

## Glycemic Index and Hedonic Acceptance of White Bread: A Mini Review

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Article Info	ABSTRACT
<p><b>Article History</b> Received: 24 December 2025 Revised: 31 December 2025 Accepted: 31 December 2025 <u>Available online: 03 February 2026</u> *Email (Author Corresponding): meylda25001@mail.upad.ac.id</p>	<p>White bread is widely consumed due to its sensory appeal and convenience, yet it is often associated with concerns related to its glycemic index (GI). This narrative literature review examines recent evidence on the glycemic index and hedonic acceptance of white bread formulated from wheat flour. Relevant peer-reviewed studies published between 2021 and 2025 were identified through searches of ScienceDirect, PubMed, and Emerald databases. The review focuses on studies assessing glycemic response, sensory acceptance, or both, using experimental, predictive, or in vitro approaches.</p> <p>The reviewed literature indicates that white bread is generally characterized by a moderate to high glycemic response, with reported GI values varying according to formulation and assessment method. Despite this variability, consumer acceptance remains consistently favorable across formulations associated with differing estimated GI values. This pattern suggests that sensory preference for white bread is primarily driven by immediate perceptual attributes, whereas glycemic response represents a post-consumption physiological outcome that does not directly influence hedonic evaluation. Interpretation of these findings is constrained by methodological heterogeneity and the absence of studies involving Indonesian consumer populations, highlighting the need for future research integrating standardized human-based glycemic testing and population-relevant sensory evaluation.</p> <p><b>Keywords:</b> White bread, Glycemic index, Sensory evaluation, Consumer acceptance</p>

### Introduction

White bread is one of the most widely consumed bakery products in Indonesia and is readily available in supermarkets, bakeries, and local stores (Chudori & Nunung Nurjanah, 2024). Its soft texture, mild flavor, and versatility make it a popular choice for breakfast and snacks across different age groups (Sulistiyawati et al., 2020). In addition, increasing urbanization and lifestyle changes have contributed to a growing preference for convenient food products such as white bread, which in some households has partly replaced traditional staple foods.

Despite its popularity, white bread consumption is frequently associated with health concerns, particularly related to its glycemic index (GI). The GI reflects the rate at which carbohydrates in food raise blood glucose levels after consumption (Zhang et al., 2021). White bread is commonly characterized as a high-GI food, leading to perceptions that it may contribute to obesity, diabetes, and other metabolic disorders (Grujić & Odžaković, 2021). While these concerns are supported by some scientific evidence, public perceptions are often

shaped by generalized assumptions rather than by a nuanced understanding of formulation differences, testing methods, and dietary context.

Research on white bread has expanded in recent years, addressing not only its glycemic properties but also its sensory characteristics and consumer acceptance. Hedonic perception plays an important role in determining consumption behavior, as foods perceived as less palatable are unlikely to be adopted even when nutritional improvements are introduced. However, findings across studies vary due to differences in bread formulation, GI assessment methods, and sensory evaluation approaches, making it difficult to draw general conclusions from individual studies.

Therefore, this narrative literature review aims to summarize and discuss existing research on the glycemic index and hedonic perception of white bread, with particular attention to studies relevant to wheat-based formulations. By integrating evidence from recent publications, this review seeks to provide a balanced overview of current knowledge and to support a more informed understanding of white bread consumption, especially within the context of Indonesian dietary patterns.

## **Material and Methods**

### **Literature Search Strategy**

A narrative literature review approach was employed to collect and synthesize scientific evidence related to the glycemic index (GI) and hedonic perception of white bread. The review focused on studies examining glycemic response, sensory acceptance, and their methodological approaches within the context of white bread formulated from wheat flour. Literature searches were conducted using three electronic databases, namely ScienceDirect, PubMed, and Emerald, which were selected for their broad coverage of peer-reviewed journals in food science, nutrition, and sensory analysis.

The search was performed using combinations of keywords related to glycemic response, white bread, and sensory evaluation. The following search string was applied to titles, abstracts, and keywords: (“glycemic index” OR “glycaemic index” OR “GI” OR “postprandial glucose”) AND (“white bread” OR “bread”) AND (“hedonic” OR “hedonic properties” OR “consumer acceptance”). The search was limited to articles published in peer-reviewed journals, written in English, and available as open-access publications. To reflect recent developments in the field, the review focused on studies published between 2021 and 2025.

### **Study Selection and Data Collection**

Articles retrieved from the database searches were screened based on their relevance to the objectives of this review. Original research articles investigating white bread produced from 100% wheat flour and reporting both glycemic index values and sensory or hedonic evaluation outcomes were considered. Publications that focused on bread types other than white bread, did not address glycemic response or sensory acceptance, or were published as review articles, book chapters, or conference proceedings were excluded.

Following an initial screening of titles and abstracts, full texts of relevant articles were examined to confirm their suitability and scientific relevance. From the identified literature, six articles were selected for detailed analysis. These studies were chosen to represent recent research trends and methodological approaches rather than to provide an exhaustive overview of all available publications. Key information extracted from the selected studies included publication characteristics, sensory panellist composition, hedonic evaluation methods, and reported GI values.

## Data Synthesis and Analysis

The selected literature was analyzed qualitatively using a narrative synthesis approach. Rather than applying a formal systematic review protocol or quantitative meta-analysis, findings were integrated descriptively to identify general patterns in glycemic index levels and consumer acceptance of white bread. Attention was also given to methodological similarities and differences across studies, particularly in relation to sensory evaluation design and GI assessment techniques.

This narrative approach allowed for flexible integration of evidence derived from diverse study designs and research contexts. By synthesizing findings thematically, the review provides an overview of current knowledge on the relationship between glycemic index and hedonic perception of white bread, while also highlighting methodological limitations and areas that warrant further investigation.

## Results and Discussion

### Characteristics of the Reviewed Studies

As summarized in **Table 1**, the six studies reviewed were published between 2021 and 2025 and appeared in peer-reviewed journals covering food chemistry, applied food research, food engineering, and biological macromolecules. This distribution indicates that research on white bread is approached from multiple disciplinary perspectives rather than being confined to a single methodological or conceptual framework. Such diversity is important because both glycemic response and sensory acceptance are influenced by formulation, processing conditions, and analytical approaches.

The geographical scope of the reviewed studies includes Taiwan, Brazil, Mexico, Thailand, Nigeria, and India. This distribution suggests that interest in the glycemic and sensory properties of white bread extends beyond Western dietary settings and is also relevant in regions experiencing dietary transitions and increasing consumption of wheat-based products. Despite differences in regional food practices, the studies share a common focus on white bread as a reference or baseline product, against which nutritional or functional modifications are evaluated. This repeated use of conventional white bread as a benchmark implicitly positions sensory familiarity as a central consideration in study design and interpretation.

**Table 1.** Inclusion Journal Profiles

No	Author's Country	Quartile Published Journal	Journal Name	Publisher Name	Reference
1	Taiwan	Q1	Foods	MDPI	(Wang et al., 2024)
2	Brazil	Q1	Food Chemistry: X	Elsevier	(Brites et al., 2022)
3	Mexico	Q2	Applied Food Research	Elsevier	(Jiménez et al., 2025)
4	Thailand	Q1	Journal of Food Engineering	Elsevier	(Yun et al., 2021)
5	Nigeria	Q2	Applied Food Research	Elsevier	(Olugbuyi et al., 2023)
6	India	Q1	International Journal of Biological Macromolecules	Elsevier	(Maibam et al., 2023)

Across the reviewed literature, most investigations examined technological or compositional modifications while preserving the defining sensory characteristics of white bread. Nutritional interventions were therefore implemented within relatively constrained formulation boundaries. This pattern reflects an underlying assumption that consumer acceptance is closely linked to familiarity and that substantial deviation from conventional white bread characteristics may reduce acceptability. Consequently, efforts to improve nutritional attributes, including glycemic response, were typically incremental rather than transformative.

Although the journals listed in **Table 1** are recognized for their scientific rigor, the limited number of studies meeting the inclusion criteria indicates that research explicitly integrating glycemic index assessment with hedonic evaluation of white bread remains relatively scarce. This limited evidence base contributes to variability in methodological choices across studies and restricts direct comparison of results. It also highlights the need for more coordinated research designs that explicitly address both metabolic outcomes and sensory perception within a unified analytical framework.

### **Sensory Evaluation Design and Panellist Characteristics**

The sensory evaluation designs and panellist characteristics employed across the reviewed studies reveal important methodological patterns that directly influence the interpretation of consumer acceptance data (**Table 2**). The predominant use of untrained panellists in five of the six studies reflects an explicit orientation toward capturing everyday consumer liking rather than analytical sensory evaluation. This approach is appropriate for white bread, a product typically evaluated based on familiarity and overall liking rather than nuanced sensory attributes. At the same time, it constrains the analytical depth of the sensory data, as untrained panellists are less sensitive to subtle formulation-induced differences that may influence glycemic behavior without producing noticeable changes in liking.

Panellist size variation represents another important methodological consideration. As shown in **Table 2**, sample sizes ranged from fewer than 30 to more than 100 participants. Larger panellists, such as those employed by Brites et al. (2022), enhance the statistical stability of hedonic estimates and reduce the influence of individual preference extremes. In contrast, smaller panellists increase uncertainty and may amplify the effect of personal familiarity with white bread, thereby masking minor sensory differences between formulations. This variability limits the extent to which hedonic outcomes across studies can be interpreted as reflecting true differences in product acceptability.

Demographic reporting across studies was limited and inconsistent, with gender and age information only partially documented. Wang et al. (2024) and Yun et al. (2021) reported a predominance of female participants, while other studies provided minimal demographic detail. Given that sensory perception and carbohydrate preference can be influenced by age, gender, and dietary habits, the absence of detailed demographic information restricts interpretation of the observed hedonic responses. Consequently, it remains unclear whether reported acceptance levels reflect broadly generalizable consumer responses or are specific to particular participant profiles.

Differences in sensory measurement scales further influence interpretive potential. While most studies applied a nine-point hedonic scale, Brites et al. (2022) used a nine centimeter visual analogue scale. Although both tools assess liking, they differ in resolution and data characteristics. As a result, numerical hedonic values across studies should not be directly compared, and observed similarities or differences should be interpreted cautiously and within the methodological context of each study.

**Table 2.** Panellistlists Profile

No	Panellistlist Type	Number	Gender Ratio	Hedonic Scale	Age	Reference
1	Untrained	50	17 men and 33 women	9 points	21-54	(Wang et al., 2024)
2	Untrained	116	N.M.	9 cm	17-59	(Brites et al., 2022)
3	Untrained	83	N.M.	9 points	N.M.	(Jiménez et al., 2025)
4	Untrained	26	18 women and 7 men	9 points	20-29	(Yun et al., 2021)
5	Untrained	40	N.M.	9 points	18-62	(Olugbuyi et al., 2023)
6	semi-trained	30	N.M.	9 points	N.M.	(Maibam et al., 2023)

Taken collectively, the sensory evaluation designs used in the reviewed literature are well suited to assessing general consumer acceptance of white bread but are less effective for elucidating subtle sensory effects associated with glycemc modulation. The current data suggest that moderate formulation changes aimed at altering glycemc response can be implemented without eliciting strong negative reactions from consumers. However, the predominance of untrained panellists, combined with limited demographic reporting and heterogeneous scale usage, reduces the ability to identify threshold levels at which nutritional modification begins to affect sensory perception. Addressing these limitations in future research would enhance understanding of how glycemc-focused formulation strategies interact with consumer acceptance.

### Glycemc Index Profiles of White Bread

The glycemc index values reported for white bread across the reviewed studies are summarized in **Table 3**. Overall, the findings consistently indicate that white bread is characterized by a moderate to high glycemc response, although the magnitude of reported values varies depending on formulation and assessment method. Most studies reported estimated or predicted GI values exceeding 90, placing white bread firmly within the high GI category (Wang et al., 2024; Brites et al., 2022; Jiménez et al., 2025; Maibam et al., 2023). Yun et al. (2021). similarly reported high GI values based on in vitro digestion analysis. In contrast, Olugbuyi et al. (2023) reported a lower GI value of 64.96, which falls within the medium GI range.

This variation in reported GI values reflects, in part, differences in methodological approaches rather than solely differences in product composition. Several studies relied on in vitro digestion models or predictive calculations, which estimate starch hydrolysis rates under controlled laboratory conditions. While these approaches are valuable for comparative screening and formulation development, they do not fully capture the complexity of postprandial glucose responses in humans. The lower GI value reported by Olugbuyi et al. (2023) was derived from an animal-based in vitro model, which further limits direct comparison with studies employing human-relevant or predictive methods. Consequently,



numerical GI values across studies should be interpreted within the context of the applied methodology rather than as directly equivalent measures.

**Table 3.** Hedonic Score and GI Level of White Bread (100% wheat flour)

No	GI Level	Estimated GI Level	Hedonic Overall Score	Reference
1	-	95.99 ± 0.22	6.8/9	(Wang et al., 2024)
2	-	94.61	6.51 ± 1.52/9	(Brites et al., 2022)
3	-	94.61	6.90 ± 1.51/9	(Jiménez et al., 2025)
4	92.79 ± 3.75 - 95.60 ± 1.94	-	72%/100% acceptance	(Yun et al., 2021)
5	64.96	-	8.00±0.82/9	(Olugbuyi et al., 2023)
6	-	94.61	8.5/9	(Maibam et al., 2023)

**Notes:** GI level was measured using in-vitro (Yun et al., 2021). Wistar rats was utilised to analyse the in-vitro GI level (Olugbuyi et al., 2023).

Despite methodological heterogeneity, the predominance of high GI values suggests that the rapid digestibility of starch remains a defining characteristic of conventional white bread. Processing conditions, including milling degree, starch gelatinization during baking, and crumb structure, likely contribute to accelerated enzymatic access to starch granules. Even in studies exploring compositional modification, reductions in GI tended to be modest, indicating that incremental formulation changes may not be sufficient to substantially alter glycemic response without more pronounced structural or compositional intervention.

The data presented in **Table 3** also suggest that moderate reductions in GI are achievable under certain experimental conditions without fundamentally altering the identity of white bread. However, the limited number of studies reporting medium GI values restricts broader generalization. Moreover, the absence of standardized in vivo GI testing across studies reduces confidence in translating these findings into dietary guidance. Without consistent human-based assessment, it remains uncertain whether observed differences in estimated GI values would result in meaningful differences in postprandial glucose response among consumers.

The available evidence indicates that white bread is consistently associated with a high glycemic response, while also revealing substantial variability arising from differences in assessment methods and experimental design. The predominance of in vitro and predictive approaches limits the extent to which reported GI values can be directly compared or translated into dietary recommendations. At the same time, the observed range of GI values suggests that formulation and processing strategies have the potential to influence glycemic behavior, although such effects appear constrained when modifications are implemented within conventional white bread formulations. Greater methodological consistency, particularly through the incorporation of standardized human-based GI testing, is necessary to clarify whether observed differences in estimated GI values correspond to meaningful physiological outcomes.

## Relationship Between Glycemic Index and Hedonic Acceptance

Analysis of the studies summarized in **Table 3** shows no consistent correspondence between glycemic index values and hedonic acceptance scores. Formulations predicted to elicit high postprandial glycemic responses were frequently associated with favorable consumer liking. Wang et al. (2024), Brites et al. (2022), and Jiménez et al. (2025) each reported high hedonic ratings for white bread samples characterized by estimated GI values exceeding 90. These observations indicate that consumer acceptance of white bread is not directly constrained by its glycemic characteristics within the formulation ranges explored.

This apparent dissociation reflects the fundamentally different pathways through which sensory perception and glycemic response are experienced. Hedonic evaluation occurs during consumption and is driven by textural, visual, and flavor-related cues, whereas glycemic response manifests post-consumption and is not perceptible to consumers at the point of eating. As a result, modifications that alter starch digestibility without substantially affecting crumb structure or flavor profile are unlikely to influence immediate liking, even if they modify metabolic outcomes.

Evidence from Olugbuyi et al. (2023), which reported a medium GI value alongside acceptable hedonic scores, suggests that reductions in glycemic response can be achieved without disrupting sensory acceptance. However, this evidence remains limited in scope and is shaped by the methodological diversity discussed in earlier sections. Differences in GI estimation approaches and sensory evaluation designs complicate interpretation of whether such findings reflect genuine formulation effects or methodological variation.

An additional consideration is the narrow formulation space examined across the reviewed studies. Most investigations aimed to preserve the defining sensory identity of white bread, thereby constraining the extent of glycemic modification. Within this restricted space, sensory acceptance appears relatively insensitive to changes in glycemic potential, while GI values show greater methodological variability. This imbalance limits insight into how far glycemic reduction strategies can be pursued before sensory perception is affected.

The current literature therefore provides stronger evidence regarding the resilience of consumer acceptance than regarding the boundaries of glycemic modification. Clarifying the point at which nutritional interventions begin to alter sensory perception will require studies that deliberately explore formulations beyond conventional white bread while applying harmonized methods to assess both glycemic response and hedonic acceptance.

## Methodological Limitations and Interpretive Considerations

Interpretation of the findings in this review must be grounded in the methodological characteristics of the underlying studies summarized in **Tables 1–3**. A primary limitation concerns the restricted number of eligible studies that concurrently evaluated glycemic index and hedonic acceptance of white bread. Only six studies published between 2021 and 2025 met the inclusion criteria, which limits the analytical breadth and increases sensitivity to differences in experimental design.

Substantial heterogeneity is evident in glycemic index assessment methods across the reviewed literature (**Table 3**). Several studies relied on *in vitro* digestion models or predictive calculations to estimate GI values (Wang et al., 2024; Brites et al., 2022; Jiménez et al., 2025; Yun et al., 2021), while Maibam et al. (2023) employed indirect estimation approaches. Olugbuyi et al. (2023) reported a medium GI value using an animal-based *in vitro* model. Although these methods are appropriate for comparative screening and formulation development, they differ in physiological relevance and limit direct comparability. The absence of standardized human-based GI testing across studies constrains interpretation of whether

observed differences in reported GI values correspond to meaningful variations in postprandial glycemic response.

Comparable methodological variability is observed in sensory evaluation design (**Table 2**). Most studies employed untrained consumer panellists (Wang et al., 2024; Brites et al., 2022; Jiménez et al., 2025; Yun et al., 2021; Olugbuyi et al., 2023), while only one study used a semi-trained panellist (Maibam et al., 2023). Panellist sizes ranged from fewer than 30 to more than 100 participants, and demographic characteristics were inconsistently reported. These differences limit the extent to which hedonic outcomes can be compared across studies and restrict interpretation of whether observed acceptance levels reflect formulation effects or panellist composition.

Geographical representation constitutes an additional interpretive limitation. As shown in **Table 1**, all reviewed studies were conducted outside Indonesia, with research originating from Taiwan, Brazil, Mexico, Thailand, India, and Nigeria (Wang et al., 2024; Brites et al., 2022; Jiménez et al., 2025; Yun et al., 2021; Olugbuyi et al., 2023; Maibam et al., 2023). Consequently, the available evidence reflects consumer responses and formulation contexts specific to these regions. Differences in dietary habits, wheat bread consumption frequency, and sensory expectations across countries limit the generalizability of the findings to Indonesian consumers. In the absence of primary or secondary data derived from Indonesian populations, any country-specific claims regarding Indonesian consumer perception or formulation suitability are not supported by the reviewed evidence.

Another limitation relates to the formulation scope explored in the reviewed studies. Most investigations examined white bread formulations within narrow compositional and structural boundaries, aiming to preserve conventional sensory characteristics (Wang et al., 2024; Brites et al., 2022; Jiménez et al., 2025). This focus constrains insight into how more substantial formulation changes might influence glycemic response and consumer acceptance simultaneously. As a result, the findings primarily inform incremental modification strategies rather than broader reformulation approaches.

### **Implications for Product Development and Future Research**

Evidence from recent studies indicates that consumer acceptance of white bread can remain high across formulations associated with substantially different glycemic index values. Wang et al. (2024), Brites et al. (2022), and Jiménez et al. (2025) each reported favorable hedonic responses for formulations predicted to elicit rapid postprandial glycemic responses. This pattern suggests that, within conventional white bread formulations, sensory acceptance is relatively insensitive to moderate changes in starch digestibility. For product development, this implies that strategies aimed at modifying glycemic response may be implemented without immediate sensory penalties, provided that core structural and sensory attributes are preserved.

At the same time, the literature indicates that reported reductions in glycemic index are often modest and strongly influenced by the choice of assessment method. Olugbuyi et al. (2023), reported a medium glycemic index value using an animal-based *in vitro* model, whereas other studies relied on predictive or laboratory digestion approaches (Wang et al., 2024; Yun et al., 2021). These methodological differences limit confidence in translating estimated glycemic values into meaningful physiological outcomes. For formulation strategies intended to support nutritional positioning, reliance on estimated glycemic index values alone is insufficient. Validation through standardized human-based testing remains necessary to establish metabolic relevance.

The reviewed studies also suggest that most formulation efforts have operated within a narrow design space. Investigations by Brites et al. (2022), and Jiménez et al. (2025) prioritized

maintaining the defining sensory identity of white bread, which constrains exploration of more substantial compositional or structural modifications. While this approach supports consumer familiarity, it may also limit the magnitude of achievable glycemic improvement. Future product development research should therefore distinguish between incremental optimization strategies and more transformative reformulation approaches, as these objectives entail different technical and sensory challenges.

From a research standpoint, several priorities emerge. Greater methodological coherence between glycemic assessment and sensory evaluation would strengthen inference regarding the relationship between metabolic response and consumer acceptance. Studies that integrate standardized glycemic testing with clearly defined and transparently reported sensory protocols would provide a more robust basis for formulation decisions.

A further research priority concerns geographical relevance. All reviewed studies were conducted outside Indonesia, despite the widespread consumption of white bread within the country. Differences in dietary patterns, wheat product familiarity, and sensory expectations across regions limit the applicability of findings derived from other populations. Indonesian consumers should therefore be positioned as a focus for future investigation rather than as a population represented by existing evidence. Research involving Indonesian formulations and consumer panellists would provide essential context for translating glycemic modification strategies into locally relevant product development.

Finally, future studies should move beyond documenting acceptance at isolated formulation points and instead examine threshold effects. Identifying the extent to which glycemic modification can be pursued before sensory perception is altered would provide critical insight into the trade-offs inherent in nutritionally oriented bread reformulation.

## Conclusion

This narrative review examined recent evidence on the glycemic index and hedonic acceptance of white bread, drawing on studies published between 2021 and 2025. The reviewed literature indicates that white bread is consistently associated with a moderate to high glycemic response, while consumer acceptance remains relatively stable across formulations exhibiting differing estimated glycemic index values. These findings suggest that sensory preference for white bread is primarily governed by immediate perceptual attributes, whereas glycemic response operates through post-consumption mechanisms that do not directly influence hedonic evaluation at the point of eating.

The reviewed studies further demonstrate that attempts to modify the glycemic characteristics of white bread have largely been pursued within narrow formulation boundaries aimed at preserving its conventional sensory identity. Within this constrained design space, moderate variation in estimated glycemic index does not appear to substantially affect consumer liking. At the same time, the predominance of *in vitro* and predictive approaches for glycemic assessment limits confidence in the physiological relevance of reported glycemic differences, particularly when such differences are small.

Interpretation of the current evidence must also account for methodological and contextual limitations. Variability in glycemic assessment methods, sensory evaluation design, and panellist characteristics restricts cross-study comparability and constrains inference regarding the relationship between glycemic response and sensory acceptance. In addition, the absence of studies conducted in Indonesia precludes population-specific conclusions regarding Indonesian consumers. The Indonesian context should therefore be regarded as a priority area for future research rather than as a population represented by the existing literature.

Despite these limitations, the reviewed evidence contributes to understanding how glycemic considerations and sensory acceptance coexist in white bread research. The findings support the view that improving the glycemic profile of white bread without compromising consumer acceptance is technically feasible within certain bounds, while also highlighting the need for more integrated and methodologically aligned research. Future studies combining standardized human-based glycemic testing with well-defined sensory evaluation, particularly within underrepresented consumer populations, will be essential for advancing both product development and evidence-based dietary guidance.

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### Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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