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Effects of Using Legume Flours and Different Gums on The Textural Properties of Gluten-Free Bread

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ABSTRACT

This study examined the effects of various gum types, gum amounts, and legume flour types on the textural characteristics of gluten-free breads. The results showed that higher amounts of gum were generally associated with higher values of textural characteristics like chewiness, elasticity, and gumminess, and that these increases were statistically significant. Specifically, adding up to 13 g of gum improved the elasticity and structural strength. Bean flour showed slightly better results in certain parameters, such as elasticity and chewiness, but overall differences between flour types were limited. This implies that bean flour works better to enhance the gluten-free bread's textural qualities. Breads with locust bean gum–xanthan gum and tara gum–xanthan gum mixtures had the highest chewiness and elasticity ratings among gum varieties. On the other hand, most textural parameters significantly decreased when tara gum was used exclusively. These findings suggest that some gums work in concert to produce better results. In conclusion, improving the textural qualities of gluten-free breads primarily depends on the type of flour and gum used, as well as the quantity of gum.

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INTRODUCTION

Due to its accessibility, affordability, and capacity to satisfy hunger as an energy source, bread holds a prominent place in the typical human diet. Gliadin and glutenin make up the protein complex known as gluten, or the bread protein, which is the main storage protein of wheat grains. Cereals like wheat, barley, and rye naturally contain it (Bagolin do Nascimento et al., 2014; Biesiekierski, 2017; Myhrstad et al., 2021).

Gluten is an essential structural protein that gives dough its high gas retention capacity and viscoelastic properties during the bread-making process. Additionally, it significantly affects the bread's overall quality and texture (Alvarez-Jubete et al., 2010; Capriles & Arêas, 2014; Gallagher et al., 2004). Additionally, gluten delays the staling process and protects starch granules by absorbing excess moisture (Dizlek, 2012). Without gluten, the dough has less volume, a paler color, and a more fluid consistency.

These changes make it harder to reach the required degree of product quality and accelerate the staleness of the baked good (Pszczola, 2012; Torbica et al., 2010).

Some individuals are allergic to this protein. Known as celiac disease, this condition is defined as a chronic inflammatory disorder of the small intestine triggered by the consumption of gluten-containing foods (Villanacci et al., 2011). Some individuals are allergic to this protein. Known as celiac disease, this condition is defined as a chronic inflammatory disorder of the small intestine triggered by the consumption of gluten-containing foods (Villanacci et al., 2011). The primary treatment for celiac disease, which results from gluten intolerance, is strict adherence to a gluten-free diet (Rinaldi et al., 2017).

The limited availability and quality of gluten-free products is one of the main obstacles that people with celiac disease face when trying to follow a gluten-free diet. Patients' dietary options are limited, especially in nations like Turkey where cereal-based diets are common and there is a lack of production and variety of gluten-free products. Additionally, compared to their gluten-containing counterparts, gluten-free products are substantially more expensive due to the fact that the majority of them are imported (İşleroğlu et al., 2009).

Although gluten-containing cereals are not safe for people with celiac disease, gluten-free cereals like rice and corn, along with legumes like beans, lentils, and chickpeas, are regarded as trustworthy substitutes (Demirçeken, 2011). Numerous studies in literature have examined the use of various flours, gums, and their combinations to achieve the desired properties in the production of gluten-free bread, and research in this area is still ongoing.

In this regard, a study examined the impact on the quality of gluten-free breads of employing various hydrocolloids and their combinations at 3% and 5% concentrations. The findings showed that hydrocolloids enhanced the quality of bread; all 5% hydrocolloid formulations had the highest sensory acceptability scores, and the bread with 5% hydroxypropyl methylcellulose + methylcellulose had the softest texture (Öncel et al., 2025).

Another study looked into how different molecular weights of xanthan gums (XG) affected gluten-free bread. The study's medium molecular weight XG improved dough leavening and produced breads with more volume, less firmness, and less stickiness (Zhang et al., 2025).

The physical and chemical characteristics of the breads were investigated in a different study using different flours, including rice, corn, green buckwheat, chickpea, amaranth, and banana flour. New formulations with enhanced texture, flavor, and nutritional value were created as a result of the study (Utarova et al., 2024).

The goal of the current study was to create gluten-free bread with palatable texture. In order to replicate the functional qualities of gluten, different ratios of chickpea flour and lentil flour were combined with XG, locust bean gum (LBG), tara gum (TG), and their various combinations. Rice flour, corn flour, and corn starch were kept constant in the bread formulation.

MATERIALS AND METHODS

MATERIALS

The flours and gum materials used in this study were supplied by Smart Kimya (Izmir, Turkey) the flours and gums used in this study, while other raw materials (oil, salt and baker's yeast) were purchased from Niğde local markets. Chemicals used in the analyses were obtained from Sigma-Aldrich (Steinheim, Germany).

METHOD

Fatty Acid Composition Analysis

The fatty acid methyl esters of the sunflower oil used in the study were prepared by IUPAC Method 2.301 (IUPAC, 1992). The resulting methyl esters were examined using a Shimadzu GC-2010 gas chromatograph (Japan). The analyses were conducted using a flame ionization detector (FID) and a DB-23 column (30 m length, 0.25 mm internal diameter, 0.25 μm film thickness; J&W Scientific). Injector, column, and detector temperatures were set at 250°C, 180°C, and 240°C, respectively. Helium was used as the carrier gas, and its flow rate was 1 mL/min. The split ratio was set at 1:90.

Bread Production

Based on the process suggested by Demirkesen (2010), the bread production method was modified. To achieve this, 22.5 g of legume flours, 112.5 g of rice flour, 135 g of corn flour, 180 g of corn starch, 2.5 g of salt, 3.4 g of baker's yeast, 10 g of sunflower oil, and distilled water were combined in a mixing bowl and kneaded until a smooth dough was formed. Preliminary experiments indicated that gluten-free bread formulations required an additional amount of distilled water equal to the amount of added gums (Table 2).

After preparation, the dough was placed in a Teflon mold (Figure 1) and left to ferment for 20 hours at 24 ± 0.5°C. Following fermentation, the dough was proofed for one hour at 40 ± 0.5°C, and then baked for 30 minutes at 240 ± 5°C in a preheated oven (Figure 2).

Figure 1. Dough of gluten-free bread prepared with legume flour before baking

Figure 2. Appearance of gluten-free bread prepared with legume flour after baking

Table 2. Experimental design used in bread production (D-optimal 2FI model)

Sample no	BF (g)	CF (g)	LF (g)	LBG (g)	XG (g)	TG (g)	Water (mL)
1	22.5			9.00			309.0
2			22.5	9.00			309.0
3		22.5		9.00			309.0
4			22.5	13.5			313.5
5	22.5			4.50			304.5
6			22.5	4.50			304.5
7		22.5		4.50			304.5
8	22.5			4.50	4.50		309.0
9			22.5	4.50	4.50		309.0
10	22.5			4.50	4.50		309.0
11	22.5			6.75	6.75		313.5
12		22.5		4.50	4.50		309.0
13		22.5		2.25	2.25		304.5
14			22.5			4.50	304.5
15	22.5					9.00	309.0
16	22.5					9.00	309.0
17		22.5				9.00	309.0
18		22.5				9.00	309.0
19			22.5			13.5	313.5
20		22.5			4.50	4.50	309.0
21			22.5		6.75	6.75	313.5
22			22.5		2.25	2.25	304.5
23		22.5			4.50	4.50	309.0
24	22.5				4.50	4.50	309.0
25	22.5				4.50		304.5
26			22.5		13.5		313.5
27		22.5			9.00		309.0
28			22.5		4.50		304.5
29		22.5			9.00		309.0
30	22.5				9.00		309.0

BF: Bean flour, TG: Tara gum, CF: Chickpea flour, XG: Xanthan gum, LF: Lentil flour, LBG: Locust bean gum

Determination of Bread Height

The breads were sliced, and the height was measured with a ruler from the inside to ascertain their height. To determine the degree of bread rise, measurements were made from three distinct areas.

Textural Analyses of Bread

Samples were first cut into 2 cm-thick slices in order to conduct textural analyses of the breads. A TA-XT2i Texture Analyzer (Stable Micro Systems Ltd., UK) fitted with a P/32 probe was used to perform Texture Profile Analysis (TPA) and firmness measurements. The pre-test speed was set at 1 mm/s, the test speed at 5 mm/s, the post-test speed at 5 mm/s, the deformation ratio at 50%, and the waiting time between two compressions at 5 seconds for the TPA test. The pre-test speed was 1 mm/s, the test speed was 1 mm/s, the post-test speed was 5 mm/s, and the deformation ratio was 30% for the firmness analysis.

Statistical Analysis

The experimental setup for bread production was designed using a D-optimal 2FI model. The Design Expert 8.0.7.1 software program (Stat-Ease Inc., Minneapolis, MN, USA) was used to conduct regression analysis and analysis of variance (ANOVA). All experiments were performed in triplicate.

RESULTS AND DISCUSSION

Fatty Acid Composition Analysis Results

The fatty acid composition of sunflower oil used in the study was determined as 59.24±1.08% linoleic, 30.17±0.81% oleic, 6.72±0.11% palmitic, 3.49±0.10% stearic, 0.34±0.01% linoleic and 0.04±0.01% palmitoleic acid. All these results are in accordance with the Turkish Food Codex-Communiqué on Oils Called by Plant Name (Communiqué No: 2012/29) (Codex, 2012). The predominance of linoleic and oleic acids in the oil composition is characteristic of high-quality sunflower oil, indicating favorable oxidative stability and nutritional value. The high content of unsaturated fatty acids also plays a minor role in the softness and shelf-life of bread, as unsaturated lipids can interfere with starch retrogradation during storage, delaying staling. Similar fatty acid profiles have been reported in other studies (Ahlborn et al., 2005), confirming that the oil component used in this study was both technologically and nutritionally suitable for gluten-free bread production.

Bread Height

There is a significant relationship between bread height and other properties (hardness, firmness, etc.). Bread height should not be too low or too high. Optimum bread height is achieved with appropriate flour quality, balanced water and yeast content, adequate kneading, and controlled fermentation. Figure 3 shows the effects of different factors on the height of gluten-free breads. According to the regression analysis showing the effect of gum amount on bread height, a slight increase in bread height was observed with an increase in gum amount, but this relationship was not statistically significant (P>0.05). On the other hand, the average height of samples produced with chickpea flour was slightly higher than the other samples, while the height was lowest in samples containing bean flour. However, these differences observed between flour types were limited. The graph assessing the effect of gum type shows that different gum mixtures have more pronounced effects on bread height. In particular, the bread height increased significantly in samples using only XG and was distinguished from the other groups. This result suggests that XG can contribute to dough structure and increase gas retention capacity. This is consistent with the findings of Demirkesen et al. (2010) who reported that gums enhances dough viscosity and stabilizes air bubbles during proofing, thereby increasing loaf volume.. Consequently, it appears that the gum type has the most significant effect on bread height, whereas the gum concentration and flour type exert relatively limited effects. As reported in numerous studies, hydrocolloids markedly alter the volume of gluten-free breads (Ahlborn et al., 2005; Demirkesen et al., 2010; Lazaridou et al., 2007; Ribotta et al., 2004).

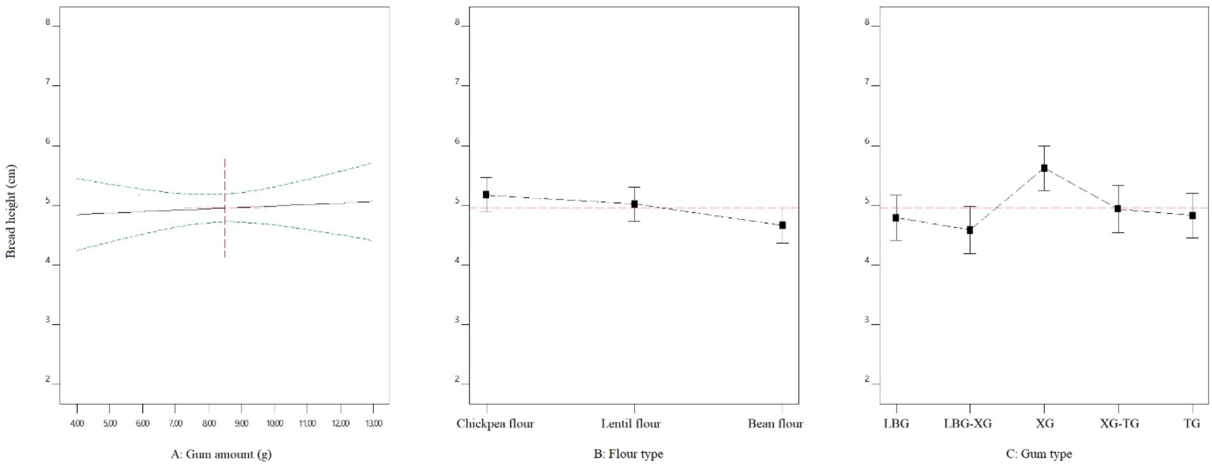

Figure 3. Effects of gum amount, flour type, and gum type on bread height. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

The positive influence of xanthan gum (XG) on loaf height can be explained by its strong water-binding and viscosity-enhancing capacity, which stabilizes the gas cells formed during fermentation. In contrast, tara gum (TG) and locust bean gum (LBG) alone may exhibit slower hydration and weaker gas stabilization, leading to lower loaf volumes. The limited influence of legume flours suggests that their protein and starch compositions were insufficient to fully replicate gluten's viscoelastic properties; however, chickpea flour's slightly higher protein content may have contributed to better gas retention. Previous studies (Gallagher et al., 2004; Lazaridou et al., 2007) support the conclusion that gum type, rather than flour base, is the primary determinant of loaf expansion in gluten-free systems. The observed trends also indicate that moderate gum levels can optimize gas entrapment, while excessive viscosity may hinder dough expansion, emphasizing the importance of fine-tuning hydrocolloid concentration.

Textural Analysis Results

Firmness

The impact of various formulation parameters on bread firmness is assessed in Figure 4. As the gum content increased, bread firmness significantly increased, as the figure illustrates. Values for firmness increased significantly, especially in samples with more than 9 g of gum. This suggests that adding a lot of gum to the dough can make it stiffer and produce a firmer finished product.

Samples containing lentil flour had the lowest firmness values among the legume flours, while samples containing chickpea flour had higher values. The level of firmness produced by bean flour was moderate. These variations could be explained by the different starch/protein compositions and water-holding capacities of the legume flours that were used.

When assessing how gum type affected bread firmness, samples with only TG showed the lowest values, whereas samples with only LBG showed a significant increase in firmness. The sample that contained LBG had the highest firmness. This implies that various gum varieties have different effects on dough rheology and gas retention, with LBG producing a firmer product texture.

In summary, the most important variables influencing bread firmness are gum type and quantity. Specifically, XG tends to reduce firmness, promoting a more voluminous and porous bread structure, whereas high gum content and the use of LBG increase firmness.

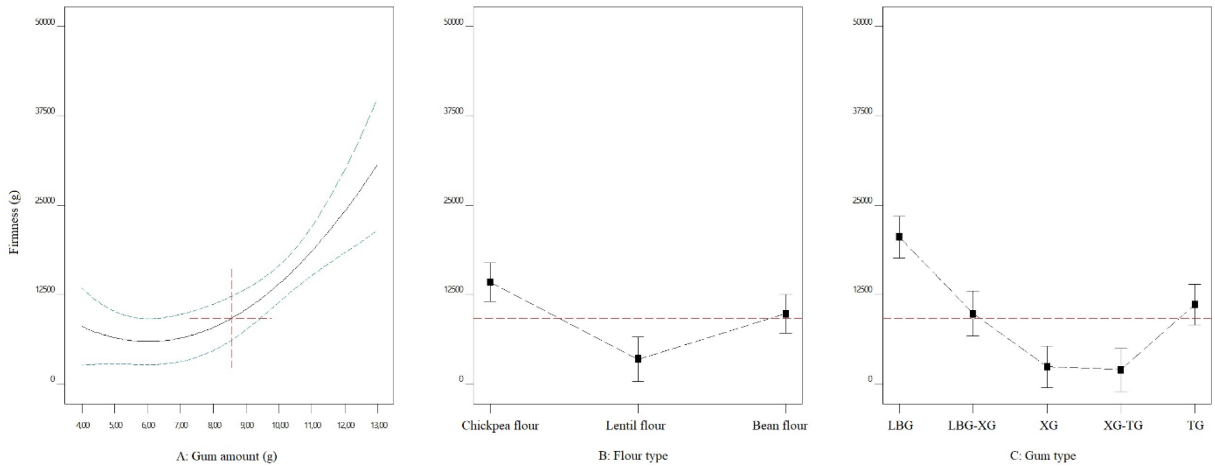

Figure 4. Effects of gum amount, flour type, and gum type on bread firmness. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

The observed increase in firmness with higher gum concentration likely results from greater water immobilization within the dough matrix. Gums form a hydrated polymer network that binds free water and increases dough viscosity, which in turn limits gas expansion during baking, yielding denser crumbs. LBG's pronounced firming effect is consistent with its known galactomannan structure, which produces a highly viscous solution when hydrated (Ribotta et al., 2004). In contrast, XG's pseudoplastic properties reduce dough resistance under shear, promoting gas bubble expansion and resulting in softer crumbs (Demirkesen et al., 2010). The differences among legume flours can also be linked to protein–starch interactions: lentil flour's lower firmness may be due to weaker gelation capacity and smaller starch granules, while chickpea flour's higher firmness reflects stronger water absorption and protein aggregation. These findings align with Lazaridou et al. (2007), who reported that hydrocolloid addition increases mechanical strength but can compromise softness when overused.

Hardness

Figure 5 shows the effects of different formulation factors on bread hardness. Hardness values tend to increase slightly with increasing gum content; however, this increase is not statistically significant ($p>0.05$). This indicates that the amount of gum used has a limited effect on bread hardness within the range of 4–13 g.

Similarly, the effect of different legume flours (chickpea, lentil, and bean flour) on bread hardness was also found to be statistically insignificant ($p>0.05$), as all samples exhibited similar firmness levels. This suggests that flour type is not a determining factor for hardness.

On the other hand, when evaluating the effect of gum type, more pronounced differences were observed. While higher firmness values were recorded in samples containing TG and LBG-XG combinations, a decrease in hardness was observed in samples containing LBG and XG individually. This indicates that the impact of gum type on bread texture varies depending on the specific gum used, and that the combined use of LBG and XG results in a firmer bread structure. This finding clearly demonstrates an interaction between LBG and XG, suggesting a synergistic effect.

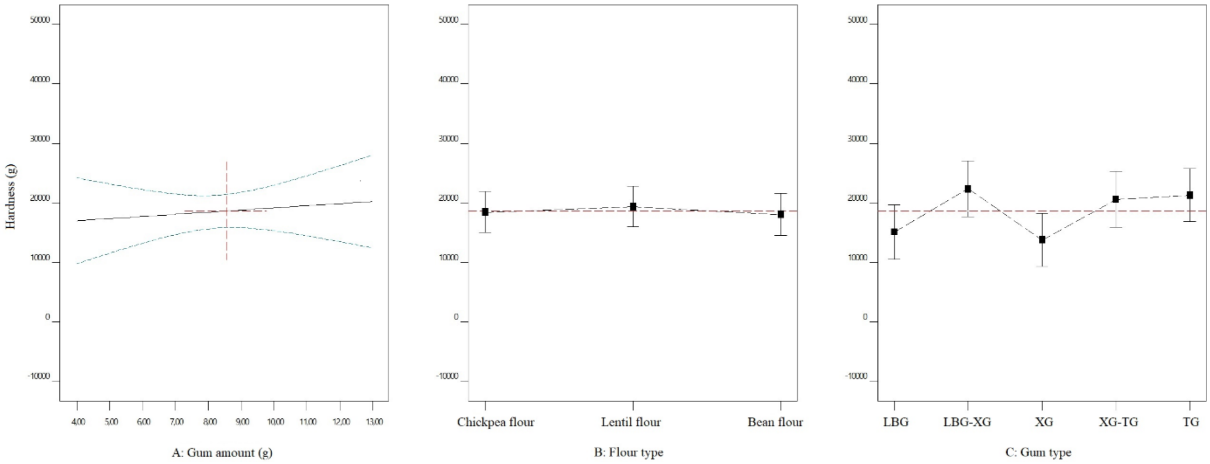

Figure 5. Effects of gum amount, flour type, and gum type on bread hardness. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

Although the gum amount did not statistically affect hardness, the observed trends point toward a textural stabilization effect at higher gum concentrations. Hardness and firmness, while related, respond differently to gum addition—hardness reflects the resistance to initial compression, whereas firmness involves overall structural strength. The synergistic increase in hardness for LBG-XG blends supports the well-documented compatibility between galactomannans and xanthan gum. Their molecular interactions, primarily through hydrogen bonding between mannose side chains and xanthan carboxyl groups, create a three-dimensional gel network that strengthens the bread crumb (Gallagher et al., 2004; Lazaridou et al., 2007). The slightly lower hardness in individual LBG and XG formulations may result from weaker cross-linking or uneven hydration. These findings emphasize that balanced gum combinations can optimize the viscoelastic properties of gluten-free dough, achieving improved mechanical integrity without excessive rigidity.

Springiness

An evaluation of the springiness properties of gluten-free bread revealed that the most significant factor was the gum type. The LBG-XG and XG-TG combinations significantly increased springiness values, demonstrating a positive synergistic effect between the gums. In particular, the use of TG alone significantly reduced springiness; however, this negative effect was mitigated when TG was used in combination with other gums. Increasing the amount of gum had a positive and statistically significant effect on springiness ($p \leq 0.05$), while the type of flour (chickpea, lentil, bean) had a limited impact (Figure 6). These findings demonstrate that the type and combination of gums used in gluten-free formulations play a key role in enhancing product elasticity.

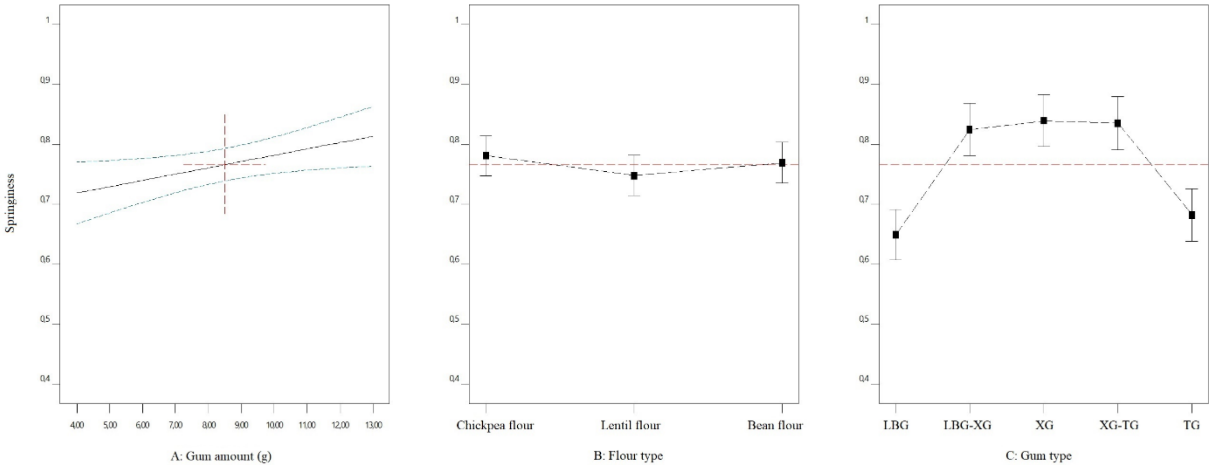

Figure 6. Effects of gum amount, flour type, and gum type on bread springiness. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

The enhanced springiness observed in gum mixtures can be attributed to synergistic molecular interactions between XG and galactomannan gums (LBG and TG). Such combinations form semi-interpenetrating polymer networks that mimic gluten's elastic behavior, allowing the bread to recover its shape after deformation. The weaker performance of TG alone may relate to its slower hydration rate and limited network formation ability when used without complementary polymers. Increasing gum concentration likely improved gas-cell stability during baking, preventing collapse and supporting elastic recovery. These results are consistent with the findings of Lazaridou et al. (2007), who demonstrated that hydrocolloid mixtures yield more cohesive and resilient gluten-free crumbs. The overall improvement in elasticity also suggests better water retention and uniform moisture distribution within the bread matrix.

Adhesiveness

The results presented in Figure 7 show that the amount of gum has a distinct and curvilinear effect on surface adhesiveness, with adhesiveness reaching its maximum level at approximately 12–13 grams of gum. No significant differences were observed among the flour types (chickpea, lentil, and bean flour). However, regarding gum types, it was found that the adhesiveness of breads containing TG, XG, and a TG–XG blend decreased, while LBG resulted in higher adhesiveness. Overall, gum amount and type were the primary factors affecting adhesiveness, whereas the effect of flour type was limited.

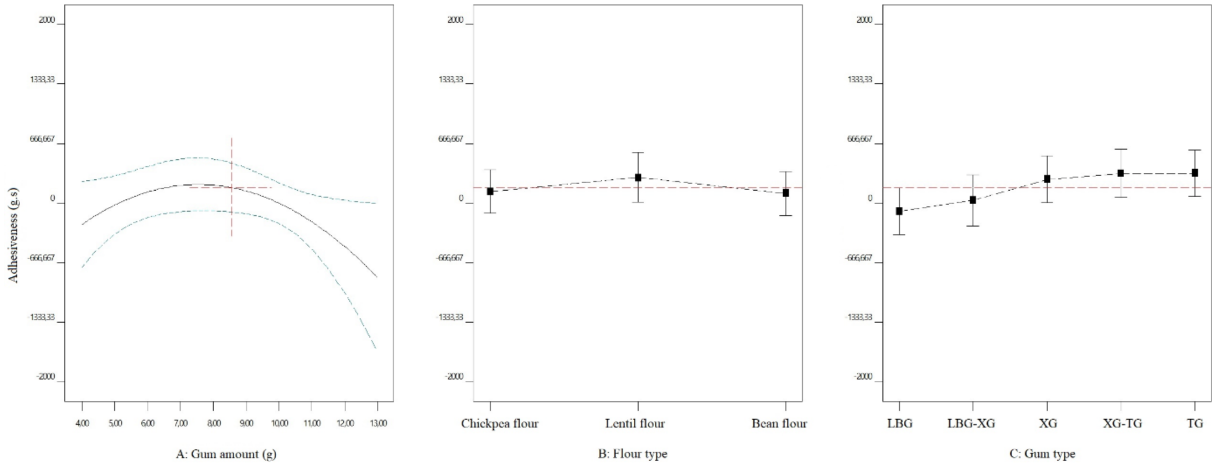

Figure 7. Effects of gum amount, flour type, and gum type on bread adhesiveness. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

Adhesiveness is primarily related to the amount of free water available on the crumb surface and the strength of the internal polymer network. The increase in adhesiveness at high gum concentrations indicates excess water retention that exceeds the binding capacity of the matrix, resulting in a tackier surface. The reduction of adhesiveness in TG-, XG-, and TG–XG-containing samples may arise from improved water distribution and gel network formation, which immobilize moisture more effectively. In contrast, LBG's higher adhesiveness could stem from its strong water-binding capability but limited gel strength when used alone, leaving a slightly sticky surface. Similar effects were observed by Capriles and Arêas (2014), who noted that excessive hydrocolloid addition can impair dough handling. Therefore, while moderate gum levels enhance cohesiveness and elasticity, excessive levels should be avoided to prevent undesirable surface stickiness.

Cohesiveness

Figure 8 shows the effects of gum amount, flour type, and gum type on cohesiveness. As shown in the figure, cohesiveness increased significantly and linearly with increasing gum amount. While small differences were observed among flour types (chickpea, lentil, and bean flour), lentil flour slightly reduced cohesiveness, whereas bean flour tended to increase it. Among the gum types, the lowest cohesiveness was observed with LBG and TG, while the highest values were found with mixed gums (LBG-XG and TG-XG). These findings demonstrate that both gum type and amount significantly affect cohesiveness. The high cohesiveness achieved by the gum mixtures (LBG-XG and TG-XG), in particular, suggests interactions between the gums.

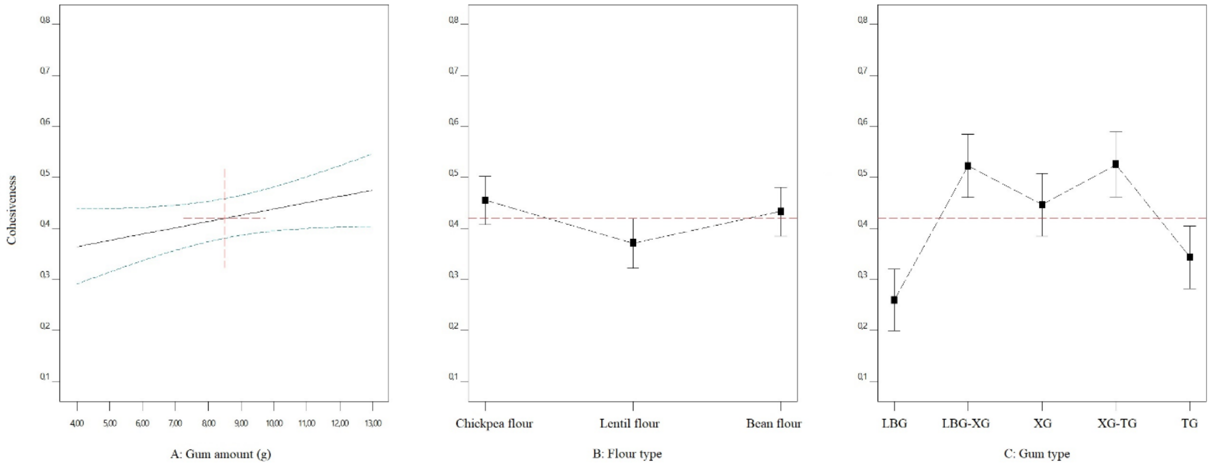

Figure 8. Effects of gum amount, flour type, and gum type on bread cohesiveness. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

The linear increase in cohesiveness with gum content suggests that hydrocolloids promote stronger internal bonding within the dough, leading to a more integrated crumb structure. Cohesiveness is closely associated with the network's ability to resist fragmentation under stress; therefore, the high values in mixed gum samples indicate that XG enhances the gel-forming capacity of galactomannans through intermolecular hydrogen bonding. This molecular synergy improves not only mechanical strength but also moisture retention, as reported by Gallagher et al. (2004). Bean flour's slightly higher cohesiveness can be explained by its relatively balanced protein and starch composition, which favors the development of an interconnected network. Conversely, lentil flour's lower cohesiveness might be due to its smaller starch granules and lower swelling capacity. Overall, these results highlight that both gum interactions and flour composition jointly define the internal integrity of gluten-free breads.

Gumminess

Gumminess significantly increased with an increase in gum content, suggesting that higher gum levels improve structural integrity. Bean flour displayed a slight increase in gumminess when compared to the other flour types, but no discernible differences were found. In terms of gum types, LBG had the lowest gumminess values, whereas the LBG-XG and TG-XG combinations had the highest values. This implies that these gums interact, much like cohesiveness does (Figure 9).

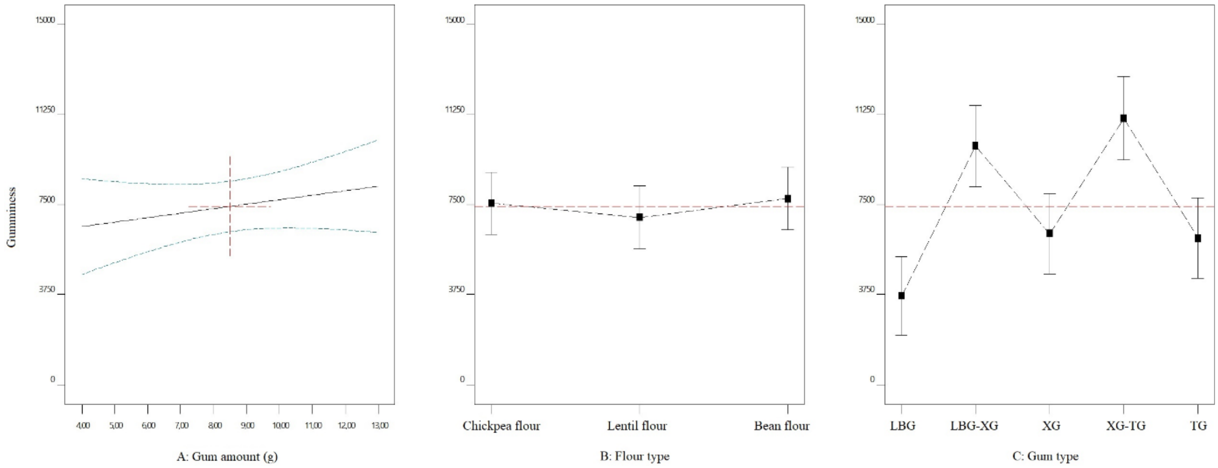

Figure 9. Effects of gum amount, flour type, and gum type on bread gumminess. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

Gumminess is a complex textural parameter derived from the combination of firmness and cohesiveness. The observed increase with gum addition reflects the strengthening of the dough's internal polymer matrix. The synergistic effect of LBG-XG and TG-XG blends confirms that interactions between galactomannans and xanthan gum enhance viscoelasticity, enabling the crumb to resist deformation while maintaining flexibility. The low gumminess of LBG alone can be attributed to its high viscosity but limited elasticity, which restricts network extensibility. Bean flour's slightly higher gumminess likely results from protein–hydrocolloid interactions that reinforce the dough structure. These results align with findings by Lazaridou et al. (2007), who reported that the combination of different hydrocolloids in gluten-free systems leads to improved mechanical strength and a more stable crumb structure. However, excessive gum addition may produce overly dense textures, suggesting the need for optimized concentrations for consumer-acceptable mouthfeel.

Chewiness

The results of the chewiness analysis show that chewiness is positively impacted by an increase in gum content (Figure 10). Bean flour seemed to slightly increase chewiness, but no discernible differences between the types of flour were found. Breads with TG-XG and LBG-XG blends had the highest chewiness values among gum types, whereas breads with just TG and LBG had the lowest values. These results imply interactions between these gums and are in line with the cohesiveness and gumminess findings.

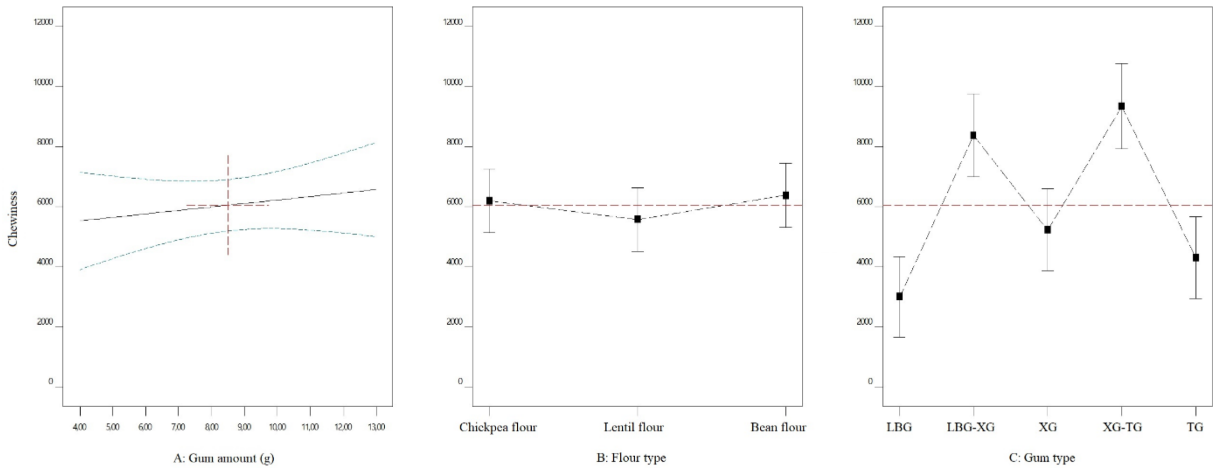

Figure 10. Effects of gum amount, flour type, and gum type on bread chewiness. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

Chewiness is an integrated parameter influenced by firmness, cohesiveness, and elasticity, and its increase with gum concentration indicates better crumb resilience and mouthfeel. The high chewiness in TG-XG and LBG-XG mixtures reinforces the hypothesis of synergistic network formation between these gums, yielding textures that more closely resemble gluten-containing breads. Such interactions likely improve both water retention and gas cell stability during baking, leading to a more uniform and elastic crumb. Bean flour's minor positive effect on chewiness may be attributed to its higher protein quality and ability to interact with polysaccharide gums, forming secondary bonds that stabilize the matrix. Similar enhancements in chewiness through mixed hydrocolloid systems have been reported by Ribotta et al. (2004) and Zhang et al. (2025). These findings highlight the potential of using blended gums to achieve desirable chewiness without compromising softness—a critical factor for consumer acceptance of gluten-free bread.

Resilience

The findings for bread resilience values show that adding more gum has a positive impact on resilience (Figure 11). Bean flour outperformed the other flour types in terms of increasing resilience. Breads with LBG-XG and TG-XG blends had the highest resilience values among gum types. However, using TG alone resulted in a significant decrease in resilience. These findings imply interactions between LBG-XG and TG-XG, which is in line with other textural analyses.

Based on the textural analysis results, it can be inferred that hydrocolloids exert a pronounced influence on the texture of gluten-free breads, which is consistent with the findings reported in numerous previous studies (Ahlborn et al., 2005; Lazaridou et al., 2007; Ribotta et al., 2004).

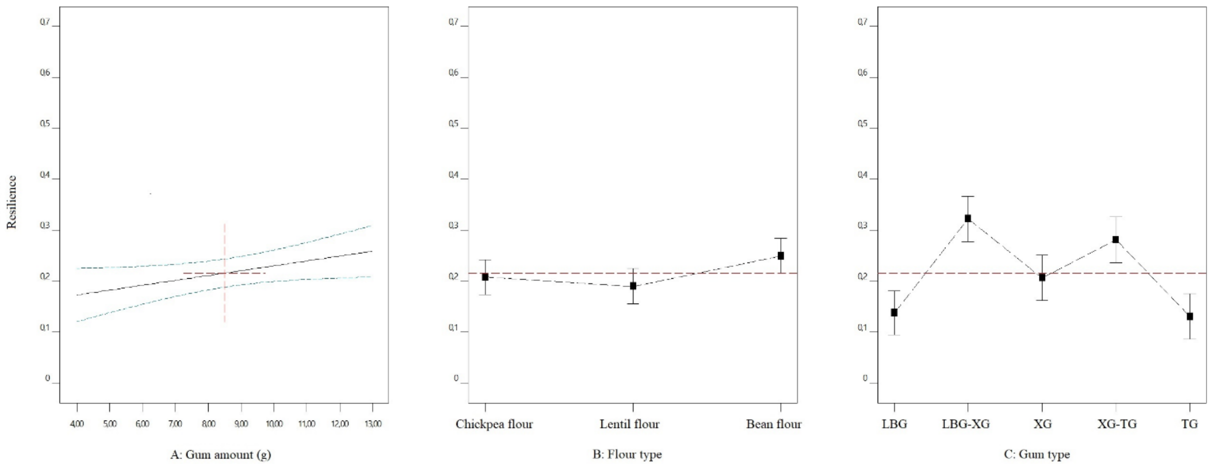

Figure 11. Effects of gum amount, flour type, and gum type on bread resilience. TG: Tara gum, XG: Xanthan gum, LBG: Locust bean gum

Resilience represents the bread's ability to regain its shape after compression, serving as an indicator of internal elasticity and freshness perception. The strong improvement in resilience for mixed gum systems confirms the synergistic behavior observed in previous parameters. The LBG-XG and TG-XG networks likely allow reversible deformation under stress, mimicking the elastic recovery of gluten. TG alone reduced resilience due to insufficient cross-linking density, resulting in less elastic crumbs. Bean flour's superior resilience may be linked to its balanced composition of proteins and starches, which interact with gums to enhance elasticity. Comparable results were reported by Gallagher et al. (2004), who noted that hydrocolloid–protein interactions play a central role in improving crumb recovery. Overall, the findings indicate that resilience, together with springiness, can be used as a key parameter to assess the success of hydrocolloid blends in reproducing gluten-like textures in gluten-free breads.

CONCLUSION

This study evaluated the effects of different gum types, gum concentrations, and legume flours on the physical and textural properties of gluten-free breads. The findings revealed that gum type plays a decisive role in determining bread quality. Loaf height increased markedly in samples containing only xanthan gum (XG), whereas locust bean gum (LBG) enhanced firmness and produced a denser structure. Synergistic interactions were observed in several textural parameters—such as hardness, adhesiveness, cohesiveness, gumminess, chewiness, and elasticity—particularly in blends containing LBG–XG and TG–XG combinations.

Increasing gum concentration generally improved most textural parameters; however, excessive levels (12–13 g) led to adverse effects such as higher adhesiveness. The influence of flour type (chickpea, lentil, and bean) was relatively limited, although bean flour contributed positively to certain properties, especially elasticity.

Overall, the selection and combination of hydrocolloids are critical factors for optimizing the structure and texture of gluten-free breads. Specifically, the LBG–XG and TG–XG blends demonstrated potential for enhancing product quality. Nevertheless, this study was limited to three legume flour types and a small number of hydrocolloids. The absence of sensory and shelf-life evaluations represents a major limitation, highlighting the need for further comprehensive studies to fully assess product performance and consumer acceptability.

Conflict of Interest

The author has declared that that there are no competing interests.

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