarda *et al.* (2004) ; Rosell *et al.* (2001). These findings align with Kohajdová and Karovičová (2009), who found that controlled thawing processes preserved the sensory characteristics of the crust and crumb, leading to higher overall acceptability of the bread.

Table 3: Sensory characteristics of developed breads.

Expt.	Taste	Appearance	Aroma	Colour	Texture	Overall Acceptability
1.	5.5	5.5	6.5	6.5	6	5
2.	8	8.5	8	8	7.5	7
3.	8.5	8	9	7.5	8	7.5
4.	9	8.5	8.5	8	8.5	8
5.	7	7	8	7	7	7
6.	8.5	8	8	7.5	8	8
7.	7	7	8.5	8	7	7
8.	7.5	8	8	7.5	7.5	7
9.	5	5.5	5.5	5	5.5	5
10.	6	6	6.5	6	6.5	6
11.	6	6	6	6.5	6	6.5
12.	6.5	7	7	6	6	6
13.	6	5.5	5.5	5	5	5
14.	5	5	6.5	6	5.5	5.5
15.	5	5.5	5	5.5	5	5.5
16.	5	6.5	6	6	6	6
17.	5.5	6	5.5	5	5.5	5
18.	7	7	7	7	7	7
19.	5	6	6	6.5	5	5.5
20.	7	7.5	8.5	7	7	7
21.	7	7	6.5	7	7	6.5
22.	6.5	5	5	5	5	5
23.	9	9	9	8.5	8.5	8.5
24.	4.5	5	5	4	4.5	4.5
25.	5	6	6.5	6	6	6
26.	7.5	7	7	7	7	7
27.	7	7	7	7.5	7	7.5
28.	6	6.5	5.5	6	6.5	6
29.	6	6	6	6	6.5	6
30.	6	6	6	6	6.5	6

Table 4: ANOVA for second order regression model for sensory characteristics of developed breads.

Source	Taste	Appearance	Aroma	Colour	Texture	Overall Acceptability
Model SS	33.29	27.79	31.21	26.79	27.63	21.46
Model MS	8.32	6.95	7.80	6.70	6.91	5.36
Model DF	4	4	4	4	4	4
Error SS	3.87	1.21	1.83	2.21	0.7083	2.21
Error MS	0.7750	0.2417	0.3667	0.4417	0.1417	0.4417
Error DF	5	5	5	5	5	5
F Ratio	14.92	21.58	14.82	22.48	29.56	13.71
F Table	5.19	5.19	5.19	5.19	5.19	5.19
R^2 %	70.47	77.54	70.34	78.24	82.54	68.68
Std.Dev	0.7470	0.5675	0.7255	0.5459	0.4834	0.6256
Mean	6.48	6.62	6.77	6.48	6.47	6.32
C.V.%	11.52	8.58	10.72	8.42	7.48	9.90

Table 5: Regression coefficient of full second order model and significant terms for sensory characteristics of developed breads.

Coeff.	Taste	Appearance	Aroma	Colour	Texture	Overall Acceptability
Cons	6.48	6.62	6.77	6.48	6.47	6.32
Linear terms						
A	0.3542	0.3958	0.3125	0.3333	0.3750	0.3750
B	0.3125	0.3542	0.3542	0.2083	0.2917	0.3333
C	-0.1875	-0.2708	-0.1875	-0.2083	-0.2917	-0.1250
D	-1.06	-0.8958	-1.02	-0.9583	-0.9167	-0.7917

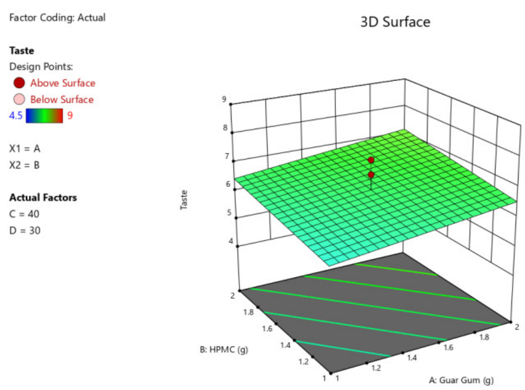

Fig. 1. Taste.

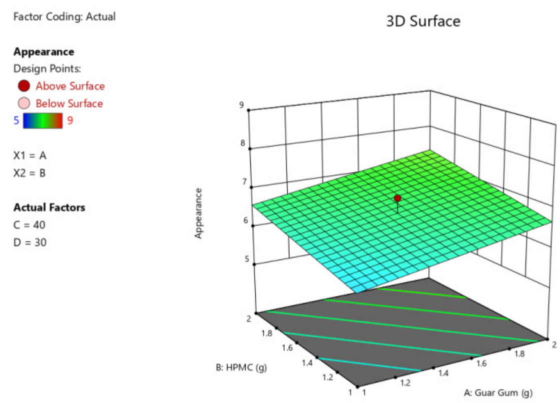

Fig. 2. Appearance

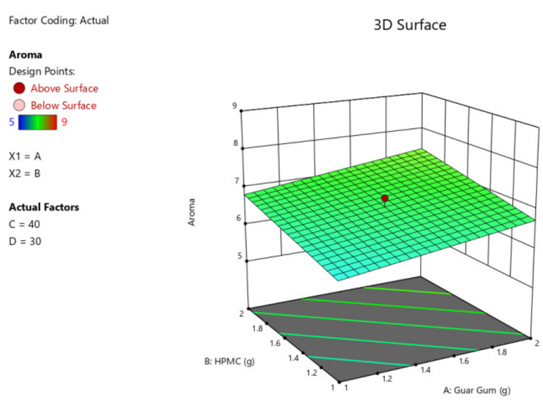

Fig. 3. Aroma.

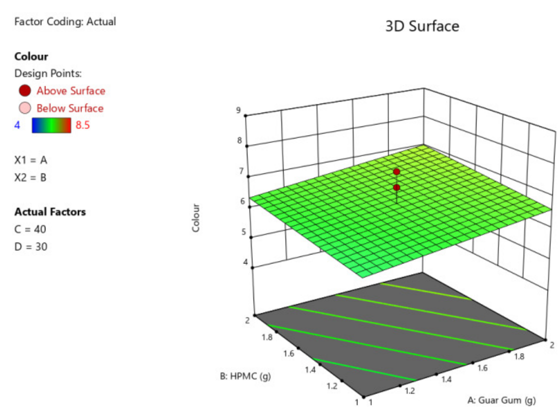

Fig. 4. Colour.

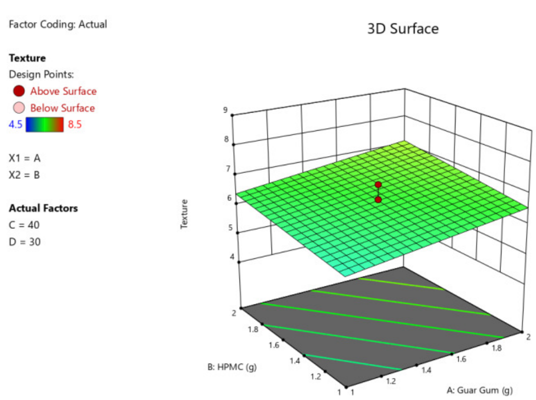

Fig. 5. Texture.

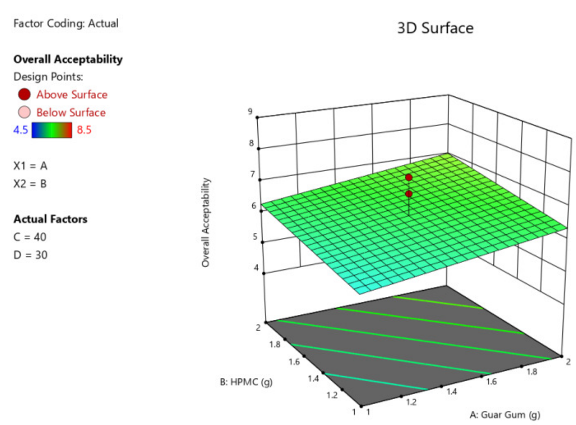

Fig. 6. Overall Acceptability.

CONCLUSIONS

The sensory evaluation of developed breads highlights the significant impact of different level of both hydrocolloids and frozen storage time on taste, appearance, aroma, colour, texture, and overall acceptability. Based on all the analysis, it can be concluded that Guar Gum and HPMC had a significant positive linear effect; it means hydrocolloids improved sensory attributes, while frozen storage for long duration negatively impacted on all the studied sensory characteristics that is aligning with prior studies. Thawing at controlled temperature results better appearance, colour and texture while not significant for taste and aroma but preserved crust and crumb characteristics, enhancing overall acceptability. Overall acceptability of developed bread was influenced by different level of hydrocolloids and frozen storage duration. Bread developed with 1.5 g of Guar Gum and 1.5 g of HPMC, for fresh state of dough (0 day of frozen) was best combination for all the sensory attributes and mostly liked by sensory panel lists.

FUTURE SCOPE

Frozen technology is set to become a crucial method for preserving food while maintaining its original qualities in the near future. Dough is perishable and susceptible to microbial attack, so ongoing research is needed to enhance quality and increase acceptability using frozen technology. Further studies on interaction of different hydrocolloids with different dough constituents could be done in this field.

Acknowledgement. I extend my sincere thanks to Dr. Pratibha Parihar (major advisor), Dr. S.S. Shukla, Head of Department of Food Science and Technology and to my advisory committee members for giving me proper guidance throughout the course of study. I also acknowledge the Department of Food Science and Technology for provide all necessary facilities during study.
Conflict of Interest. None.

REFERENCES

Ahmed, J., Al-Attar, H., & Uthman, H. (2013). Rheological properties of water–wheat flour dough: Effect of arabic gum and xanthan gum addition. *Food Hydrocolloids, 30*(1), 479-490.

Amerine, M. A., Roessler, E. B., & Ough, C. S. (1965).Acids and the acid taste. I. The effect of pH and titratable acidity. *American Journal of Enology and Viticulture, 16*(1), 29-37.

Asghar, A., Anjum, F. M., Butt, M. S., & Hussain, S. (2006). Shelf life and stability study of frozen dough bread by the use of different hydrophilic gums. *International Journal of Food Engineering, 2*(3).

Asghar, A., & Zia, M. (2016). Effects of xanthan gum and guar gum on the quality and storage stability of gluten free frozen dough bread. *American Journal of Food and Nutrition, 6*(4), 107-112.

Myers, R. H. (1976). Response surface methodology. Allyh and Bacon, Boston.

Baik, M. Y., & Chinachoti, P. (1997). Moisture redistribution and phase transitions during bread staling. *Cereal Foods World, 42*(3), 129-137.

Guarda, A., Rosell, C. M., Benedito, C., & Galotto, M. J. (2004). Different hydrocolloids as bread improvers and antistaling agents. *Food Hydrocolloids, 18*(2), 241-247.

Kohajdová, Z., & Karovičová, J. (2009). Application of hydrocolloids as baking improvers.*Chemical Papers, 63*(1), 26-38.

Lazaridou, A., Duta, D., Papageorgiou, M., Belc, N., & Biliaderis, C. G. (2007). Effects of hydrocolloids on dough rheology and bread quality parameters. *Food Chemistry, 99*(4), 1183-1197.

Maleki, G., & Milani, J. M. (2013). Effect of guar gum, xanthan gum, CMC, and HPMC on dough rheology and physical properties of Barbari bread. *Food Science and Technology Research, 19*(3), 353-358.

Piga, A., Catzeddu, P., Farris, S., Roggio, T., Sanguinetti, A. M., & Scanu, C. (2005).Texture evolution of Amaretti cookies during storage.*European Food Research and Technology, 221*(3), 387-391.

Rosell, C. M., Rojas, J. A., & De Barber, C. B. (2001). Influence of hydrocolloids on dough rheology and bread quality. *Food Hydrocolloids, 15*(1), 75-81.

Sahar, A., & Ali, A. (2019). Effect of thawing methods on quality attributes of frozen dough. *International Journal of Food Science and Technology, 54*(7), 2358–2365.

Wang, P., Singh, J., MacRitchie, F., & Shewry, P. R. (2017). Relationships of gluten protein structure to wheat quality and functionality. *Cereal Chemistry, 94*(1), 65-72.

How to cite this article: Ishita Rajput, Pratibha Parihar, Rajendra Singh Thakur and Shiv Shanker Shukla (2024). Sensory Attributes of Bread as Influenced by Hydrocolloids, Frozen Storage of Bread Dough and Thawing Temperature. *Biological Forum – An International Journal, 16*(7): 260-265.