

Functional food availability and classification in Lahore, Pakistan: a cross-sectional market survey



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ABSTRACT

A cross-sectional market survey was conducted in Lahore, Pakistan, to identify and classify functional food products available across various retail formats. The study aimed to provide insights into the current state of the functional food market and highlight its potential role in improving public health. A total of 64 unique functional food items were identified and categorized based on food group and functional category. The 'bread, cereal, rice, and pasta' group was the largest (26.6%), followed by the 'fruit' (15.6%) and 'milk, yogurt, and cheese' (15.6%) groups. Naturally Occurring Functional Foods (NOFF) were the most frequent (40.6%), followed by Fortified Foods (FF) (32.8%). The availability and variety of functional foods differed significantly between store types, with specialized health stores offering a wider range of products compared to general supermarkets (χ^2 (4, N = 64) = 45.2, $p < .001$). Nestlé and Tayyib Foods emerged as leading brands, focusing on fortified/enriched products and natural/herbal products, respectively. This study provides a foundational market profile of functional foods in Lahore, highlighting the diversity and segmentation of the market, the influence of retail format on product availability, and the coexistence of global and local brands. The findings serve as a diagnostic baseline for future research, market growth, and public health initiatives aimed at harnessing functional foods to improve nutrition in Pakistan.

Keywords: Functional foods, Lahore, Market survey, Product categorization, Retail environment

INTRODUCTION

Functional foods are defined by their health benefits that extend beyond basic nutrition, assisting in the prevention and management of various diseases (Vlaicu *et al.*, 2023). These foods supply essential nutrients and energy, supporting physiological processes that promote long-term health (Stockwell, 2022). Common examples include foods enhanced with vitamins, minerals, probiotics, prebiotics, omega-3 fatty acids, and items that are naturally abundant in antioxidants. Over the past two decades, functional foods have gained increasing importance in the domains of nutritional science and public health due to their role in improving health outcomes and reducing the burden of chronic diseases.

Functional foods can be categorized into various groups. Naturally occurring functional foods, including fruits, vegetables, whole grains, legumes, nuts, and seeds, are abundant in fiber, vitamins, minerals, and bioactive compounds that strengthen immunity and reduce oxidative stress (Fan *et al.*, 2023). Fortified and enriched foods have nutrients added to improve their nutritional profile or to replace nutrients lost during processing; typical examples include iodized salt and iron-fortified flour (Bird *et al.*, 2023). Probiotic and prebiotic foods constitute another essential category, with probiotics being live beneficial bacteria present in yogurt and kefir, while prebiotics are dietary fibers that specifically nourish these bacteria, thus enhancing gut health and digestion (Scudino *et al.*, 2021; Duche *et al.*, 2023). Additionally, herbal and plant-based functional products, such as green tea, moringa, and turmeric, are commonly consumed for their antioxidant, anti-inflammatory, and immune-boosting properties (Amanpour *et al.*, 2023).

Despite the growing recognition of these foods, there is presently no extensive catalog of functional foods accessible in Pakistan. Gaining insight into the availability, diversity, and market distribution of these products from the supply-side perspective is an essential initial step, as functional foods play a crucial role in preventing nutrient deficiencies and promoting optimal health (Paterson *et al.*, 2023). For instance, fortified foods such as vitamin D-enriched milk and iron-fortified flour help to combat common micronutrient deficiencies (Bird *et al.*, 2023).

This research emphasizes this supply-side analysis to create a foundational market profile. Foods abundant in probiotics aid in maintaining the balance of gut microbiota, which has been linked to immune

regulation and improved digestion (Valdes *et al.*, 2018). Similarly, fruits, vegetables, herbs, and spices that are rich in antioxidants contribute to alleviating oxidative stress, decreasing inflammation, and protecting against infections (Ighodaro and Akinloye, 2018).

The consistent consumption of functional foods has been associated with the prevention and management of chronic diseases, such as cardiovascular conditions, diabetes, obesity, and hypertension. Functional components like omega-3 fatty acids play a role in enhancing brain function and cardiovascular health (Mozaffarian and Wu, 2011), while antioxidants and phytochemicals assist in reducing cellular damage and promoting healthy aging (Bitwell *et al.*, 2023; Jomová *et al.*, 2023). Additionally, recent studies emphasize their importance in improving physical performance, boosting energy levels (Cui *et al.*, 2022), and fortifying immunity (Jinek *et al.*, 2012). Given these numerous health advantages, functional foods are increasingly viewed as a safe and natural approach to fostering well-being and improving quality of life (Vlaicu *et al.*, 2023).

In this context, the present study aims to conduct a groundbreaking market survey of functional foods available in Lahore, Pakistan. The objectives include identifying at least ten functional foods from different food groups, documenting their availability in stores and supermarkets, and assessing the range of products classified as functional foods. By compiling this inventory, the study will provide valuable insights into the current state of functional foods in Lahore and highlight their potential role in improving public health, serving as a diagnostic baseline for future research and market advancement.

MATERIALS AND METHODS

Study Design and Location:

A cross-sectional market survey was conducted in the field in September 2025 in Lahore, Pakistan. Lahore is a significant metropolitan region characterized by a diverse and swiftly expanding retail sector, making it an appropriate setting for this preliminary market evaluation. The objective was to methodically assess the availability, diversity, and categorization of functional food products across different retail formats.

Store Selection and Sampling:

A purposive sampling technique was utilized to select eight retail outlets, ensuring representation from both conventional supermarkets and specialized health food stores. This method was adopted to reflect the variety of retail formats that are likely to offer functional foods, rather than to attain statistical representativeness of all outlets in Lahore. The selected stores included:

1. MS Mart and Stationeries, Hussain Complex, 18 km Ferozepur Road, Lahore
2. Panda Super Store, Block A, Pak-Arab Housing Scheme, Lahore
3. Chohan Super Store, Block B, Pak-Arab Housing Scheme, Lahore
4. Shadab Super Store, Shadab Colony, 18 km Ferozepur Road, Lahore
5. Family Choice Super Store, Sherwani Town Housing Scheme, Lahore
6. Bismillah General Store, Sherwani Town Housing Scheme, Lahore
7. Aiwan Super Store, Waheed Brother Colony, Lahore
8. Tayyib Store, Block E, Gulberg, Lahore

Data Collection:

Data was gathered via direct physical observation and careful analysis of product labels. For every functional food product identified, the subsequent data was documented in a standardized format: Store Name, Product Name, Food Group, Functional Category, and Key Functional Ingredients.

Categorization Framework:

Each product was categorized using a two-tier classification system:

1. **Food Group:** In accordance with the USDA's Food Guide Pyramid, products were allocated to one of seven distinct groups:
 - Group 1: Bread, Cereal, Rice, and Pasta
 - Group 2: Fruit
 - Group 3: Vegetable
 - Group 4: Meat, Poultry, Fish, Dry Beans, Eggs, and Nuts
 - Group 5: Milk, Yogurt, and Cheese
 - Group 6: Fats, Oils, and Sweets
 - Group 7: Miscellaneous (Herbs, Spices, Teas, etc.)
2. **Functional Category:** Products were classified based on the characteristics of their functional benefits:
 - Naturally Occurring Functional Food (NOFF)
 - Fortified Food (FF)

- Enriched Food (EF)
- Probiotic Food (PF)
- Herbal and Plant-Based Functional Product (HPF)

Statistical analysis:

Data were inputted and analyzed utilizing IBM SPSS Statistics Version 28 (Field, 2017). Descriptive statistics, including frequencies and percentages, were applied to summarize the distribution of products (Mishra *et al.*, 2019). The Chi-Square test of independence was utilized to assess whether there was a significant relationship between the type of store (General Superstore versus Specialized Health Store) and the functional categories of products available (Nilsson *et al.*, 2015). A p-value of under 0.05 was deemed statistically significant (Seehra *et al.*, 2023).

RESULTS

A thorough market survey was carried out in eight retail outlets located in Lahore, Pakistan, to compile and classify the functional food products available. A total of 64 unique functional food items were recognized and methodically categorized based on their food group and functional category. The findings are outlined below, providing details on the distribution among food groups, functional categories, retail outlets, and prominent brands.

1-Distribution of functional foods by food group:

The 64 products identified were spread across seven specific food groups. As indicated in (Table 1), the bread, cereal, rice, and Pasta group was the largest, making up 26.6% (n=17) of the total products. Next was the Fruit group at 15.6% (n=10), along with the milk, yogurt, and Cheese group at 15.6% (n=10). The overall distribution among all groups is detailed in (Table 1) and illustrated in (Fig. 1).

Table 1. Frequency and percentage of functional food products by food group

Food Group	Frequency (n)	Percentage (%)
Bread, Cereal, Rice, and Pasta	17	26.6%
Fruit	10	15.6%
Milk, Yogurt, and cheese	10	15.6%
Vegetable	9	14.1%
Meat, Poultry, Fish, Dry Beans, Eggs, and Nuts	7	10.9%
Fats, Oils, and Sweets	7	10.9%
Miscellaneous (Herbs, Spices, Teas, etc.)	4	6.3%
Total	64	100.0%

Table (1) gives a numerical summary of the functional food market by main food group. It reveals that grain products and dairy items make up a large part of the functional foods available in Lahore, suggesting that the market emphasizes these essential categories.

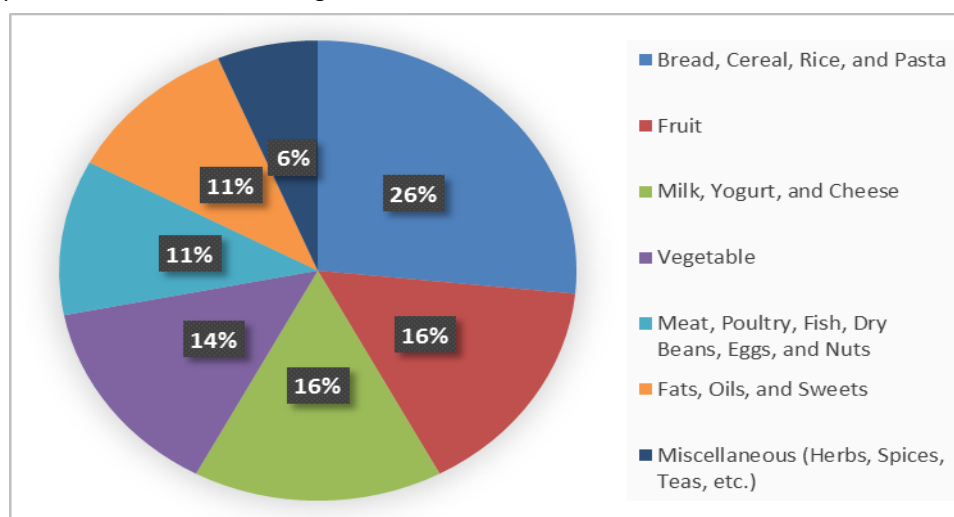


Fig. 1. Distribution of identified functional foods by food group (n=64)

Fig. (1) provides a visual display of the information from (Table 1), clearly showing the market share of each food category. The chart emphasizes the leading position of the 'Bread, Cereal, Rice, and Pasta' category, indicating that fortification and functional development are most prevalent in these essential food products.

1-Distribution of functional foods by category:

Products were divided into five functional categories. As shown in (Table 2), Naturally Occurring Functional Foods (NOFF) were the most frequent, making up 40.6% (n=26) of the total. Fortified Foods (FF) followed as the second most common at 32.8% (n=21). The rest of the products were categorized as Enriched Foods (EF) (9.4%, n=6), Herbal and Plant-Based Functional Products (HPF) (9.4%, n=6), and Probiotic Foods (PF) (7.8%, n=5).

Table 2. Frequency and percentage of products by functional category

Functional Category	Frequency (n)	Percentage (%)
Naturally Occurring Functional Food (NOFF)	26	40.6%
Fortified Food (FF)	21	32.8%
Enriched Food (EF)	6	9.4%
Herbal and Plant-Based Functional Product (HPF)	6	9.4%
Probiotic Food (PF)	5	7.8%
Total	64	100.0%

Table (2) categorizes the products based on their functions. It shows that the Lahore market has a significant amount of both naturally functional whole foods and processed foods enriched with extra nutrients, which together account for almost 75% of all the products listed.

3- Store-wise availability and product variety:

The range of functional foods differed greatly among the eight retail locations. Fig. (2) illustrates that Tayyib Store, which is a specialized health food shop, had the most extensive selection with 23 products. MS Mart and Stationeries, a large supermarket, which offered 16 products, and Panda Super Store followed this with seven products. The smaller general stores, including Chohan, Shadab, Bismillah, and Aiwan, each had between 1 and 4 products

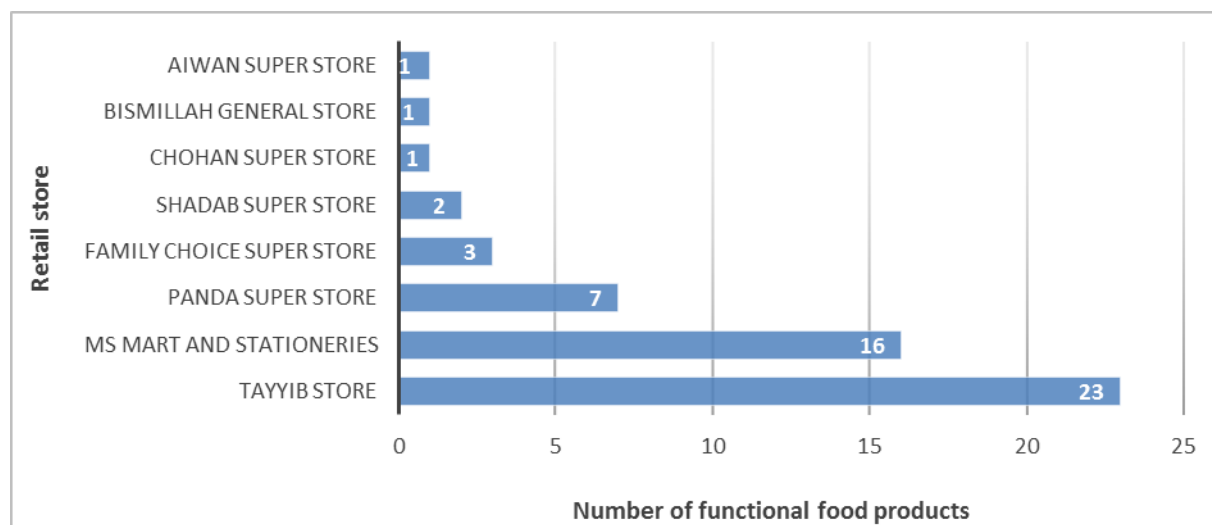


Fig. 2. Total number of functional food products identified per store

Fig. (2) show the differences in the variety of functional foods available in various retail formats. It makes it clear that larger supermarkets and specialized health stores are the main providers of a wide range of functional foods, while smaller general stores have a very limited selection.

A cross-tabulation analysis showed a clear trend in the types of functional foods available at different store types. As illustrated in (Fig. 3), large supermarkets like MS Mart mainly stocked Fortified (FF) and Enriched (EF) products, such as fortified cereals, milk, and cooking oils. On the other hand, the specialized Tayyib Store provided a wide variety, focusing heavily on Naturally Occurring Functional Foods (NOFF) and Herbal and Plant-Based Functional Products (HPF), which include superfood blends, seed mixes, and organic teas. Smaller general stores primarily offered basic Fortified Foods like iodized salt and fortified cooking oil.

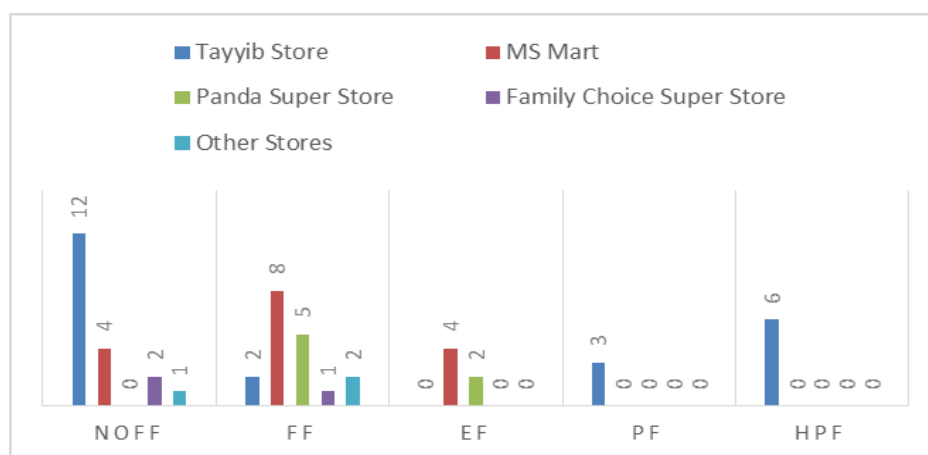


Fig. 3. Distribution of functional food categories by store

Fig. (3) shows a clear view of the product mix in each store. It visually supports the trend of specialization: general supermarkets concentrate on mass-market fortified/enriched staples, while the specialized health store offers a wider range, including niche items like probiotics and herbal products that are mostly missing from other stores.

To statistically evaluate the link between store type and product category, a Chi-Square test of independence was conducted. The stores were categorized into 'General Superstore' (MS Mart, Panda, Family Choice, Chohan, Shadab, Bismillah, Aiwan) and 'Specialized Health Store' (Tayyib Store). The test showed a statistically significant relationship between store type and the functional product categories available, $\chi^2 (4, N = 64) = 45.2$, $p < .001$. This indicates that the product selection in specialized health stores is significantly different from that in general supermarkets.

Table 3. Chi-Square test of independence between store type and functional food category

Variable	χ^2 (Chi-Square)	df	N	p-value	Interpretation
Store Type × Product Category	45.2	4	64	< .001	Significant association between store type and product categories

df = degrees of freedom, which indicate the number of categories minus restrictions applied in the test; N = total sample size (number of functional food products analyzed); p-value = probability of obtaining the observed result by chance. A p-value less than .05 indicates statistical significance, and in this case, $p < .001$ confirms a highly significant association.

Table (3) shows the results of the Chi-Square test of independence, which was done to see if the distribution of functional food categories differed significantly between types of stores. The analysis produced a Chi-Square value of 45.2 with 4 degrees of freedom, based on a sample of 64 products. The p-value was under .001, showing a statistically significant relationship.

This indicates that the product selection in specialized health stores (like Tayyib Store) is clearly different from that in general supermarkets (such as MS Mart, Panda, and smaller general stores). In particular, specialized stores were more inclined to offer Naturally Occurring Functional Foods (NOFF) and Herbal & Plant-Based Functional Products (HPF), whereas general supermarkets primarily stocked Fortified (FF) and Enriched Foods (EF).

4- Leading brands in the functional food market:

A study of the brands that provide functional foods revealed that Tayyib Foods and Nestlé emerged as the most significant players. As depicted in (Fig. 4), each brand was linked to 8 products.

Fig. (4) illustrates the primary participants in the Lahore functional food market. It indicates that both large multinational companies (such as Nestlé) and local specialized brands (like Tayyib Foods) maintain a significant presence, with various other brands catering to specific product niches.

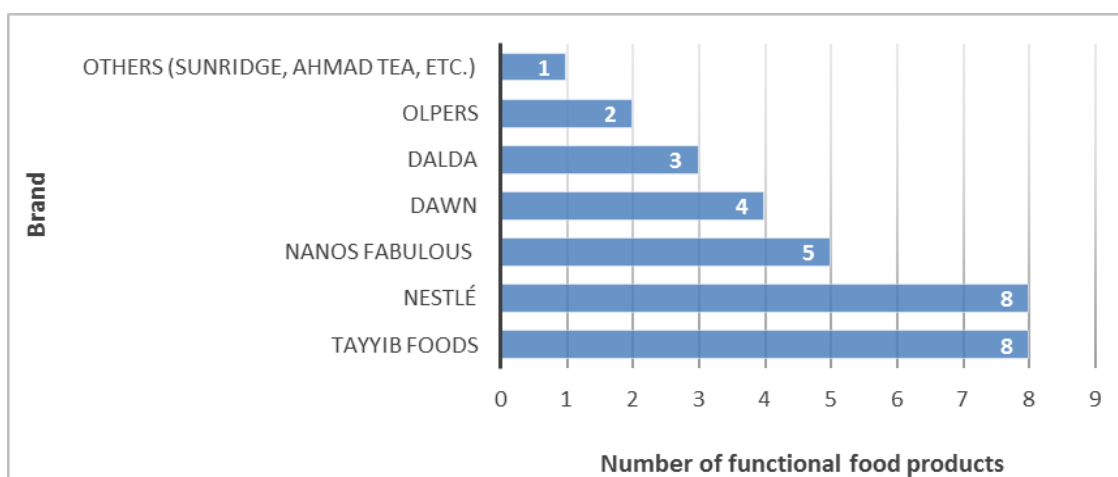


Fig. 4. Number of functional food products by leading brand

Nonetheless, their functional emphasis varied considerably. As shown in (Fig. 5), Nestlé focused almost entirely on Fortified and Enriched products (for instance, Cerelac, Nido, Milo Cereal). Conversely, Tayyib Foods provided a diverse range of naturally occurring and specialty items, including seed mixes, nut blends, and plant-based milks. Other prominent brands such as Tapal and Ahmad Tea played crucial roles in the Herbal and Plant-Based category.

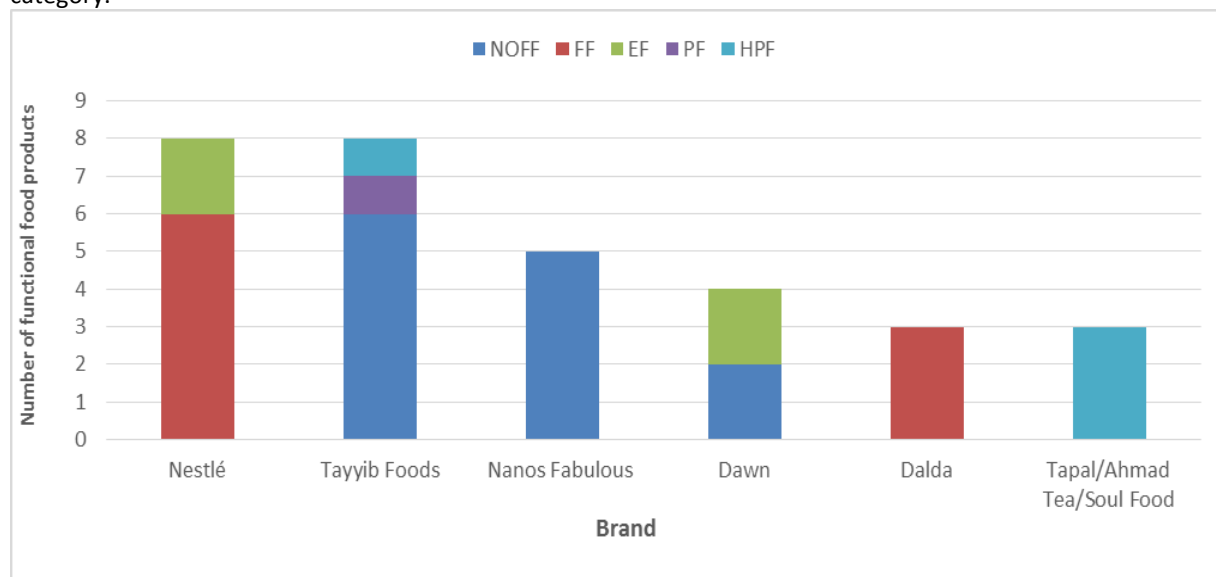


Fig. 5. Types of functional foods introduced by leading brands

Fig. (5) provides a detailed analysis of brand-level data categorized by function, illustrating various market strategies. It emphasizes Nestlé's leading position in the fortified/enriched segment and Tayyib Foods' prominence in the natural, probiotic, and plant-based categories, highlighting the coexistence of various business models within the functional food industry.

In conclusion, the functional foods market in Lahore is characterized by its diversity, showcasing a robust presence of both mass-market fortified staples and specialized natural and herbal products. The availability of these products is significantly affected by the type of retail outlet, with specialized stores presenting a wider selection of niche functional foods compared to general stores.

DISCUSSION

This cross-sectional market survey provides a thorough supply-side analysis of the functional food industry in Lahore, Pakistan, showcasing a market that is in a state of active development. To the best of our knowledge, this represents the first research effort to deliver such an extensive inventory and classification within the Pakistani framework, thereby addressing a significant knowledge deficiency. The findings effectively address the preliminary research questions regarding the availability, variety, and categorization of these

products across different retail formats. The identification of 64 unique products signifies a notable market presence, predominantly driven by grain-based items and dairy products, aligning with global trends where staple foods act as primary vehicles for fortification (Stevens *et al.*, 2022; Bird *et al.*, 2023). The importance of the 'Bread, Cereal, Rice, and Pasta' category suggests that functional food innovation in Lahore is currently centered on enhancing the nutritional quality of vital dietary staples, potentially functioning as a public health strategy to address micronutrient deficiencies within the community.

The classification of distribution by functional type offers crucial insights into the market's composition (Colliard and Hoffmann, 2017). The significant prevalence of Naturally Occurring Functional Foods (NOFF) indicates a consumer inclination towards whole foods that are perceived as inherently healthy (Wang *et al.*, 2022). In contrast, the strong presence of Fortified Foods (FF) underscores the food industry's vital role in creating value-added products (Bird *et al.*, 2022). This coexistence of 'natural' and 'processed' functional items reflects a dual consumer demand: one for traditional, clean-label health foods and another for modern, scientifically enhanced convenience foods, a distinction noted in emerging markets. Nevertheless, it is essential to recognize that this conclusion regarding consumer demand is derived solely from product availability; a direct examination of consumer purchasing motivations remains a critical area for future investigation.

A particularly significant observation is the strong relationship between the type of store and the functional categories available. The Chi-Square test confirms that specialized health stores, such as Tayyib Store, offer a notably different and more diverse range of products, including niche categories like probiotics and herbal items, which are largely absent from general supermarkets. This suggests that access to a wider variety of functional foods, particularly those targeting specific health benefits beyond general wellness, is currently limited to consumers who shop at specialized and potentially more expensive retail outlets (Fernández-Escobar *et al.*, 2023). This conclusion is consistent with research in other areas that highlight a socio-economic disparity in access to a variety of healthy food choices.

The examination of brands further elucidates the stratification present within this market. The concurrent prominence of a multinational corporation (Nestlé) alongside a local specialized brand (Tayyib Foods), each utilizing distinct product strategies, highlights the coexistence of global mass-market and local niche business models. Nestlé's focus on fortified and enriched staples serves as an example of a large-scale public health and marketing strategy (Heckman *et al.*, 2010), while Tayyib Foods' emphasis on NOFF and herbal products caters to an increasing demographic of health-conscious consumers seeking natural and traditional remedies. This indicates that the functional food market in Lahore is not homogeneous but rather segmented based on brand philosophy, distribution channels, and target consumer demographics.

This research presents certain limitations despite its significant findings. The purposive sampling technique employed in Lahore limits the generalizability of the results to other urban or rural areas in Pakistan. Moreover, the study focuses solely on the supply side and does not address demand-side factors such as consumer awareness, preferences, or buying behaviors. The cross-sectional design only captures data from a single point in time (September 2025) and does not account for market trends, seasonal variations, or evolving consumer preferences. Furthermore, the study relied exclusively on observational data and label analysis; it did not incorporate sales data to evaluate actual consumption or consumer surveys to investigate purchasing motivations, perceptions, or barriers such as price sensitivity and trust in health claims (Fu, 2023).

Future research should employ longitudinal designs and random sampling across different cities to observe market fluctuations. It is crucial to investigate consumer perspectives via surveys and focus groups to understand the motivations, awareness, and trust elements that affect functional food purchases in Pakistan, which represents a vital subsequent step after this initial supply-side analysis. Additionally, performing chemical analyses of products may validate the precision of label assertions regarding the levels of functional ingredients. In conclusion, this research establishes a foundation for comprehending the functional food market in a prominent city in Pakistan. It reveals that the market is diverse and segmented, with the availability of products significantly influenced by retail formats. The findings highlight the impact of both international and local brands on the market and suggest potential inequalities in access to specialized functional foods. As the market continues to grow, this study acts as an essential reference and an initial diagnostic tool for industry stakeholders, public health authorities, and researchers dedicated to promoting healthier food environments in Pakistan.

CONCLUSION

This groundbreaking market survey conducted in Lahore, Pakistan, effectively identified and classified 64 distinct functional food items across seven food categories, with the 'Bread, Cereal, Rice, and Pasta' category being the most common. Naturally Occurring Functional Foods (NOFF) and Fortified Foods (FF)

emerged as the leading functional categories. The research indicated a statistically significant impact of retail format on product diversity, with specialized health stores providing a broader selection of niche products compared to general supermarkets. The market is marked by the presence of major multinational brands such as Nestlé, which focuses on fortified staples, alongside local specialized brands like Tayyib Foods, which prioritize natural and herbal products. This research offers an essential preliminary diagnostic profile of the functional food supply in Lahore, setting a foundation for future studies, market growth, and public health initiatives aimed at utilizing functional foods to enhance nutrition in Pakistan.

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AI-assisted technology or generative AI statement

The authors attest that no artificial intelligence (AI) or AI-assisted technology was used in the creation of this work.

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