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Consumer preference and perception toward functional banana chips with reduced fat

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Abstract
Banana chips are a widely consumed fried snack in many regions, but their high oil content often raises health concerns. The objective of the study is to assess consumer preferences, consumption frequency and attitudes towards on consumption of nutritionally enhanced banana chips with reduced fat content. Responses were collected from 117 respondents belonging to the state of Kerala, India through a structured questionnaire and data were analysed in terms of preference patterns, consumption frequency and health-related perceptions. Results revealed that banana chips (48.7%) fried in the coconut oil were the most preferred by consumers in Kerala overall, followed by potato (29.9%) and tapioca chips (19.7%). Concerns regarding fat content were evident, with 59% acknowledging pressure to avoid fried chips due to high fat content. Importantly, 77.8% expressed preference for low-fat banana chips and 87.1% favoured functional variants with enhanced nutritional value. In response, a functional banana chip with hydrocolloid-based coating was developed and compared with conventional chips for oil absorption, sodium content, texture and sensory acceptability. The coated chips exhibited significantly 48% reduction in oil content and 26.7% reduction in sodium levels while maintaining desirable texture and overall acceptability. These findings indicate a growing market potential for functional, health-oriented banana chips that balance sensory acceptability with reduced oil content.

Keywords: Banana chips, consumer preference, low-fat snacks, functional foods

Introduction
Changing consumer lifestyles, health awareness and eating patterns are expected to fuel the growth in the snack industry. The snacking industry can take several steps to promote healthier choices. It should offer diet-specific products and work on improving the nutritional value of its snacks. Alongside this, companies should support healthy lifestyle campaigns and ensure that their marketing targets audiences with great responsibility. Most importantly, they need to avoid promotion of unhealthy eating habits (Astrup *et al*., 2006) [4].

Banana chips are a traditional fried snack, particularly popular in South and Southeast Asia. However, their high oil content has raised consumer concerns regarding health and obesity risks. Oil uptake during frying also needs to be considered during frying because the fat content of a product will also affect its flavour, odour and general organoleptic properties (Aida *et al*., 2016) [1]. Increasing awareness on diet-related non-communicable diseases (NCDs) has shifted consumer interest towards healthier alternatives, including snacks with reduced fat and enriched nutritional value.

Similarly, high sodium consumption is strongly linked to hypertension and increased risk of cardiovascular morbidity and mortality (He and MacGregor, 2009) [6]. The World Health Organization (WHO) recommends limiting sodium intake to less than 2 g per day (equivalent to 5 g of salt) to reduce these risks (WHO, 2012). Since fried snacks like banana chips are a major source of discretionary salt, lowering sodium content in such products can play a significant role in population-wide salt reduction strategies. The application of casein-based edible coatings for banana chips effectively reduces oil uptake and salt retention (Sinu, 2025) [8]. Previous studies suggest that consumer acceptance of modified snack products largely depends on balancing sensory quality with health attributes. However, there is limited information regarding specific consumer attitudes toward low-fat and functional banana chips.

This study is aimed to assess how consumers perceive and prefer nutritionally enhanced banana chips with low fat content. The modified banana chips were also compared with control for sensory qualities, texture, salt content and other attributes.

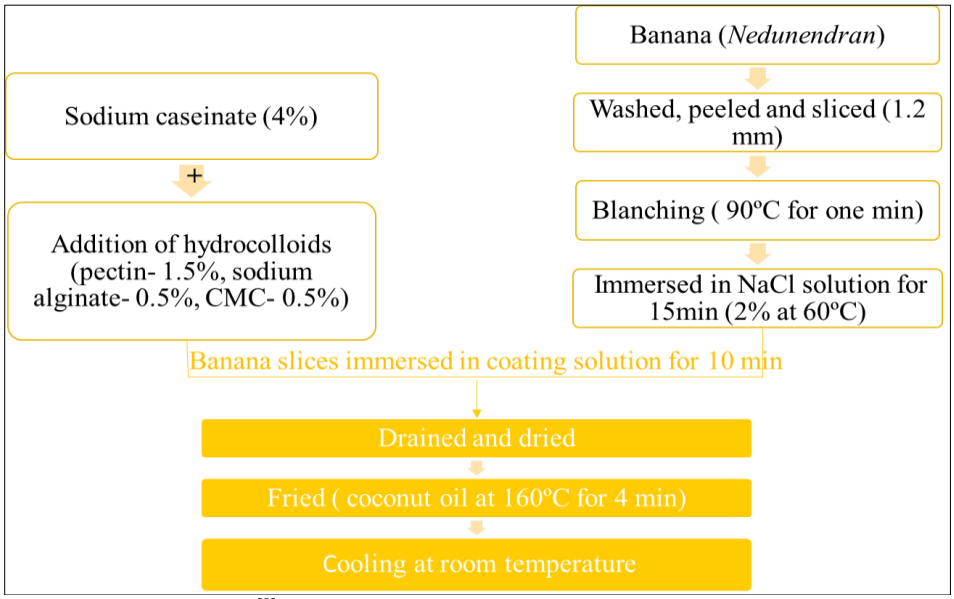
Methodology

A cross-sectional survey was conducted using a structured questionnaire, distributed to 117 participants in Kerala, India. The survey included questions on:

1. Preference for different types of fried chips.
2. Frequency of banana chip consumption.
3. Concerns regarding fat content.
4. Willingness to consume low-fat banana chips.
5. Preference for nutritionally enriched or functional banana chips.

Responses were collected and analysed as percentages and absolute frequencies to determine consumer trends.

As part of the study, banana chips with reduced fat content were developed using the procedure by Sinu (2025) [8]. These chips were then evaluated for overall acceptability, as well as for sodium and oil content. Casein based edible coated banana chips with reduced fat was prepared as per the following flow chart (fig.1.).



Coating (Ref: Sinu, 2025) [8]

Fig 1: Flowchart for the preparation of banana chips with casein-based edible

Determination of quality parameters

Sensory evaluation of chips using nine-point hedonic scale is a method to assess the liking or disliking of chips by a panel of judges. All the samples were displayed to the ambient conditions. The panellist was asked to give numerical values between one and nine with like extremely-9, dislike extremely -1 to various quality attributes (colour and appearance, flavour, crispiness, oiliness and overall acceptability). Higher score of sensory on oil content were associated with lower oil content, indicating a preference for products with reduced oil content. The control sample was the unripe banana chips without edible coating. The oil content of banana chips was analysed using the Mojonnier method, following AOAC 925.12 (2016) protocol. Before proceeding with the analysis as per AOAC method, the sample was hydrolysed using hydrochloric acid. The crispness of the prepared banana chips was evaluated by measuring hardness using a texture profile analyzer (Stable Micro systems, TA HD Plus, UK) equipped with a compression platen (P/75) probe. For determining salt (sodium chloride) content in food samples, one of the most widely accepted methods is Mohr's method (2022) was used. This involves titrating the chloride ions in the sample with a standard silver nitrate ($AgNO_3$) solution using potassium chromate as an indicator. The endpoint is indicated by the formation of a reddish-brown precipitate of silver chromate.

Results and Discussion

The results of the study, encompassing survey findings, physicochemical analysis and sensory evaluation are presented below.

Survey findings

1. Preference for fried chips

Among the respondents, banana chips were the most preferred (48.7%), followed by potato chips (29.9%) and tapioca chips (19.7%). Only 1.7% selected other varieties. The results are represented in Fig 2.

2. Frequency of banana chip consumption

The majority consumed banana chips occasionally (57.3%) or rarely (28.2%), while daily consumption was reported by only 9.4% of respondents in Kerala. A negligible proportion (0.9%) reported never consuming them. The results were illustrated in Fig 3.

3. Concerns about fat content

A total of 59% of participants reported feeling pressured to avoid fried chips due to their fat content, while 41% did not perceive fat as a deterrent. The outcomes of the study are depicted in Fig 4.

4. Preference for low-fat banana chips

A significant majority (77.8%) expressed preference for consuming banana chips with reduced fat content, while

22.2% did not consider this important. Fig 5 presents the findings obtained from the analysis.

5. Oiliness as a factor in avoidance

Oiliness was cited as a major reason to avoid fried banana chips by 82.9% of respondents, whereas only 17.1% disagreed. The results were illustrated in Fig 6.

6. Functional banana chips with nutritional enrichment

An overwhelming 87.1% of respondents expressed preference for functional banana chips with enhanced nutritional value and reduced fat content, while only 12.9% rejected this option. Fig 7 provides a visual representation of the observed results.

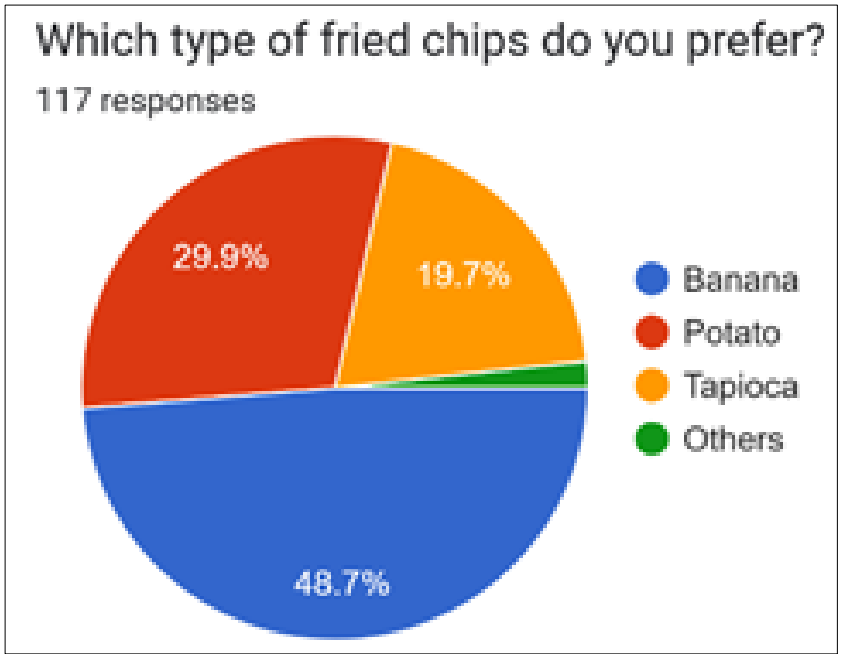


Fig 2: Preference for fried chips

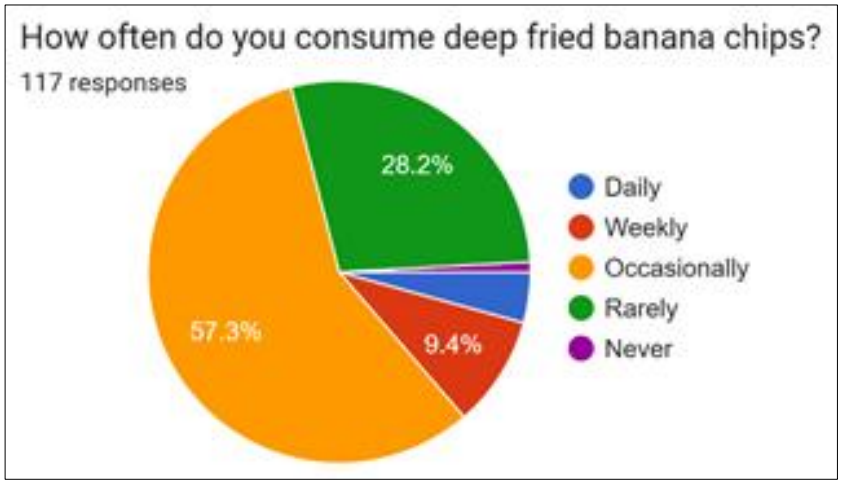


Fig 3: Frequency of banana chip consumption

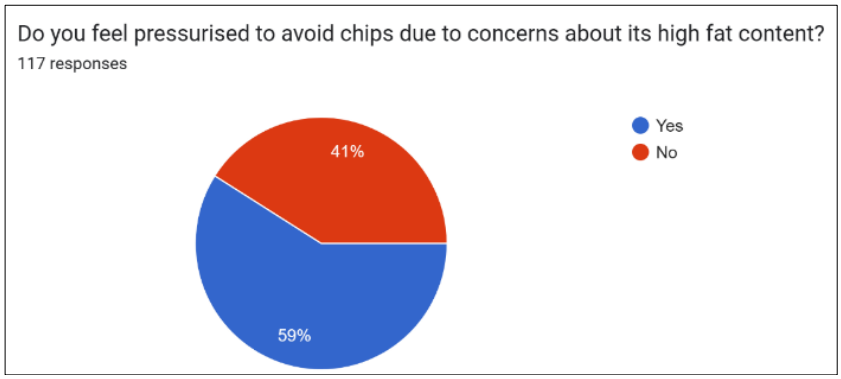


Fig 4: Concerns about fat content

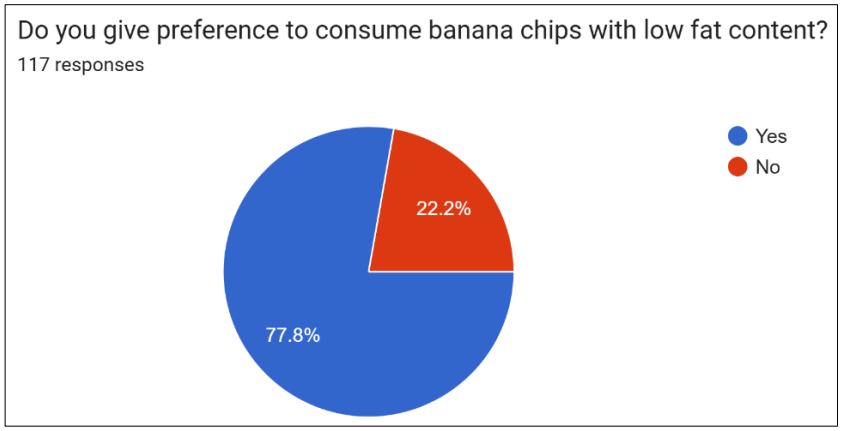


Fig 5: Preference for low-fat banana chips

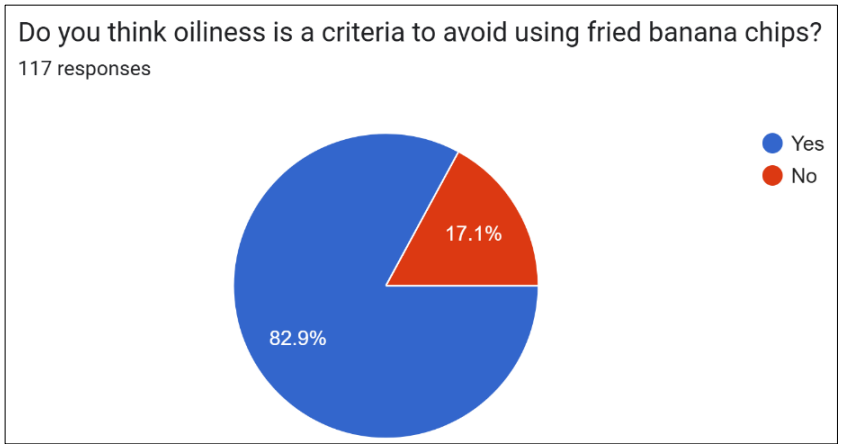


Fig 6: Oiliness as a factor in avoidance

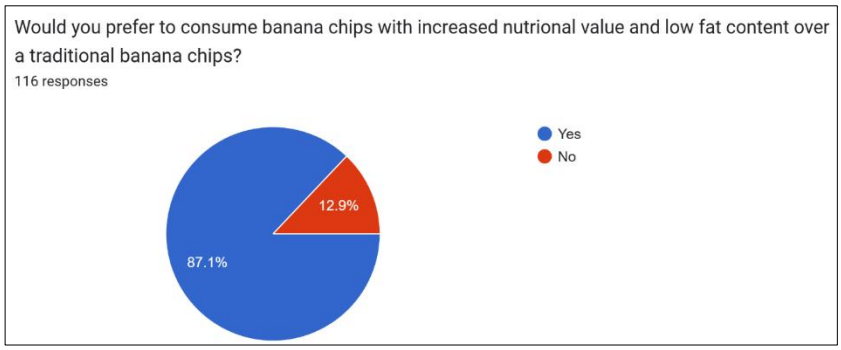


Fig 7: Functional banana chips with nutritional enrichment

The findings highlight a shift in consumer behaviour from traditional snack preferences to healthier alternatives. The high percentage (77.8%) favouring low-fat banana chips indicates that consumers are increasingly health-conscious, aligning with global trends toward functional foods. Similarly, the strong preference (87.1%) for nutritionally enriched banana chips suggests potential for product innovation in the snack food industry.

Sensory and physico chemical analysis

Sensory evaluation

The sensory analysis of the developed product, *viz*, banana chips with casein based edible coating was done against the uncoated or control. The evaluation was carried out by a panel of five judges on hedonic scale. The sensory scores obtained were subjected to statistical analysis using Mann Whitney U test and the results are summarised in Table 1. The results indicates that the colour and appearance and flavour did not differ significantly but the oiliness ($p< 0.01$), crispness and overall acceptability ($p<0.05$) values of coated chips were significantly higher than those of control.

Table 1: Sensory characteristics of control and edible coated banana chips

Sensory attributes	Control	Coated banana chips	U- statistic
Colour and appearance	8.38±0.13	8.56±0.12	89^{ns}
Flavour	8.16±0.12	8.18±0.13	111^{ns}
Crispness	8.08±0.11	8.53±0.12	55*
Oiliness	7.03±0.13	8.43±0.12	4**
Overall acceptability	7.91±0.11	8.4±0.12	55*

Figures are mean± standard error of three replications, **- Significant at one percent level ($p<0.01$), *- Significant at five percent level ($p<0.05$), ns- non significant

Texture profile analysis: The texture characteristics of banana chips coated with casein based edible coating was

analysed by the Texture Profile Analyser. The textural attributes (hardness, cohesiveness, gumminess and springiness) of sample were compared with that of control (Table 2). The statistical analysis of the data revealed that there was no significant difference between coated and control banana chips in all attributes. The hardness of fried banana chips with casein-based edible coating was 4428.86 ± 1493.02 N, while the control chips exhibited a higher hardness of 6106.40 ± 656.75 N. This reduction in hardness for coated samples suggests that the casein-based coating contributed to improved crispiness, as lower hardness values are generally associated with greater consumer-perceived crispiness. Statistical analysis was performed using an independent samples t-test.

Table 2: Textural analysis of banana chips with casein based edible coating and control

Textural attribute	Banana chips with casein based edible coating	Control sample	t value
Hardness (N)	4428.856±1493.016	6106.401±656.748	-1.78^{ns}
Cohesiveness	0.909±0.061	0.682667±0.274	1.39^{ns}
Gumminess (kgf)	4056.172±898.082	4178.227±1004.470	-0.09^{ns}
Springiness (mm)	0.273333±0.068	0.329667±0.018	-1.38^{ns}

Figures are mean± standard error of three replications, **- Significant at one percent level (p<0.01), ns- non significant

Oil content

In fried products such as chips, oil absorption contributes to crispness and palatability, which are key factors influencing consumer acceptance (Bouchon, 2009) [5]. However, excessive oil uptake during frying increases the energy density of the product and is associated with negative health outcomes, including obesity, cardiovascular diseases and metabolic disorders (Mozaffarian *et al*., 2006) [7]. Therefore, controlling oil content in chips is vital not only for improving their nutritional profile but also for meeting the growing demand for healthier snack alternatives. To reduce oil absorption in fried products, hydrocolloids can be applied as edible coatings (Sothorvit, 2011) [6]. The data obtained was statistically analysed using independent samples t-test (Table 3).

Table 3: Oil content of banana chips with casein based edible coating and control

Parameter	Banana chips with casein based edible coating	Control sample	t value
Oil content	17.69±0.352	33.43±0.533	-42.6233**

Figures are mean± standard error of three replications, **- Significant at one percent level (p<0.01), ns- non significant

Sodium content

The sodium content of banana chips treated with a casein-based edible coating was significantly lower (1.51 ± 0.021 mg/g) compared to the control sample (2.06 ± 0.006 mg/g). The difference was statistically significant, with a t-value of 41.32 (p< 0.01), indicating that the application of the edible coating effectively reduced sodium levels in the final product. The result obtained was summarised in Table 4. The results were subjected to statistical analysis using an independent samples t-test. The use of edible coatings appears to play a key role in reducing sodium retention during processing. According to Alam *et al.* (2020) [2], applying starch and chitosan-based coatings to air-dried green bananas helped preserve essential nutrients while limiting the absorption or loss of external additives. These findings reinforce the concept that edible coatings serve as protective barriers, reducing the interaction between the food surface and external sodium sources. The resulting lower sodium levels in coated banana chips hold significant value from a public health perspective.

Table 4: Sodium content of banana chips with casein based edible coating and control

Parameter	Banana chips with casein based edible coating	Control sample	t value
Sodium content	1.51±0.021	2.06±0.006	41.32**

Figures are mean± standard error of three replications, **- Significant at one percent level (p<0.01), ns- non significant

Conclusion

The present study highlights both consumer preferences and the potential for healthier alternatives in the fried snack sector. Survey results revealed that banana chips remain the most preferred snack among respondents, yet growing awareness of the negative health impacts of fat and sodium intake influences consumption patterns. A majority of consumers expressed willingness to adopt low-fat and functional variants of banana chips, underscoring market demand for healthier formulations. In response, a coated banana chip product was developed using hydrocolloid-based technology, which significantly reduced oil absorption and sodium content compared with conventional chips. Importantly, sensory evaluation confirmed that the coated chips maintained desirable texture and acceptability, demonstrating that nutritional improvements need not compromise consumer satisfaction. The development of low-fat, low-sodium banana chips aligns with global dietary recommendations aimed at reducing the risk of lifestyle-related diseases such as obesity, hypertension and cardiovascular disorders. These findings suggest that functional banana chips have strong potential as a commercially viable, health-oriented snack option that meets both nutritional guidelines and consumer expectations.

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