



## RESEARCH ARTICLE

### EXAMINING THE ASSOCIATION BETWEEN DIETARY PATTERNS AND PLANT BASED MEAT ALTERNATIVE CONSUMPTION

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#### ABSTRACT

This study investigates the relationship between dietary patterns, geographic location, and consumption behaviours related to plant based meat alternatives (PBMA) among Indian consumers. Using chi square analysis on a sample of 300 respondents, this research examines whether significant associations exist between categorical variables, viz., dietary type (vegan, vegetarian, non vegetarian), city of residence, and various consumption dimensions of PBMA. The findings reveal statistically significant associations between geographic location and intention to consume PBMA at different locations/situations ( $\chi^2 = 14.23$ ,  $p = 0.027$ ), between dietary type and past PBMA consumption ( $\chi^2 = 11.73$ ,  $p = 0.003$ ), and between dietary type and meal frequency of PBMA ( $\chi^2 = 14.31$ ,  $p = 0.001$ ). However, no significant relationship was found between dietary type and time spent consuming PBMA ( $\chi^2 = 0.77$ ,  $p = 0.680$ ). These results suggest that not only individual dietary preferences but cultural, geographic factors also play major roles in determining PBMA consumption. The study helps in understanding the market segmentation for PBMA in the Indian context and thus helps in formulating targeted marketing strategies and public health interventions for promoting sustainable dietary transitions.

## INTRODUCTION

The global food system is presented with the challenge to balance environmental sustainability while protecting public health, and providing food security. Traditional animal based protein production have been proven to be significant contributors of greenhouse gas emissions, land degradation, water consumption, and biodiversity loss (Springmann *et al.*, 2016). On the other hand, rising concerns about animal welfare and the health implications of excessive meat consumption have catalysed interest in alternative protein sources (Onwezen *et al.*, 2021). In this context, plant based meat alternatives (PBMA) have emerged as a good solution that can solve environmental, ethical, and health concerns while providing the sensory experience and cultural significance associated with meat consumption (Apostolidis & McLeay, 2016). PBMA are nothing but novel food technologies which are designed to replicate the taste, texture, and nutritional profile of conventional animal meat products while exclusively using plant derived ingredients (Michel *et al.*, 2021). In the global market, these products have experienced exponential growth in Western countries, with the global market valued at approximately 4.6 billion USD in 2018 and projected to reach 85 billion USD by 2030.

Despite of having such commercial success in developed markets, adoption patterns in emerging economies, particularly India, remain understudied. Understanding the factors influencing PBMA consumption in diverse cultural contexts is essential for market development, policy formulation, and achieving sustainable dietary transitions (Moreira *et al.*, 2022).

**Research Gap:** While vast number of research papers have examined PBMA acceptance in Western populations, there exists a critical knowledge gap regarding consumption patterns in the Indian subcontinent, where dietary practices are profoundly influenced by religious beliefs, regional culinary traditions, and socioeconomic factors (Knaapila *et al.*, 2022). India serves as a unique context with approximately 38% of the population following vegetarian diets, the highest proportion globally. At the same time, the Indian non vegetarian consumers are exhibiting growing meat consumption trends. This dietary heterogeneity creates a complex landscape for understanding PBMA adoption. Existing literature has predominantly employed multivariate techniques such as structural equation modelling and regression analysis to examine PBMA consumption with limited focus on investigation into the fundamental associations between categorical demographic and behavioural variables. The current study aims to fill this gap as

understanding these basic relationships is crucial for market segmentation, identifying target consumer groups, and developing culturally appropriate marketing strategies. Furthermore, the interaction between geographic location, dietary identity, and specific consumption behaviours of PBMA remains unexplored in the Indian context, representing a significant gap in both academic literature and practical market intelligence.

**Need for Research:** The current study addresses several areas of research in understanding PBMA consumption patterns. First, identifying which demographic segments are more receptive to PBMA can inform targeted interventions promoting sustainable food choices. Second, with the growing and changing meat consumption patterns of urbanised India, understanding the dimensions of PBMA consumption across different dietary groups can help policymakers and industry stakeholders navigate this transition toward more sustainable alternatives.

Third, from a methodological perspective, this study employs chi square tests to examine associations between dietary type, geographic location, and multiple dimensions of PBMA consumption, including past consumption behaviour, time investment in PBMA consumption, meal frequency incorporating PBMA, and location preferences for consumption. This methodology is great for exploratory research in heterogeneous populations. Insights therefrom provide essential insights for developing evidence based strategies for market penetration, product positioning, and consumer education initiatives.

## Objectives

The primary objectives of this study are:

- To examine the association between geographic location (city of residence) and intention to increase PBMA consumption across different locations (at home, restaurants, both, or neither).
- To investigate the relationship between dietary type (vegan, vegetarian, non vegetarian) and past consumption behaviour of PBMA.
- To assess the association between dietary type and time investment in consuming PBMA.
- To determine the relationship between dietary type and the frequency of meals incorporating PBMA.

## Hypotheses

Based on the research objectives and theoretical framework, the following hypotheses were formulated:

**H<sub>1</sub>:** There is a significant association between geographic location (city of residence) and intention to increase PBMA consumption at different locations.

**H<sub>2</sub>:** There is a significant association between dietary type and past consumption behaviour of PBMA.

**H<sub>3</sub>:** There is a significant association between dietary type and time spent consuming PBMA.

**H<sub>4</sub>:** There is a significant association between dietary type and frequency of meals incorporating PBMA.

## METHODOLOGY

**Research Design:** This study employed a quantitative, cross sectional research design to examine associations between different categorical variables related to PBMA consumption. Specifically, chi square test of independence was used as the primary statistical technique to check for significant associations between dietary patterns, geographic location, and consumption behaviours. This non parametric approach was selected because it does not require assumptions about the distribution of the underlying population and is particularly appropriate for analysing nominal and ordinal categorical data.

**Sample and Data Collection:** 300 respondents across different India states were acquired through purposive snowball sampling. The sampling strategy only targeted individuals who were aware of PBMA, as without knowledge on PBMA, it is impossible to get real and meaningful answers regarding them. Detailed demographic statistics of the sample can be referred in Table 1. The sample was geographically distributed across North/Central India (21.67%, n=65), South India (70%, n=210), and West India (8.30%, n=25). It can be concluded that majority of sample is concentrated in urban centres, and in the Southern India region.

Table 1. Demographic statistics of the sample

| Demographic variables | Category            | Frequency (n) | Percentage (%) |
|-----------------------|---------------------|---------------|----------------|
| Age group             | 18-25               | 58            | 19.33%         |
|                       | 26-35               | 129           | 43.00%         |
|                       | 36-45               | 81            | 27.00%         |
|                       | 46-55               | 23            | 7.67%          |
|                       | 56+                 | 9             | 3.00%          |
|                       | Total               | 300           | 100.00%        |
| Gender                | Male                | 160           | 53.30%         |
|                       | Female              | 140           | 46.67%         |
|                       | Total               | 300           | 100.00%        |
| Education level       | Below Graduation    | 12            | 4.00%          |
|                       | Graduation          | 129           | 43.00%         |
|                       | Masters             | 144           | 48.00%         |
|                       | Above masters       | 15            | 5.00%          |
|                       | Total               | 300           | 100.00%        |
| City of residence     | North/Central India | 65            | 21.67%         |
|                       | South India         | 210           | 70.00%         |
|                       | West India          | 25            | 8.30%          |
|                       | Total               | 300           | 100.00%        |
| Dietary types         | Vegan               | 59            | 19.67%         |
|                       | Vegetarian          | 70            | 23.33%         |
|                       | Non vegetarian      | 171           | 57%            |
|                       | Total               | 300           | 100.00%        |

Source: Compiled by the authors.

Coming to dietary types, the sample comprised diverse dietary groups: ranging from non vegetarians (57%, n=171), vegans (19.67%, n=59), to vegetarians (23.33%, n=70). The demographic composition included predominantly millennials, with 43% aged 26-35 years and 27% aged 36-45 years. Gender distribution was relatively balanced with 53.3% male and 46.67% female respondents. Educational attainment was high, with 48% holding master's degrees and 43% having completed undergraduate education, reflecting the urban, educated demographic typically associated with early adoption of innovative food products.

**Table 2. Cross tabulation of intention to increase consumption of PBMA with respect to location**

| Location            | Intention to increase consumption of PBMA |                |                              |            |       |
|---------------------|---|----------------|------------------------------|------------|-------|
|                     | At Home                                   | At restaurants | At both home and restaurants | At neither | Total |
| North/central India | 21  | 12             | 18                           | 14         | 65    |
| South India         | 48  | 43             | 85                           | 34         | 210   |
| West India          | 0   | 6              | 11                           | 8          | 25    |
| Total               | 69  | 61             | 114                          | 56         | 300   |

Source: compiled by the authors.

**Measurement Instrument:** Data collection employed a structured online questionnaire administered through Google Forms. The questionnaire captured demographic information including age, gender, education level, city of residence, and self reported dietary type. Geographic location was recorded as an open ended response capturing respondents' city of residence which was further categorized into three regional groups for easy and robust analysis. Dietary type was measured using a single item categorical variable with three mutually exclusive options: vegan, vegetarian, and non vegetarian. PBMA consumption behaviours were assessed using multiple items measured on seven point Likert scales. The variable INT measured intention to increase PBMA consumption with the item: 'I intend to increase PBMA consumption at home/restaurants/both/neither.' Three consumption behaviour variables were measured: CON1 captured past consumption with the item 'I used to consume PBMA's'; CON2 assessed time investment with the reverse coded item 'I spend little time in consuming PBMA's'; and CON3 evaluated meal frequency through the reverse coded item 'The number of my meals which have PBMA's is low.' For chi square analysis, continuous responses were dichotomized into low (scores 1-4) and high (scores 5-7) categories to create contingency tables suitable for categorical analysis.

**Statistical Analysis:** The main statistical analysis used was the chi square tests of independence. Through SPSS statistical software, the test was performed on the four sets of variables, viz., dietary type with INT, CON1, CON2 and CON3. The chi square statistic tests the null hypothesis that two categorical variables are independent by comparing observed frequencies in contingency tables with frequencies expected under independence. The degrees of freedom for chi square tests were calculated as  $(r-1)(c-1)$ , where  $r$  represents the number of rows and  $c$  represents the number of columns in the contingency table. The test statistic was calculated as  $\chi^2 = \sum[(O - E)^2/E]$ , where  $O$  represents observed frequencies and  $E$  represents expected frequencies. The resulting chi square values were compared with the standard alpha level ( $p$  value) of 0.05. For variables with chi square values less than the  $p$  value, the null hypothesis of independence was rejected.

## RESULTS

**Association Between Geographic Location and Intention with respect to location:** The first hypothesis examined whether geographic location (grouped into North/Central India, South India, and West India) was statistically associated with intention to increase PBMA consumption at different locations (at home, restaurants, both, or neither). Cross tabulation analysis revealed variation in location preferences across regions. The chi square test ( $\chi^2 = 14.23$ ,  $df = 6$ ,  $p = 0.027$ ) results show a  $p$  value of 0.027 which is less than 0.05. Therefore, we reject the null hypothesis that there is no

marketers, this indicates that marketing strategies and distribution channels for PBMA should be geographically tailored rather than uniform across the country.

**Association Between Dietary Type and Past Consumption:** The second hypothesis examined whether dietary type was statistically associated with past consumption of PBMA (CON1). CON1 was captured using the measurement item 'I used to consume PBMA's' on a 7 point Likert scale ranging from ranging from strongly disagree to strongly agree. Responses were dichotomized into low consumption (scores 1-4) and high consumption (scores 5-7) categories and presented in table 3. From the cross tabulation, it can be inferred that CON1 values vary among dietary groups. Vegans reported the highest proportion of past consumption with 27.7% ( $n=23$ ) in the high consumption category, followed by vegetarians at 10.9% ( $n=6$ ), while non vegetarians showed the lowest prevalence at 11.7% ( $n=19$ ) in the high consumption category.

**Table 3. Cross tabulation of past consumption (CON1) with respect to dietary type**

| Dietary Type   | Low (1-4) | High (5-7) | Total |
|----------------|-----------|------------|-------|
| Non-vegetarian | 143       | 19         | 162   |
| Vegan          | 60        | 23         | 83    |
| Vegetarian     | 49        | 6          | 55    |
| Total          | 252       | 48         | 300   |

Source: Compiled by the authors.

The chi square test results ( $\chi^2 = 11.729$ ,  $p = 0.003$ ) show a  $p$  value of 0.003 which is less than 0.05. Therefore, we reject the null hypothesis that there is no significant association between dietary type and CON1. In other words, this means that dietary type and CON1 are not independent variables. Hypothesis  $H_2$  is therefore supported by the data. This finding suggests that vegans exhibit substantially higher rates of past PBMA consumption which makes sense theoretically as well because vegans are constantly looking for meat alternatives. Conversely, the low adoption among non vegetarians suggests that PBMA's have not yet successfully penetrated the mainstream omnivorous market in India, despite their intended positioning as meat substitutes.

**Association Between Dietary Type and Time Spent in Consumption:** The third hypothesis examined whether dietary type was statistically associated with time investment in PBMA consumption (CON2) captured by the reverse coded item 'I spend little time in consuming PBMA's' on a 7 point Likert scale ranging from ranging from strongly disagree to strongly agree. After reverse coding, low scores represented high time investment while high scores represented minimal time investment and presented in table 4. Cross tabulation showed that 73% ( $n=219$ ) of respondents across all dietary types reported high time investment in PBMA consumption, with relatively similar proportions across groups: non vegetarians 71% ( $n=115$ ), vegans 74.7% ( $n=62$ ), and vegetarians 76.4% ( $n=42$ ).

**Table 4. Cross tabulation of time spent consuming (CON2) with respect to dietary type**

| Dietary Type   | Low (1-4) | High (5-7) | Total |
|----------------|-----------|------------|-------|
| Non-vegetarian | 115       | 47         | 162   |
| Vegan          | 62        | 21         | 83    |
| Vegetarian     | 42        | 13         | 55    |
| Total          | 219       | 81         | 300   |

Source: Compiled by the authors.

The chi square test results ( $\chi^2 = 0.77$ ,  $df = 2$ ,  $p = 0.680$ ) show a p value of 0.680 which is higher than the standard 0.05. Therefore, we accept the null hypothesis that there is no significant association between dietary type and CON2. In other words, this means that dietary type and CON2 are independent variables. Hypothesis H<sub>3</sub> is therefore not supported by the data. The lack of significant association suggests that when consumers choose to engage with PBMA, the temporal investment they make is consistent regardless of their dietary identity. This finding challenges the assumption that vegans or vegetarians might dedicate more time to incorporating PBMA into their diets compared to non vegetarians. The uniformity across groups may reflect that PBMA consumption, regardless of motivation, requires similar levels of planning, preparation, and meal integration.

#### Association Between Dietary Type and Meal Frequency:

The fourth hypothesis examined whether dietary type was statistically associated with the frequency of meals incorporating PBMA (CON3), captured through the reverse coded item 'The number of my meals which have PBMA is low' on a 7 point Likert scale ranging from ranging from strongly disagree to strongly agree. After the reverse coding, a low score means the respondents represents a low frequency of PBMA meals and vice versa and presented in table 5. Cross tabulation revealed that 91% (n=273) of all respondents reported low meal frequency of PBMA. Notably, 100% of vegans (n=83) fell into the low frequency category, compared to 89.5% of non vegetarians (n=145) and 81.8% of vegetarians (n=45). Only 27 respondents (9%) reported high meal frequency, with this group comprising non vegetarians (10.5%, n=17) and vegetarians (18.2%, n=10), but excluding all vegans.

**Table 5. Cross tabulation of meal frequency of PBMA (CON3) with respect to dietary type.**

| Dietary Type   | Low (1-4) | High (5-7) | Total |
|----------------|-----------|------------|-------|
| Non-vegetarian | 145       | 17         | 162   |
| Vegan          | 83        | 0          | 83    |
| Vegetarian     | 45        | 10         | 55    |
| Total          | 273       | 27         | 300   |

Source: Compiled by the authors.

The chi square analysis results ( $\chi^2 = 14.31$ ,  $df = 2$ ,  $p = 0.001$ ) show a p value of 0.001 which is less than 0.05. Therefore, we reject the null hypothesis that there is no significant association between dietary type and CON3. In other words, this means that dietary type and CON3 are not independent variables. Hypothesis H<sub>4</sub> is therefore supported by the data. The results are somewhat contrasting in a way that indicating that despite vegans showing the highest past consumption rates, they paradoxically report the lowest meal frequency of PBMA. This apparent contradiction can be explained by vegans potentially prioritizing whole plant foods and naturally plant based proteins over processed meat alternatives, whereas those who do consume PBMA may do so occasionally rather than

regularly. The complete absence of vegans in the high meal frequency category suggests that PBMA serve as occasional supplements rather than dietary staples for this group. In conclusion, this study examined the associations between dietary patterns, geographic location, and various dimensions of plant based meat alternative consumption among Indian consumers. The chi square analyses revealed a complex pattern of relationships that provide important insights for understanding PBMA market dynamics in this culturally diverse context. Three of the four hypotheses were supported, indicating that both geographic and dietary factors play significant roles in shaping PBMA consumption behaviours, though not uniformly across all consumption dimensions.

#### Implications

**Theoretical Implications:** This study contributes to the theoretical understanding of food choice behaviour by demonstrating that consumption patterns for novel food technologies are shaped by complex interactions between identity based factors (dietary type), contextual factors (geographic location), and behavioural dimensions (past consumption, time investment, meal frequency). The differential associations observed across consumption dimensions suggest that PBMA adoption is not a unidimensional construct but rather comprises distinct behavioural components that respond differently to demographic characteristics. Future theoretical development should consider this multidimensionality when modelling sustainable food transitions, recognizing that trial behaviour, consumption intensity, and dietary integration represent separate processes with potentially different determinants (Michel *et al.*, 2021). The findings also highlight the importance of cultural and geographic context in food innovation adoption. While much PBMA research has emerged from Western contexts where meat consumption is culturally normative, this study demonstrates that in regions with established vegetarian traditions, the dynamics of plant based alternative adoption differ substantially. The paradox of vegans showing high experimentation but low regular consumption challenges assumptions about the relationship between dietary identity and meat alternative consumption, suggesting that theories developed in omnivorous dominant contexts may require modification when applied to vegetarian dominant or mixed cultural contexts (Povey *et al.*, 2001).

**Practical Implications:** For industry stakeholders, these findings provide actionable insights for market segmentation and targeting strategies. The strong association between dietary type and past consumption suggests that current marketing efforts should be differentiated by consumer segment. For the vegan and vegetarian markets, which show higher engagement, product positioning can emphasize variety, nutritional completeness, and convenience as additions to plant based diets. However, for the crucial non vegetarian segment, which represents the primary opportunity for meat displacement, messaging must fundamentally shift to emphasize sensory experience, culinary versatility, and taste parity with conventional meat, potentially deemphasizing ethical or environmental appeals that may create psychological resistance (Graça *et al.*, 2015). The geographic variation in location intentions highlights the need for region specific distribution strategies. In areas where home consumption dominates, retail partnerships and consumer education about preparation methods should be prioritized. In regions showing restaurant

preference, collaborations with food service providers, menu placement strategies, and chef training programs may yield better market penetration. The overall low meal frequency across all groups signals that the primary challenge is not trial conversion but rather achieving repeat purchase and dietary integration. Product development efforts should therefore focus on creating PBMA variants that are suitable for frequent consumption, avoiding flavor fatigue, offering nutritional balance, and matching the convenience and versatility of conventional meat products (Apostolidis & McLeay, 2016).

**Policy Implications:** From a policy perspective, these findings suggest that promoting dietary transitions toward plant based alternatives requires targeted interventions that account for cultural and demographic diversity. Public health campaigns promoting PBMA should be geographically tailored and segment specific rather than uniform national initiatives. Given the low adoption among non vegetarians, who represent the majority of the population and whose dietary shift would have the greatest environmental impact, targeted education campaigns emphasizing health benefits, taste quality, and culinary applications may be necessary to overcome barriers. Additionally, policy incentives such as favourable taxation, subsidies for PBMA production, or requirements for plant based options in institutional food service could accelerate market normalization and consumption integration (Springmann *et al.*, 2018).

**Limitations and Scope for Future Research:** This study has several limitations that should be acknowledged. First and foremost, even though significant associations were detected, the directionality of influence cannot be determined from chi square analysis alone. Then, instead of a single time survey, longitudinal research does a better job in tracking consumption patterns over time and would provide stronger evidence about behavioural trajectories and the stability of dietary identities in relation to PBMA adoption. Further, the purposive snowball sampling approach limits generalizability to the broader Indian population. The sample overrepresentation of educated, urban, millennial consumers means the findings may not reflect patterns among rural populations, lower socioeconomic groups, or older generations who constitute different market segments with potentially distinct consumption drivers. Similarly, the geographic distribution was unbalanced, with South India heavily overrepresented, limiting the power to detect regional differences and potentially biasing results toward South Indian consumption patterns. Stratified sampling ensuring adequate representation across all regions would strengthen geographic comparisons.

Future research should address these limitations while extending the investigation in several directions. There is good scope for qualitative research exploring the reasons behind decision making process moving beyond just descriptive findings. Understanding the why's behind low rates of adoption and varied preferences among dietary types will help in providing better knowledge on vegan markets. Second, experimental studies which involve playing around or making changes in product attributes, pricing strategies, or marketing messages could test causal hypotheses about factors influencing PBMA adoption across different demographic segments. Third, expanded geographic coverage including rural areas and smaller cities would enable more comprehensive understanding of regional variation and urban rural differences in consumption patterns. Additionally, future

research should examine psychographic variables beyond demographic categories, including environmental values, health consciousness, food neophobia, and social identity, which theoretical models suggest influence sustainable food choices. Integrating these psychological constructs with demographic patterns could provide a more comprehensive explanatory framework.

## CONCLUSION

This study examined associations between dietary patterns, geographic location, and plant based meat alternative consumption behaviours among Indian consumers using chi square analysis. The findings revealed that three of four hypothesized associations were statistically significant, revealing that both geographic factors and dietary identity play important roles in shaping PBMA consumption, though not uniformly across all behavioural dimensions. Geographic location significantly influences location intentions for PBMA consumption, highlighting regional variation in food infrastructure and cultural preferences. Dietary type strongly predicts past consumption behaviour, with vegans showing substantially higher engagement than vegetarians or non vegetarians, but paradoxically also universally low meal frequency, suggesting experimental rather than habitual consumption patterns. Time investment in PBMA consumption appears independent of dietary identity, which might mean that all dietary type consumers engage in similar amounts of time commitment once adoption occurs. Overall, the results suggest low market penetration and low meal frequency across all dietary groups.

These findings contribute to understanding the early stage market dynamics of plant based meat alternatives in a culturally diverse context such as India which is characterized by both strong vegetarian traditions and growing meat consumption. As Indian consumers are getting urbanised and learning about dietary transition and their impact on the environment, understanding the factors that facilitate or hinder adoption of sustainable protein alternatives becomes increasingly critical. However, successful adoption of plant based alternatives in India will require strategies that acknowledge and accommodate the country's dietary diversity, regional variation, and cultural food traditions while addressing the practical barriers of taste, price, availability, and habit formation that currently limit mainstream adoption.

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