Analysis on consumer awareness and preferences on plant-based protein alternatives

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Abstract

The consumption behaviour is influenced by rising concerns about environmental sustainability, health and animal welfare. Plant based Protein alternatives are having high nutritional value. hence the knowledge, attitudes and preferences for plant-based proteins among 130 consumers is analysed and presented in the article. The analysis indicated that the awareness of plant-based protein alternatives is high, with word-of-mouth and personal experience being the most common sources of information. Pea protein and nuts were the most prominent alternatives, whereas hemp protein and quinoa were less popular. Factor analysis identified four key determinants of consumer choices: branding and marketing, health and well-being, practicality and ethical concerns - especially regarding animal welfare. increasing accessibility, cost, ethical messaging and marketing methods will increase plant-based protein acceptance and consumption. Limited research exists on consumer perception and market readiness in Indian urban cities compared to developed countries. It is suggested to businesses and policymakers to strategically promote plant-based alternatives by distributing through the public distribution systems, organic product retailers in affordable assortments in the market to attain sustainable development goals.

Keywords : consumer awareness; factors influencing; marketing strategies; preferences; plant-based protein alternatives

Introduction

The global food system is under increasing pressure due to population growth, climate change and rising lifestyle diseases. Beyond fulfilling caloric needs, protein is the second most essential macronutrient for sustaining human life (1). Protein production is a serious challenge because traditional animal protein sources need a large amount of land and resources (2). Plant-based products can be classified as cereal (oat, rice, corn and wheat), legume (soy, peanut), nuts (almond, pistachio, walnut, hazelnut and coconut), seed (sunflower, sesame, hemp and flax) and pseudo-cereals (quinoa) based products (3).

Plant-based protein alternatives have drawn a significant interest as people's awareness of environmental sustainability, animal welfare and health issues has grown. These alternatives offer various nutritional benefits while meeting diverse dietary preferences, including vegetarian, vegan and gluten-free diets (4). The market for plant-based protein alternatives is expanding as a result of the increased acceptance of plant-based diets, giving customers a wide range of options that support health and wellbeing without sacrificing flavour or texture (5).

Alternative protein sources serve as viable substitutes for conventional animal-based proteins, supporting the transition to more plant-based dietary patterns. Although vegetarian and vegan diets have been popular for many years and plant-based food items such as tofu and textured soy protein have been available in the Western world since at least the 1960s, there has been a constantly increasing range of plant-based meat substitutes (6). Soy-based protein food makers have created a diverse range of food products. Global soybean production has grown significantly over the last decades (7). The Asian population consumes a lot of soy and its derivatives, like tofu, edamame and soy milk. Vegetarians have a high intake of soy protein every day (8). Pulses (peas and lentils) are a well-known source of protein due to their high globulin and albumin content (9). Notably, peas are popular due to their rich supply of essential amino acids and have several food product applications, such as meat and dairy substitutes and nutritional supplements (10).

Significantly, price, flavour, health and nutrition are often bigger determinants of food choice than production-related ones (11). Furthermore, stronger positive judgments of healthiness, safety and nutritional value have been associated with a greater tendency to buy plant-based proteins (12). Shifting consumers' perceptions of alternative protein products may be critical to improving their acceptance and consumption of these items; however, this must be done within the framework of their

preferences. Despite the growing interest in plant-based diets, there is limited region- specific research on consumer behaviour towards such alternatives, especially in urban Indian cities. Consumer preferences for various sources of protein differ and impacted by various factors, particularly food choice motives, cultural norms and emotions (13).

This study holds significant implications for understanding consumer awareness and preferences regarding plant-based protein alternatives in Coimbatore city. It is an ideal location to explore emerging dietary preferences. Furthermore, this study aims to identify the gaps where customers are not accepting the plant-based alternatives, opening the door for wider use of these products through market research. This study plays a vital role in analysing the factors influencing the preference towards plant-based alternatives, an area with limited prior research despite its economic significance. Unlike the existing studies, it combines factor analysis and percentage analysis to identify the unique adoption drivers for the adoption of the products.

Methodology

Selection of study area and sampling method

The study was conducted in Coimbatore city, Tamil Nadu due to its diverse population and growing interest in plant-based options. A sample of 130 consumers was taken using a convenience sampling method to gather data. The sample size was determined considering feasibility, budget constraints and previous similar studies. Convenience sampling was used to gather data from individuals who are easily accessible and willing to participate in the study. This approach is focusing on the awareness and preferences of plant-based protein alternatives among the residents of Coimbatore city. The sample was distributed across four localities: Gandhipuram: 39 participants (30 %), RS Puram (Ratina Sabapathi Puram): 33 participants (25 %), Peelamedu: 32 paricipants (25 %), Saibaba Colony: 26 participants (20 %). Data collection was carried out during January and February 2025, with 2025 serving as the reference of the year. In this I have used percentage analysis to calculate how much percentage contributes for awareness and for demographic studies of my study. Factor analysis is a statistical method used to describe variability among the observed variables called factors which influence the preferences of the consumers selected for my study.

Data collection

Primary data

Primary data was collected using a carefully designed interview schedule. The objectives of the study were clearly explained to the respondents to ensure accurate information and minimize errors. The structured interview schedule was validated through a pilot test with a subset of consumers to ensure clarity, relevance and reliability of the questions. Feedback from the pilot test was incorporated to refine the questionnaire, enhancing its suitability for the target respondents. The interviews focused on gathering information about sociodemographic profiles (age, gender, education, annual income, occupation, farming experience and land holdings), factors influencing the adoption of plant-based protein alternatives, awareness levels, willingness to purchase and suggestions for promoting increased use of plant -based protein alternatives. Secondary data on plant-based protein productivity and consumption- both at national and international levels were obtained from relevant publications, annual reports, articles and reputable websites.

Tools of analysis

The following statistical tools were used for analyzing and interpreting the data. Percentage analysis and factor analysis was used for analysis. Percentage analysis was employed to interpret sociodemographic variables and other relevant factors (14), while factor analysis was used to identify the key factors influencing consumer decisions regarding the purchase of plant-based protein alternatives (15). The statistical analysis was carried out using IBM SPSS statistical tool.

Descriptive analysis

Simple percentage was used to interpret the socio-demographic variables such as age, gender, educational qualification, occupation, annual income, family size, type of food consumed regularly and dietary choices. This analysis was used to assess awareness and source of awareness on plant-based protein alternatives.

Percentage analysis =

(number of respondents / total number of samples) x 100

(Eq. 1)

Factor analysis

Factor Analysis is a multivariate statistical method used to reduce many variables into fewer underlying factors based on patterns of correlations. In this study, principal component analysis (PCA) with varimax rotation was applied to extract factors influencing consumer adoption of plant-based proteins. The analysis used variables that includes taste, health, nutritional value, packaging, shelf life, availability, price, animal health, advertisement and brand. The analysis considered variables including taste, health benefits, nutritional value, packaging, shelf life, availability, price, animal welfare, advertisement and brand. Variables were selected based on their relevance to the study's objectives and their theoretical significance in prior research. Factors with eigenvalues greater than 1 were retained, aligning with the Kaiser criterion for meaningful component extraction. Varimax rotation was applied to enhance interpretability and factor loadings above 0.5 were considered significant for assigning variables to components. These thresholds ensured a robust and reliable analysis of the underlying dimensions impacting the buying of plant-based protein alternatives.

$$X_i = A_{i1}.F_1 + A_{i2}.2F_2 + A_{i3}.3F_3 + \ldots\ldots + A_{im}.MF_m + V_iU_i$$

(Eq. 2)

Where,

X_i = ith standardized variable. Where i = 1,2,3…k variables

A_{ij} = standardized multiple regression coefficient of variable "i" on common factor "j".

F_j = common factor. Where j=1,2,3…m Number of common factors.

V_i = Standardized regression coefficient of variable "i" on unique factor.

U_i = The unique factor variable "i".

Results and discussion

The demographic characteristics of the consumers–gender, age classification, family type, family size, family income, educational status, farm size and occupation type-were analyzed and the results are presented. In addition, respondents' awareness levels and the factors influencing their preferences for plant-based protein alternatives were examined and are presented in the following sections.

Demographic characteristics of the respondents

The demographic characteristics of the 130 participants are presented in Table 1. The sample comprised 61 % males and 39 % females, indicating a slight male majority. A significant proportion (17 %) were married, while 29 % were unmarried. In terms of age, the majority were young adults, with 40 % in the 21-30 age group and 47 % in the 31-40 age group. Only 2 % were over 50 years old. Most participants (83 %) lived in medium-sized families of 4-5 members. Educational attainment is notably high, with 52 % holding postgraduate degrees and 39 % possessing undergraduate qualifications. Income is predominantly in the Rs. 20000-50000 bracket (54 %), followed by Rs. 50000-100000 (29 %), with 8 % earning under Rs. 20000 and 9 % earning above Rs. 100000. In terms of dietary habits, 55 % reported consuming both vegetarian and non-vegetarian food, while 37 % followed a vegetarian diet. A significant portion (74 %) identify as non-vegetarian, with 16 % identifying as vegetarian. Employment is mainly in the private

sector (60 %), with 33 % employed in the public sector and 7 % in other fields. These socio-demographic details suggest that the sample is predominantly young, educated and middle-income, with diverse dietary choices and a significant representation in the private sector.

Awareness on plant-based protein alternatives

The awareness and source of awareness of the plant-based proteins of participants were presented in Table 2. Out of the 130 sample participants, the findings align with the results of (16) 122 (94 %), were aware of the plant-based protein substitutes, whereas just 8 (6 %), were unaware. This implies that a few sample respondents were still unaware of the benefits of plant-based protein, while the majority were well-informed. Most of the sample respondents in my study were aware of plant-based protein alternatives through family and friends, contributing 48 % with 63 respondents, followed by trying on their own, contributing 27 % with 35 respondents, participants were aware through social media with 15 % accounting for 19 individuals and 10 % were aware of plant-based protein alternatives through advertisements, accounting for 13 individuals. We may conclude that word-of-mouth is the most common source of knowledge, followed by personal experience and social media and advertisement play a little role in raising awareness.

Preferences towards different plant-based alternatives

Table 3 presents the preferences of 130 sample respondents regarding plant-based protein alternatives. Of these, pea protein (which contributes 67 %, with 88 respondents) and nuts (which contribute 60 %, with 79 sample respondents) are the most preferred choices. These plant-based protein alternatives may be available in different forms and are affordable (15). Soy milk was moderately preferred by 44 % (57 respondents), while soybeans were chosen by 45 % (58 respondents). Lentils were selected by 33 % (43 respondents) and tofu/tempeh by 16 % (21 respondents). Less commonly preferred options included edamame (14 %, 18 respondents), quinoa (8 %, 11 respondents) and hemp protein (5 %, 7 respondents), indicating lower awareness or acceptance levels for these alternatives (17, 18).

Table 1. Demographic characteristics of the respondents

Sl.no	Profile	characteristics	Frequency (n = 130)	percentage
1.	gender	Male	79	61
		Female	51	39
2.	Marital status	Married	92	71
		Unmarried	38	29
3.	Age classification	<20	4	3
		21-30	52	40
		31-40	61	47
		41-50	11	8
		>50	2	2
4.	Family size	Small <3	13	10
		Medium 4-5	108	83
		Big <5	9	7
5.	Educational status	Elementary school	1	1
		Higher secondary	4	3
		Undergraduate	51	39
		Postgraduate	67	52
		Doctoral	7	5
6.	Monthly income	<Rs.20000	11	8
		Rs.20000 - Rs.50000	69	54
		Rs.50000 - Rs.100000	37	29
		>Rs. 100000	13	9
8.	Type of food consumed	Vegetarian food	48	37
		Non-vegetarian & vegetarian food	71	55
		Plant-based protein alternative	11	7
9.	Dietary choices	Vegetarian	21	16
		Non-vegetarian	96	74
		Ovo-vegetarian	11	9
		vegan	2	1
10.	Occupation type	Private sector	78	60
		Public sector	43	33
		others	9	7

Table 2. Awareness on plant-based protein alternatives

Sl.no	Profile	Characteristics	Frequency (n = 130)	Percentage
1.	Awareness on plant-based protein alternatives	Aware	122	94
		Not aware	8	6
2.	Source of awareness	Family/friends	63	48
		Social media	19	15
		Advertisement	13	10
		Tried on own	35	27

Table 3. Preferences towards different plant-based alternatives

Sl.no	Particulars	Frequency (n = 130)	Percentage
1.	Lentils	43	33
2.	Nuts	79	60
3.	Edamame	18	14
4.	Tofu/tempeh	21	16
5.	Quinoa	11	8
6.	Pea protein	88	67
7.	Soybeans	58	45
8.	Soymilk	57	44
9.	Hemp protein	7	5

factors influencing preference of consumers

To investigate the factors influencing respondents' preference for plant-based protein substitutes, exploratory factor analysis was used. Table 4 indicates that the sample was adequate and suitable for factor analysis, with the KMO (Kaiser-Meyer-Olkin) statistic value of 0.744 (beyond the 0.5 threshold). Furthermore, an approximate chi-square statistic of 299.266 with 45 degrees of freedom was obtained using Bartlett's test; which was "significant at $p < 0.00$". It indicates that factor analysis is an effective technique for learning more about the data. Fig. 1 highlights the effectiveness of multiple factors in spreading information on plant-based protein alternatives with personal interest and through friends playing a significant role. The substantial awareness level suggests successful outreach efforts, utilizing diverse methods to educate the consumers about these plant-based protein alternatives. The scree plot was used to determine the optimal number of factors to retain in the analysis by visualizing the point where the eigenvalues level off, indicating diminishing explanatory power. To determine the optimal number of factors, a scree plot was used, which displayed a noticeable "elbow" after four factors. This suggests that four key factors were sufficient to explain most of the variance in preferences for plant-based protein alternatives.

As shown in Table 5, four of the components had eigenvalues greater than 1, collectively explaining approximately 66.27 % of the total variance. The relationships between the factors and variables determined using the PCA method are known as factor loadings (6). Although they did not clearly associate all the variables with the factors, these loadings demonstrated the relationships between the variables.

Following varimax rotation, the factor loadings are displayed in Table 6. Significant factor loadings are those that have values of 0.5 or above. The first component had three factor loadings with values above 0.5, the second had two factor loadings, the third had three factor loadings with values above 0.5 and the fourth had one factor loading with a value over 0.5. Based on their factors, these components were then given their appropriate names

Conclusion

The study offers valuable insights into consumer awareness, preferences and socioeconomic profiles related to plant-based protein alternatives. Most respondents were young, educated and belonged to middle-income groups. Among the various alternatives, nuts and pea protein emerged as the
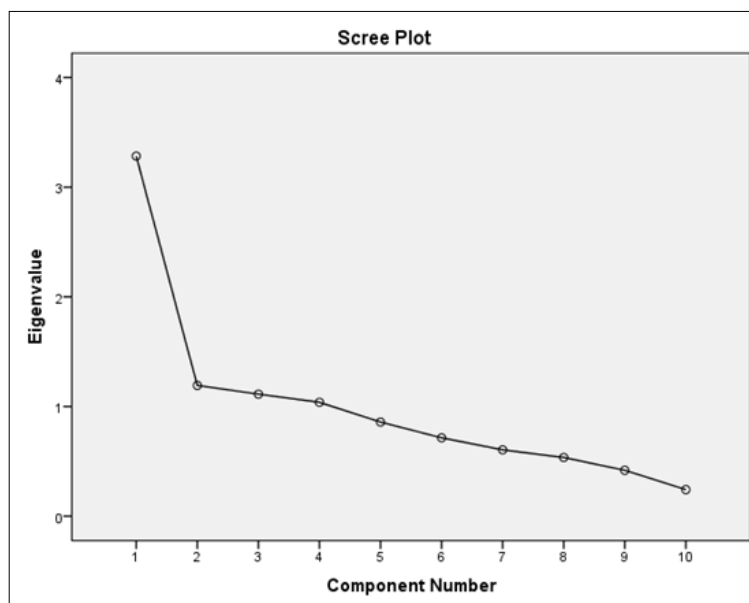

Fig. 1. Screen plot of total variance.

Table 4. KMO and bartlett's test

KMO and Bartlett's test		
Kaiser-Meyer-Olkin	Measure of sampling adequacy	.744
Bartlett's test of sphericity	Approx. Chi-square	299.266
	df	45
	Sig.	.000

Table 5. Principle component analysis

	Total variance explained					
Component	Initial eigenvalues			Rotation sums of squared loadings		
	Total	% of variance	cumulative %	Total	% of variance	cumulative %
1	3.283	32.835	32.835	2.491	24.912	24.912
2	1.192	11.923	44.758	1.528	15.280	40.192
3	1.113	11.127	55.885	1.472	14.719	54.910
4	1.038	10.381	66.266	1.136	11.356	66.266
5	.858	8.581	74.847			
6	.715	7.146	81.993			
7	.605	6.048	88.041			
8	.535	5.353	93.394			
9	.418	4.184	97.579			
10	.242	2.421	100.000			

Table 6. Rotated component matrix

Rotated component matrix[a]				
	Component			
	1	**2**	**3**	**4**
Taste	.479	-.274	.501	.094
price and affordability	.304	.128	.603	-.252
Health and wellbeing	.037	.813	.275	.014
Nutritional value	.360	.709	-.104	.045
Packaging	.826	.247	.084	-.016
Brand awareness	.861	.211	.096	-.060
Advertisement	.713	.062	.109	.193
Shelf life of product	.311	.374	.354	.346
Availability of product	-.064	.151	.786	.166
Animal welfare	.057	.034	.019	.934

Table 7. Components and factor

Components	Factor labels	Explained variance
1	Branding and marketing factors	24.912
2	Health and wellness	15.280
3	Practicality	14.719
4	Ethical considerations	11.356

most preferred options. A high awareness level (94 %), driven largely by word-of-mouth and personal experience, reflects a well-informed consumer base. In factor analysis, Table 7 revealed four key dimensions shaping consumer preference: practicality, health and wellbeing, branding and marketing concerns and ethical concerns. These elements highlight the significance of elements including product packaging, recognition of the brand, health advantages, cost and the moral ramifications of dietary decisions, especially regarding animal wellbeing. To promote wider adoption of plant-based protein alternatives, business and policymakers may consider enhancing marketing strategies, emphasizing health-related benefits, ensuring product affordability and accessibility and communicating social and ethical values (19) related to sustainability (20) and animal welfare. Further research could address these limitations by employing probability sampling, longitudinal designs and multi-location studies for broader applicability.

Authors' contributions

MC supervised the review and editing of the draft. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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Additional information