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Development of Ready to Serve Peanut Chutney Tablet

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Abstract

This study explores the development and analysis of Ready-To-Serve (RTS) peanut chutney powder, a traditional Indian condiment rich in flavour and cultural significance. The investigation delves into the formulation optimization of the chutney powder while evaluating its physiochemical, sensory, and nutritional attributes. Through a comparative analysis with commercially available chutney powders, this research aims to enhance understanding of the product's quality and market potential. The nutritional analysis reveals valuable insights into the composition of the chutney powder, highlighting its balanced profile of carbohydrates, proteins, fats, fibres, and essential minerals. Notably, the chutney powder exhibited a balanced nutritional profile, with percentages of moisture content (3.5%), carbohydrate (46.18%), protein (19.822%), fat (19.910%), fibre (6.43%), total ash (3%), and acid insoluble (0.45%) meeting desirable standards. Additionally, the chutney powder demonstrated an energy value of 443 kcal/g and a water activity of 0.582 at 23.8℃. Colour analysis revealed L* = 55.45, a* = 20.46, b* = 37.59, and ISO brightness of 7.74, enhancing its visual appeal. The study undergoes the need for standardized production, processes and packaging to ensure quality and safety, addressing concerns surrounding hygiene and shelf life. Overall, this research contributes to advancing the knowledge and development of traditional chutneys in the context of modern food processing and commercialization.

Keywords: RTS, peanut chutney, nutritional attributes, shelf life.

1.INTRODUCTION

Traditional foods and their associated technologies are an inseparable part of a country's culture. They serve as a reservoir of knowledge and know-how passed down from generation to generation. These foods are often invented and developed locally, utilizing predominantly local ingredients and ancient formulations, with an emphasis on their beneficial effects on the body and their availability throughout the year. In many cultures, traditional foods were intricately linked with the medical system. The type of food to be consumed was regulated by various factors such as the season, the properties of specific foods, the individual's health condition, and their temperament. For instance, during hot weather in tropical regions, when physical activity decreases and digestive juices are inhibited, pickles and chutneys were consumed to stimulate appetite and promote digestion. These were considered excellent household remedies for counteracting indigestion.

The term "chutney" originates from the Hindustani word "chutni," meaning a strong sweet relish. Chutneys are popular indigenous and traditional foods in India, prepared and served in homes, restaurants, and various public eating places like bus stops, railway counters, small shops, and streets. They exhibit subtle differences in blends and flavors but are essentially Indian in taste. Chutneys are typically made spicy with the addition of chilies but are consumed sparingly. When paired with bland food, it is common to make chutneys hot and pungent, while with snacks and cold

lunches, a milder flavor profile is preferred. Chutneys can vary widely in terms of heat, flavor, and consistency; they can be mild or very hot, bland or highly aromatic, sharp or sweet-sour.

Chutneys are everyday staples in households and serve to diversify the menu of ordinary home-cooked meals. Plainer foods such as bread, roti, rice, or simple pilaus provide ample opportunities for the inclusion of chutneys. In areas where refrigeration was a luxury until recently, freshly prepared chutneys served multiple purposes as relishes, accompaniments, and even entrées. A quick meal a housewife could prepare for unexpected visitors often involved serving pickles or chutneys with Paratha, Roti, or even a slice of conventional bread. Fresh chutneys are typically prepared daily in quantities sufficient for immediate consumption, boasting color, appeal, texture, taste, and appetizing quality.

Chutneys are broadly categorized into sweet and salty types. Sweet chutneys made from mango, apple, and tomato are well-known and preserved using vinegar, acetic acid, common salt, sugar, and packaged in glass bottles for domestic and export markets. On the other hand, salty chutneys (such as green chutney, tamarind chutney, garlic chutney, coconut chutney) prepared freshly have a short shelf life unless preserved under refrigeration. They are made from ingredients like green leaves (mint, coriander), coconut, tamarind, and garlic, with added Flavors from ginger, onion, herbs, and spices. However, there are concerns regarding the hygiene and safety of commercially prepared chutneys, especially those left at ambient temperature for hours before consumption.
These chutneys are often prepared in unhygienic conditions, such as streets or railway platforms, with raw ingredients that may be contaminated if not properly washed. Poor personal hygiene of food handlers and the use of contaminated water further exacerbate the risk of foodborne illnesses. The increasing popularity of Ready-to-Serve (RTS) foods served with a variety of chutneys contributes to this issue. With the changing lifestyle, more people rely on RTE foods, but the tradition of homemade chutneys is diminishing due to the labour involved and their short storage life. Commercialization and processing of traditional chutneys are necessary to improve their quality and shelf life for commercial purposes. This presents opportunities for newer food industries to scale up production and marketing efforts. However, there are currently no legal guidelines, definitions, or standards laid down for chutneys in India, and little work has been reported on standardization, large-scale production, packaging, and storage.

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Arachis hypogaea, the peanut, belongs to the Fabaceae family of legumes. In addition to being a great source of energy, they also include vitamins, minerals, antioxidants, and nutrients that are necessary for good health. Resveratrol, vitamin E, and the B-complex vitamin and mineral groups are all present in good amounts in the nuts. Peanuts can be consumed raw, used to produce oil, or added to chutney recipes. Snacks made with peanuts include peanut butter, salted peanuts, peanut brittle, and plain or roasted shelled nuts. A staple of Indian cooking, chutneys are created from chopped, cooked fruits or vegetables, or a combination of the two, combined with vinegar, spices, and other ingredients, and then reduced to a smooth pulp.

Chutneys can be preserved in a variety of methods, including by culturing citrus juice with salt, vinegar, or oil. The primary component of all chutneys is vinegar. While sodium benzoate functions as a chemical preservative, vinegar's acetic acid serves as a natural preservative. Multiple quick chutney powders, including one each for curry leaf chutney powder (*Balaswamy K, et al.,*2004), tamarind leaf chutney powder *(Prabhakara Rao PG, et al.,2004)*, raw tamarind chutney powder *(Jyothirmayi T, et al.,2006)* and raw mango chutney powder *(Narsing Rao G, et al.,2008)* and instant chutneys from Gongura and Pudina *(Satyanarayana A, et al.,2001)* were previously examined. *(Mishra P, et al.,2011)* examined that after two months of storage, a sensory assessment was conducted on the amla chutney that was ready to eat. *(Murray, et al.,2001)* was optimized the ingredients according to color, flavor, consistency, and acceptability overall using the sensory evaluation.

Instant tamarind chutney powder's approximate composition, including its moisture content, pH, acidity, carbohydrate content, and fat content, was assessed by *(Jyothirmayi T, et al.,2006)*. At 10-day intervals, the ready-to-eat Amala chutney's moisture content, pH, acidity, carbohydrate, fat, and total phenolic were evaluated *(Mishra P, et al.,2011)*. According to the *(Narsing Rao G, et al.,2008)* moisture level of the quick tomato pickle mix rose over the course of storage, independent of the packing type. After six months of storage, *(Prabhakara, et al.,2012)* noticed that the instant pulihora mix's acidity had increased from 4.22 to 4.77. After being kept in a sterile, airtight bottle for 180 days, the pickle's pH was discovered to have dropped *(Tamilselvi M, et al.,2010)* Rate of change quality parameters are the definition of quality kinetics. It was used to estimate how long a newly created product would remain wholesome at a given temperature. The mechanism of changes in active components is provided by kinetics, which also forecasts the extent of change that will transpire after a specified amount of time. *(Frankel N, et al.,1998)* examined the oxidation process's kinetics, which were consistent with an autocatalytic reaction. The kinetic behaviour of the peroxide value for refined olive oil was measured

by *(Gomez-Alonso et al.,2004)* The first order reaction was used to track the change in the hydroxy methyl furfural content of the Kheer mix samples made with instant pearl millet *(Bunkar DS, et al.,2014).* A shelf-life kinetic model was created by *(Oliveira, et al.,2014)* for the packing of fresh sliced mushrooms in a modified environment. *(Tosun I. et al.,2004)* examined the color shift and production of 5-hydroxymethyl furfural in zile pekmezi during storage in addition to assessing the reaction orders, rate constants, and activation energy. A kinetic model was developed to describe how ascorbic acid loss varies with temperature *(Polydera AC, et al.,2005).* Hence the aim of the present study was

- To optimize the formulation of RTS peanut chutney powder.
- To evaluate and analyse the physiochemical, sensory and nutritional profile of RTS peanut chutney powder.
- To conduct a comparative analysis between optimized product and commercially available other chutney powders.

2.MATERIALS AND METHOD

Peanut and all the required ingredients were purchased from the local market, Perundurai, Erode district and work were carried out at Food Process Engineering laboratory, Kongu Engineering College, Erode.

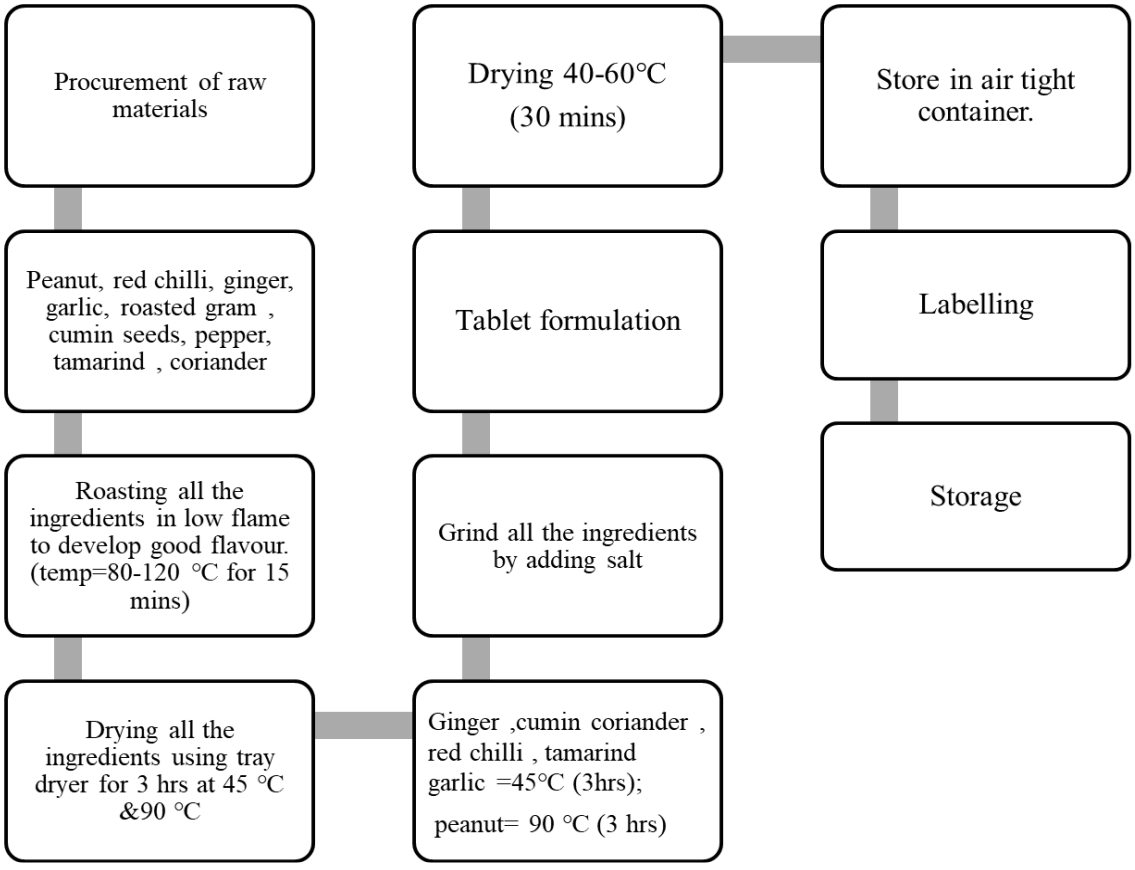

Figure 2.1. Process flow chart for preparation of peanut chutney

2.1. Recipe optimization and Design experiments

The peanuts were roasted at 100-110℃ and other ingredients such as curry leaves, cumin, asafoetida and garlic were fried at 80 – 100 ℃. Roasted peanuts, fried ingredients, red chilli, tamarind and salt were dried using tray dryer at 85-95℃ for 3 hrs

then ground together and thus the ready to serve chutney was prepared. Sensory evaluation was done by 9-point hedonic scale and 15 skilled panel members were used. Experiments were designed using Response Surface Methodology.

2.2. Estimation of quality parameters

The samples were used for estimating all quality parameters. The moisture content and of peanut chutney was determined and recorded.

The Anthrone technique was used to determine the carbohydrate content *(Sadasivam S, et al.,1997).* In a boiling tube, 0.1g of the sample was taken, and 3mL of 2.5NHCl was added. After three hours of boiling, let the mixture cool to room temperature. Pelletized sodium carbonate was added to the mixture until the effervescence stopped, and then 100 mL of distilled water were added. The solution was centrifuged at 5000 rpm for 5 minutes. Test tubes were filled with supernatant (0.5 and 1.0 mL) and glucose working standard solution (0.2, 0.4, 0.6, 0.8, and 1 mL) for analysis. Blank was kept up to date as well. Each test tube was filled with 1.0 mL of distilled water, and then 4.0 mL of the anthrone reagent was added. After 8 mins of heating, test tubes were cooled. Samples which have been cooled were examined at 630 nm using a UV spectrophotometer. A typical graph was created. Values for unknown samples were calculated from the graph and expressed as g/100g of sample.

The protein content was estimated by Lowry's method *(Sadasivam S, et al.,1997).* Using a pestle and mortar, 0.5g of the material was obtained and thoroughly ground together with 5–10mL of buffer solution. After centrifuging the mixture, the supernatant was gathered. A series of test tubes were filled with 0.2–1 mL of the working standard, and two further test tubes were filled with 0.1 and 0.2 mL of the supernatant. Fill each test tube to the full 1 mL capacity using pure water. A blank tube is filled with one mL of water. Each test tube, including the blank, received 5 milliliters of alkaline copper solution (50 mL of 2% sodium carbonate in 0.1N sodium hydroxide and 0.5% copper sulphate in 1% potassium sodium tartarate). After thoroughly mixing each tube, it was let to stand for 10 mins. Following that, add 0.5 mL of Folin-Ciocalteau5 reagent to each tube and well mix. For thirty minutes, the tubes were incubated at room temperature in the dark. The hue blue was created. The developed blue color was measured at 660 nm with a UV Spectrophotometer. A typical graph was created. Protein content was calculated from the graph and expressed as g/100g of sample. Crude fat content was determined by solvent extraction method and expressed in g/100 g of sample.

2.3. Overall acceptability

Overall acceptability of peanut chutney was estimated by sensory evaluation for 30 days at 10 days of interval.

2.4. Analysis of Variance

An analysis of variance (ANOVA) was calculated to assess how well the model was fitted to the data. ANOVA table for the effects of composition on taken responses was tabulated in (Table 3,4,5,6)

3.RESULTS AND DISCUSSION

3.1. Recipe optimization

Peanut chutney was made according to the directions provided in the procedures it was prepared to enjoy. Through sensory evaluation, the ingredients were modified based on their highest scores for color, flavor, taste, consistency, and acceptability overall. Table 1 provides the optimized recipe. The experimental design is displayed in Table 2, and quality parameters were examined for 30 days at intervals of 10 days as its packaged, ready-to-eat peanut chutney was stored under various treatment conditions.The peanut chutney was prepared and the recipe was optimized by sensory evaluation by 10 panelists who are semi trained. The sensory evaluation was done on a 9-point hedonic scale. The values are

then plotted on a radar graph. From the graph the recipe was optimized. The studies were done on this optimized recipe. The storage studies on peanut chutney were made by varying three factors such as packaging material, sodium benzoate percentage and storage temperature. Studies showed that the peanut chutney made was found to have a good taste even after a storage period of 30 days. The taste was best when taken with idly, dosa, etc

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Table 1. Optimized recipe for ready to serve peanut chutney powder

Sl. No	Ingredients	Quantity, g
1	Peanut	36
2	Roasted gram	14
3	Defatted coconut powder	17
4	Tamarind	5
5	Garlic	5
6	Ginger	5
7	Red chilli	8
8	Cumin seeds	1.5
9	Pepper	1.5
10	Coriander	1.5
11	Salt	5.5

3.2. Design matrix

The ingredient composition for RTS peanut chutney powder is optimised using Box-Behnken design using Design Expert Software version (13.0.5.0). 17 different compositions were obtained.

Table 2. Response for optimization of RTS peanut chutney powder

Run	Groundnut powder	Gram Powder	Defatted coconut powder	Fat	Protein	Rehydration ratio	Overall acceptability
	g	g	g	g/100g	g/100g	no unit	no unit
1	10	20	20	7.4	12.25	2.65	6.1
2	30	10	20	14.36	16.35	2.31	7.8
3	50	20	10	26.8	23.15	2.32	8.84
4	10	30	15	6.75	13.6	3.05	5.1
5	30	30	10	14.25	19.05	3.45	6.5
6	30	20	15	17.45	16.54	2.7	8.2
7	30	20	15	16.6	16.52	2.65	8.1
8	50	20	20	24.25	25.25	2.42	8.84
9	50	30	15	26.14	28.45	2.95	8.1
10	10	20	10	6.65	11.24	2.64	5.5
11	30	20	15	17.25	16.75	3.1	8.1
12	30	10	10	16.54	15.26	2.3	7.3
13	30	30	20	17.35	18.65	3.2	6.5
14	10	10	15	6.64	9.2	2.54	6
15	30	20	15	14.25	17.7	3.2	8.5
16	50	10	15	26.75	22.15	2.26	8.4
17	30	20	15	16.75	17.7	3.25	8.1

3.3. Effect of Different Components on the RTS Peanut chutney powder response parameters

3.3.1. Effect of composition on Fat

Table 3. ANOVA for effect of composition on fat

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	731.63	3	243.88	154.70	< 0.0001	significant
A-Groundnut powder	731.53	1	731.53	464.02	< 0.0001	
B-Gram Powder	0.0050	1	0.0050	0.0032	0.9559	
C-defatted coconut powder	0.0968	1	0.0968	0.0614	0.8082	
Residual	20.49	13	1.58			
Lack of Fit	13.90	9	1.54	0.9373	0.5732	not significant
Pure Error	6.59	4	1.65			
Cor Total	752.13	16				

- The F-value (154.70) and p-value (< 0.0001) strongly suggest that the model significantly explains the variation in the response variable (likely overall acceptability or rehydration ratio).
- Groundnut Powder: The high F-value (464.02) and p-value (< 0.0001) indicate that groundnut powder has a very strong and statistically significant impact on the response variable.
- Gram Powder: The F-value (0.0032) and p-value (0.9559) show that gram powder has a negligible effect on the response variable.
- Defatted Coconut Powder: Similar to gram powder, defatted coconut powder also has no significant influence (F-value = 0.0614, p-value = 0.8082).
- The experiment suggests that the proportion of groundnut powder is the critical factor affecting the desired outcome of the peanut chutney recipe. Gram powder and defatted coconut powder have minimal influence.
- The response surface plot visually confirms this finding, highlighting the strong dependence of the response variable on groundnut powder.

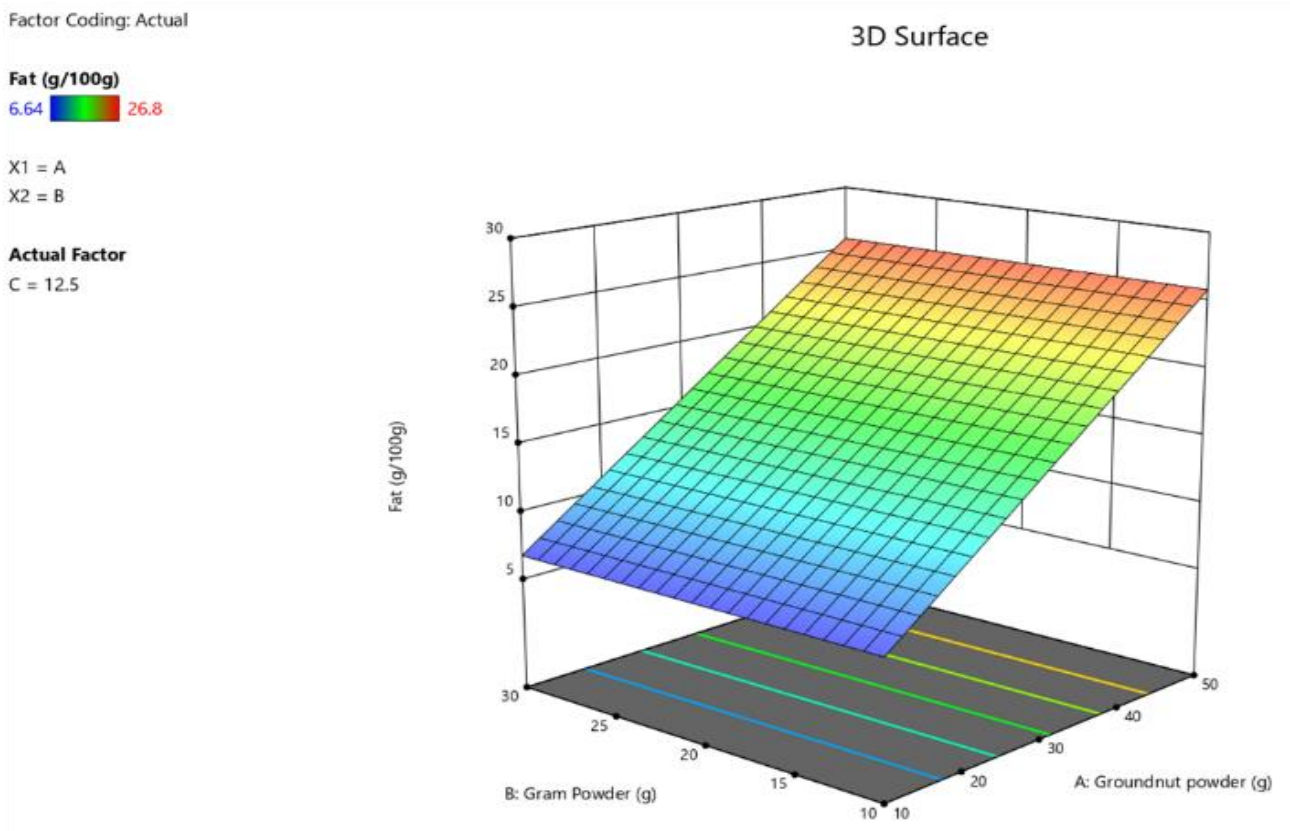

Figure 2. Effect of composition on Fat

3.3.2. Effect of composition on protein

Table 4. ANOVA for effect of composition on protein

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	384.34	3	128.11	135.41	< 0.0001	significant
A-Groundnut powder	347.29	1	347.29	367.06	< 0.0001	
B-Gram Powder	35.24	1	35.24	37.24	< 0.0001	
C-defatted coconut powder	1.80	1	1.80	1.91	0.1905	
Residual	12.30	13	0.9461			
Lack of Fit	10.82	9	1.20	3.26	0.1336	not significant
Pure Error	1.48	4	0.3689			
Cor Total	396.64	16				

- The overall F-value (135.41) and p-value (< 0.0001) indicate that the model significantly explains the variation in the response variable.
- Groundnut Powder: The high F-value (367.06) and p-value (< 0.0001) for groundnut powder signify a strong and statistically significant impact on the response variable.
- Gram Powder: Similar to groundnut powder, gram powder also shows a significant influence (F-value = 37.24, p-value < 0.0001).
- Defatted Coconut Powder: The F-value (1.91) and p-value (0.1905) for defatted coconut powder are not significant, suggesting it has minimal impact on the response variable.
- The p-value (0.1336) for lack of fit is greater than 0.05, implying that the model adequately fits the data. In other words, the model does not have any significant biases or errors in explaining the relationship between the factors and the response variable.
- It explains that the proportions of groundnut powder and gram powder in the peanut chutney recipe significantly affect the desired outcome, while defatted coconut powder has a negligible impact.

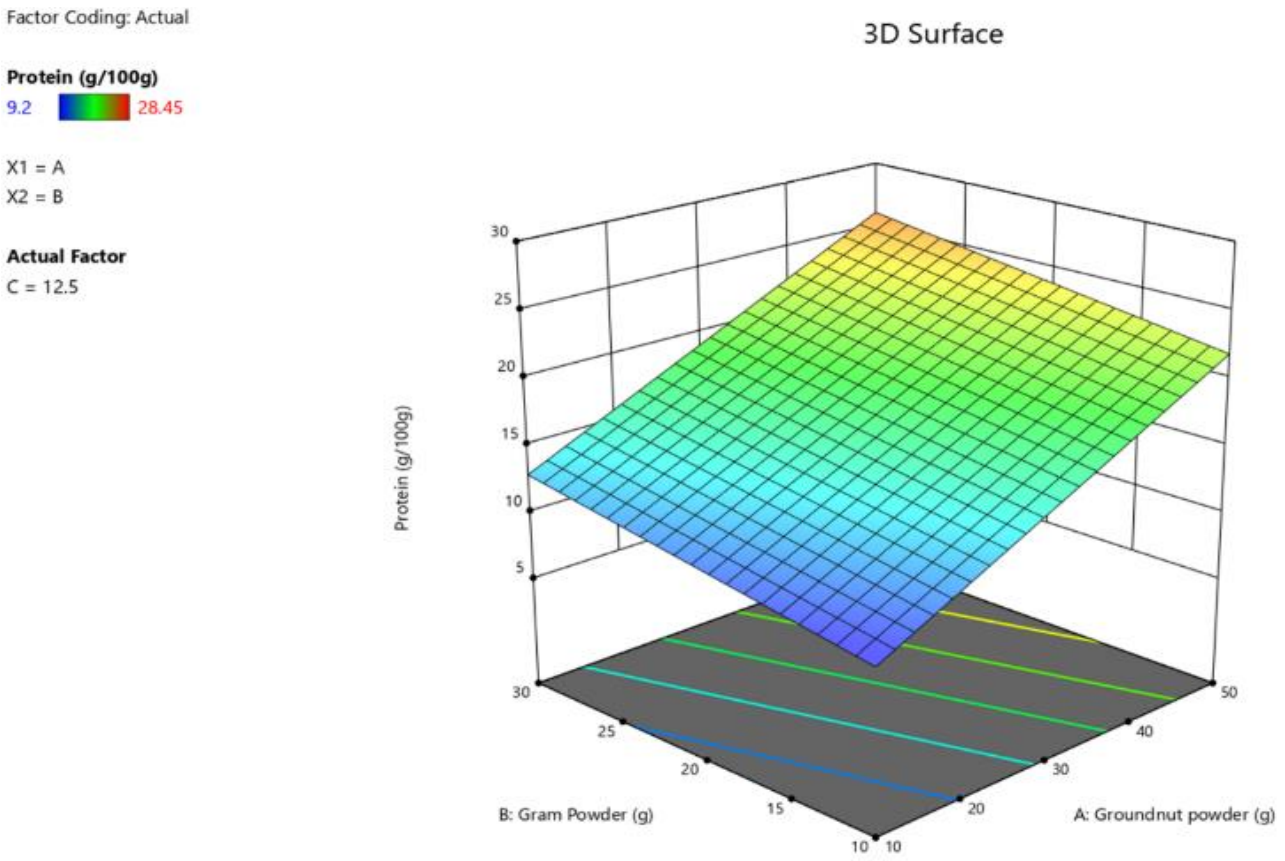

Figure 3. Effect of composition on protein

Table 5. ANOVA for effect of composition on Rehydration ratio

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	1.42	3	0.4741	6.29	0.0072	significant
A-Groundnut powder	0.1081	1	0.1081	1.43	0.2526	
B-Gram Powder	1.31	1	1.31	17.40	0.0011	
C-defatted coconut powder	0.0021	1	0.0021	0.0280	0.8697	
Residual	0.9804	13	0.0754			
Lack of Fit	0.6574	9	0.0730	0.9046	0.5890	not significant
Pure Error	0.3230	4	0.0807			
Cor Total	2.40	16				

3.3.3. Effect of composition on Rehydration ratio

- The F-value (6.29) and p-value (0.0072) indicate that the model statistically explains the variation in the response variable (possibly rehydration ratio).
- Groundnut Powder: The F-value (1.43) and p-value (0.2526) for groundnut powder show no significant effect on the rehydration ratio.
- Gram Powder: Gram powder has a significant influence (F-value = 17.40, p-value = 0.0011).
- Defatted Coconut Powder: Defatted coconut powder has no significant effect (F-value = 0.0280, p-value = 0.8697).
- The experiment demonstrates that the proportion of gram powder significantly impacts the rehydration ratio of peanut chutney, while groundnut powder and defatted coconut powder do not have statistically significant effects.
- The response surface plot visually confirms this finding, showing a clearer influence of gram powder on the rehydration ratio.

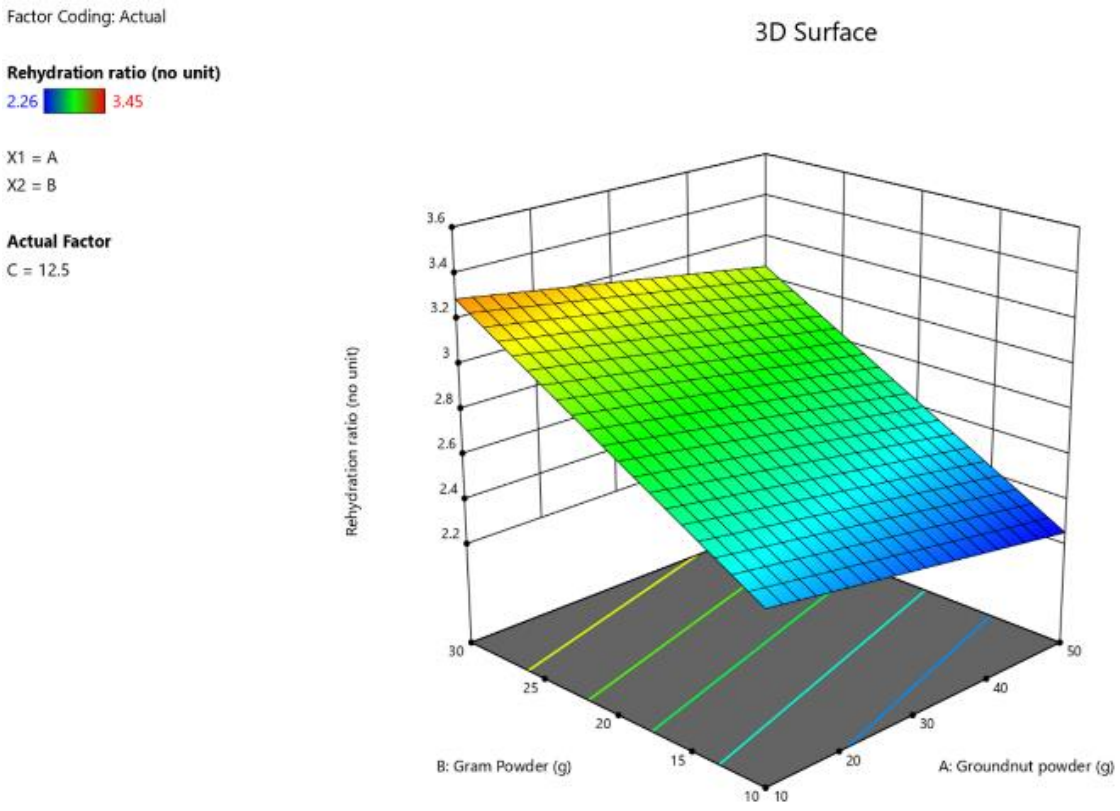

Figure 4. Effect of composition on Rehydration ratio

3.3.4. Effect of composition on Overall acceptability

Table 6. ANOVA for effect of composition on Overall acceptability

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	23.01	9	2.56	63.86	< 0.0001	significant
A-Groundnut powder	12.16	1	12.16	303.69	< 0.0001	
B-Gram Powder	0.6533	1	0.6533	16.32	0.0049	
C-defatted coconut powder	0.7317	1	0.7317	18.27	0.0037	
Residual	0.2803	7	0.0400			
Lack of Fit	0.1603	3	0.0534	1.78	0.2898	not significant
Pure Error	0.1200	4	0.0300			
Cor Total	23.30	16				

- The F-value (63.86) and p-value (< 0.0001) for the model indicate that it statistically explains the variation in overall acceptability.
- Groundnut Powder: The high F-value (303.69) and p-value (< 0.0001) for groundnut powder show a strong and statistically significant impact on overall acceptability.
- Gram Powder: Gram powder also has a significant influence (F-value = 16.32, p-value = 0.0049).
- Defatted Coconut Powder: Defatted coconut powder has a statistically significant effect (F-value = 18.27, p-value = 0.0037). However, its impact is weaker compared to the other two factors.
- The p-value (0.2898) for lack of fit is greater than 0.05, implying that the model adequately fits the data.
- The plot likely shows how the proportions of groundnut powder and gram powder (X and Y axes) affect the overall acceptability (represented by color intensity or surface height).
- Areas with warmer colors or higher surfaces indicate more acceptable chutney formulations. The experiment demonstrates that the proportions of all three ingredients (groundnut powder, gram powder, and defatted coconut powder) influence the overall acceptability of the peanut chutney.
- Groundnut powder has the most significant effect, followed by gram powder and then defatted coconut powder.

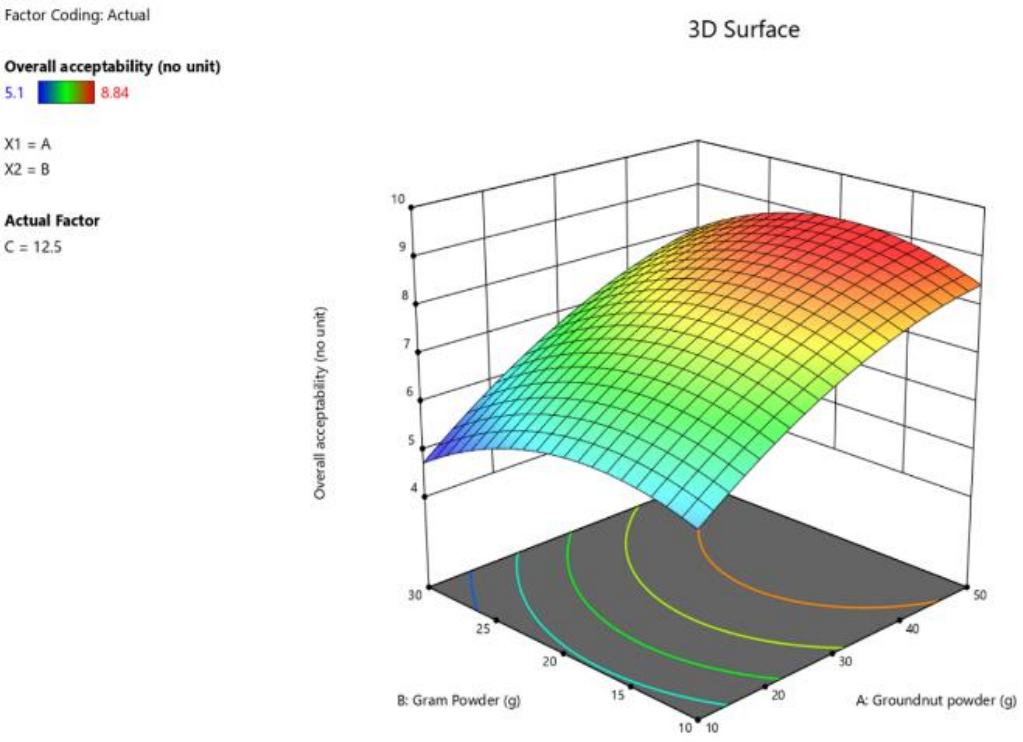

Figure 5. Effect of composition on Overall acceptability

Table 7. Comparative analysis between optimised product and commercial product

Sl. No	Parameters	Units	Optimised Product	Commercial Product
	Moisture content	%	3.5	2.6
	Carbohydrate	%	46.18	19.59
	Protein	%	19.822	28.935
	Fat	%	19.910	33.826
	Fibre	%	6.43	9.67
	Total ash	%	3	4.5
	Acid insoluble	%	0.45	0.39
	Energy value	kcal/g	443	
	Water activity ()	-	0.582 at 23.8°C	0.564 at 24.3 °C
	Colour	-	L*= 55.45 a*= 20.46 b*= 37.59 ISO bright = 7.74	L*= 52.91 a*= 8.82 b*= 23.07 ISO bright = 11.27

Table 8. Optimized product ingredients versus commercial product ingredients

Sl. No	Optimized product Ingredients	Commercial product ingredients
1	Peanut	Peanut
2	Roasted gram	Garlic
3	Defatted coconut powder	Small onion
4	Tamarind	Dry red chilli/ Dry Kashmiri red chilli
5	Garlic	Refined sunflower oil
6	Ginger	Urad dal
7	Red chilli	Rock salt
8	Cumin seeds	Tamarind
9	Pepper	Curry leaves
10	Coriander	Mustard seeds
11	Salt	Asafoetida

Table 9. Analysis of tablet

Parameters	Value
Tablet Hardness	24.53 N (117.72 g/force)
Friability	<1%
Disintegration Time	15 -20mins
Particle Size Distribution	Fine powder consistency
Moisture Content	2-4%
Texture and Consistency	Smooth and uniform
Flavour and Aroma	Good
Stability and Shelf Life	Approximately 7-9 months

Table 10. Physical and functional properties of RTS chutney powder

Analysis	Unit	RTS chutney powder
Bulk density	g/mL	0.5
True Density	g/mL	1.2
Carr Index	-	58.33
Hausner ratio	-	1.58
Angle of repose	Degree	30
Water absorption index	%	20
Water solubility index	%	10
Swelling capacity	%	57.29
Viscosity	°C	89
Antioxidant	%	50

4. CONCLUSION

Ready-to-Serve (RTS) peanut chutney powder reveals a product of exceptional quality and nutritional value. With 3.5% moisture, 46.18% carbohydrates, 19.822% protein, and 19.91% fat, our chutney powder provides a well-balanced combination of macronutrients that are necessary for a nutritious diet. Furthermore, the 6.43% fiber level of this food promotes digestive health and general wellbeing. Additionally, our chutney powder has a 3% total ash content, which means that it contains important minerals that are necessary for a number of body processes. With an energy value of 443 kcal/g, it adds nutrition to any meal while ensuring purity and quality with its 0.45% acid insoluble content. Furthermore, the colour analysis shows a vivid hue that improves the visual appeal and sensory experience, with a L* value of 55.45, an a* value of 20.46, a b* value of 37.59, and an ISO brightness of 7.74.Ready To Serve peanut chutney powder is a quality product that provides consumers with both a pleasant culinary experience and a source of necessary nutrients, thanks to its rigorous formulation and analysis. This chutney powder is evidence of our continued focus on health and wellbeing in our diets and our dedication to offering everyone access to wholesome, tasty, and rich in nutrients foods.

Ethical Approval

None.

Declaration of Interests

The authors of this study declared no conflict of interests.

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Author Contribution

Concept: KG, AJV
Design: KG, KD, AJV
Data collecting: KG, KD
Statistical analysis: KG, KD
Literature review: KG
Writing: KG, KD, AJV
Critical review: AJV

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