

Formulation and Development of Biryani Seasoning Pellets

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Abstract - Biryani is a popular delicacy around the world which is cherished for its rich aroma, exquisite flavour and distinctive spice blend. Obtaining the true flavour of biriyani frequently requires precise seasoning and time-consuming preparation. Biryani Seasoning Pellets are a useful alternative for simplifying this process. These pellets are small spice-packed units that readily dissolve in heated oil which releases a well-balanced blend of authentic biryani spices. The pellets are designed to shorten preparation time while maintaining traditional taste. They ensure consistency in flavour and aroma. This innovation intends to serve working people, dormitory students and international visitors by providing a hassle-free biryani cooking experience. This research aims to develop, optimize and evaluate the formulation of these pellets to provide a standardized, easy-to-use seasoning for an authentic biryani experience.

Keywords - Biryani seasoning pellets, spice blend, convenience food, culinary.

1. INTRODUCTION

The Indian subcontinent's rich history is interwoven with the traditional meal biriyani. The authenticity of biriyani has spread across regions, combining flavours, techniques and traditions along the way. From the royal courts of Lucknow to the bustling streets of Hyderabad and the aromatic kitchens of Bengal, biriyani has developed into numerous distinctive varieties each capturing the character of its home country. The dish is more than just a combination of rice and spices; it represents centuries of trade, migration and cross-cultural impact. Biryani perfectly exemplifies Indian cuisine's distinct blend of herbs, spices and cooking techniques making it one of the most popular meals among tourists as well as residents (Singh et al., 2024).

Beyond just being a delicious treat, biryani is a healthy well-balanced meal with a lengthy history. This classic dish with its fragrant spices, tender beef and flawlessly cooked rice has charmed food enthusiasts from all over the globe. While biriyani originated in Persia, where "birian" means "roasted before cooking" it spread to India during the Mughal Empire and became a mainstay of Indian and Islamic cuisine. Interestingly biriyani resembles Spain's saffron-infused paella implying a profound relationship between worldwide cuisines. The dish's adaptability allows it to be adapted with a variety of proteins including mutton and chicken, fish and vegetables such as potatoes and green peas (Anand & Jaisree, 2012).

In addition to being incredibly delicious, biryani is also extremely nutritious. Its traditional components neatly fit with dietary guidelines making it both rich and balanced. A dish of mutton biriyani contains the optimal ratio of carbs (46%), lipids (34%) and proteins (20%), providing necessary nutrients for energy, muscle building and overall well-being. Doctors frequently suggest it as a healthy meal option. With its rich history numerous regional modifications and health

advantages, biryani is more than just a meal; it is a culinary legacy that continues to grow while retaining its royal allure (Umachandran et al., 2018).

Spice powders, paste-based marinades and pre-mixed seasoning sachets are a few instances of already products. These products require manual mixing, have lower shelf life due to moisture sensitivity and may not deliver consistent taste dispersion when cooked. The base seasoning powder is made using a combination of fundamental biryani spices like as cumin, coriander, cardamom, cinnamon, cloves, bay leaves etc. These spices are thoroughly dried and ground to preserve their aromatic qualities before being transformed into pellets. The suggested biriyani seasoning pellets take a revolutionary approach, compressing a precise blend of spices into compact and dissolvable units. Unlike spice powders these pellets enable equal dispersion without clumping which simplifies the cooking process. They dissolve easily in heated oil, preserving the authentic flavour and aroma of traditional biriyani while enhancing convenience and shelf stability (Aguilar-Palazuelos et al., 2012).

II. MATERIALS AND METHODS

A. Raw Material Acquisition

All the raw materials were collected from verified local vendors and spice markets in and around Coimbatore, Tamil Nadu, to ensure freshness, authenticity and food safety compliance.

TABLE 1

INGREDIENTS LIST

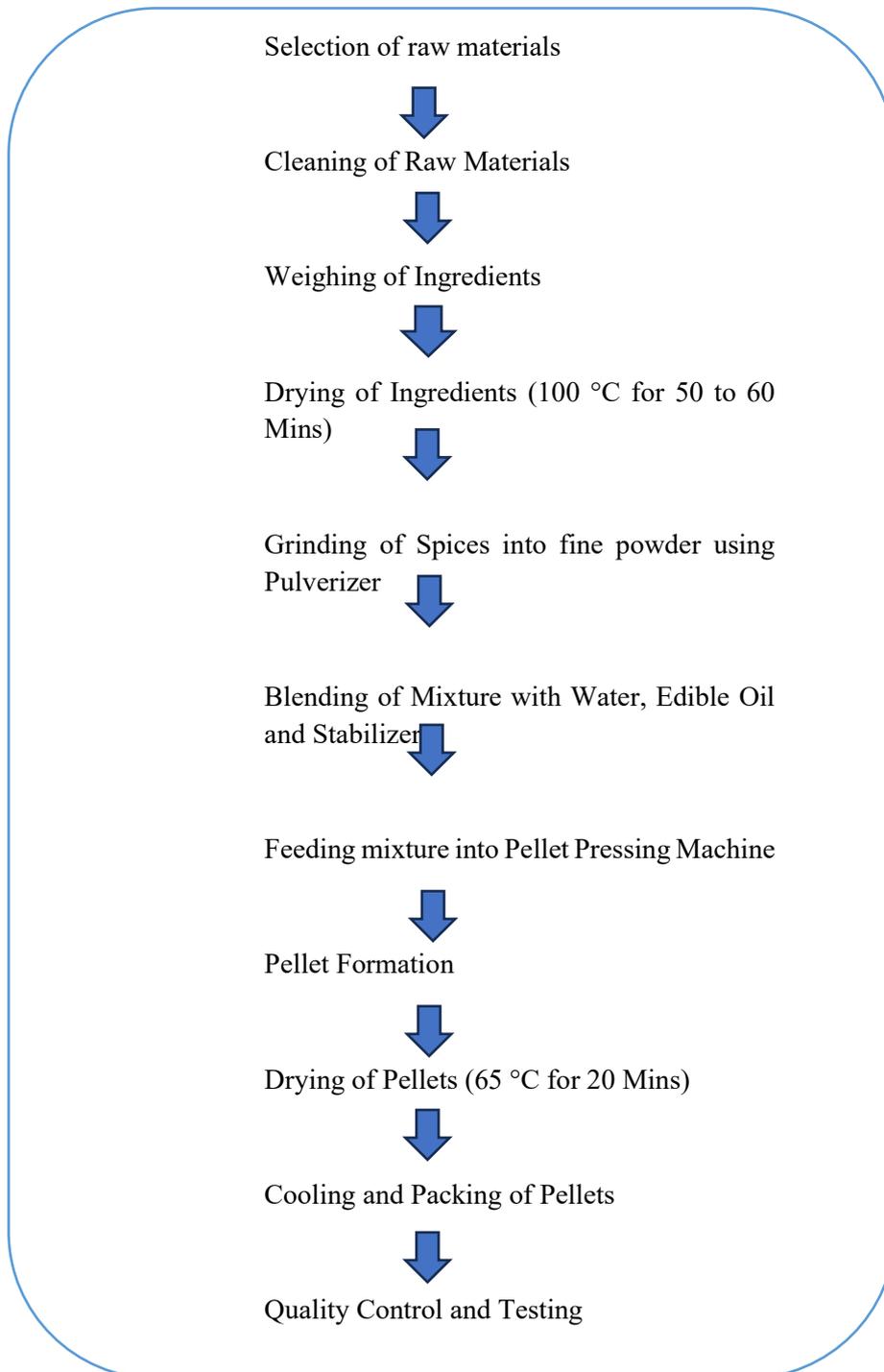
S.No	INGREDIENTS	QUANTITY (Grams)
1.	Bay Leaves	4
2.	Black Pepper	8
3.	Cardamom Pods (Black and Green)	4
4.	Cinnamon Sticks	6
5.	Cloves	2
6.	Coriander Seeds	20
7.	Cumin Seeds	12
8.	Dried Ginger and Garlic	12
9.	Fennel Seeds	12
10.	Mace	1.2
11.	Nutmeg	0.8
12.	Red Chilli (Kashmiri)	20
13.	Star Anise	2

B. Methods

Following procurement, the initial processing was carried out at the Centre for Manufacturing and Emerging Technology (CMET) laboratory located at Avinashilingam University in Coimbatore, Tamil Nadu, India. To avoid contamination and maintain quality all raw material handling and processing was done under strict hygienic circumstances. The processed spice powders were transformed into pellets at the Hindustan Incubation Centre in Malumachampatti, Coimbatore.

FLOW CHART 1

PROCESSING FLOW CHART OF BIRIYANI SEASONING PELLETS



1) Selection of Raw Materials

The process starts with choosing high-quality spices and herbs. Raw materials must be fresh, devoid of mould, bugs and foreign stuff. All spice varieties and food-grade stabilizers should meet food safety requirements. To ensure traceability and compliance, we source from verified vendors. Seasonal variations are considered to ensure aroma and flavour consistency. Spices must be pure, with no artificial colours, additives or adulterants. Proper storage in dry and sanitary conditions is certain till processing.



Fig 1. Selection of Raw Materials

2) Cleaning of Raw Materials

Spices and other ingredients are thoroughly cleaned to remove dust, dirt, stones and other particles. Garlic and ginger should be washed as soon as they are peeled. Cleaning improves microbiological safety and extends shelf life. Cross-contamination is avoided by following proper sanitation standards. Hygienic conditions are maintained throughout to ensure compliance with food safety laws. Before moving on to the next phase, cleaned raw materials are thoroughly examined.

3) Weighing of Ingredients

According to the specifications of the formulation, each spice is weighed. Digital weighing scales are used to ensure precision and accuracy. A proper spice ratio guarantees that each batch has a consistent flavour. Ingredients are weighed in clean, food-safe containers. To ensure traceability, batch numbers and weight records are documented. Slight weight variations can affect the final taste or texture. The formula also determines the weight of ingredients such as stabilizer and oil. Personnel labelled containers should be used to ensure there are no mix ups while weighing. The weighted materials are now ready for blending. The initial ratios were determined based on conventional biryani seasoning recipes. Ingredient quantities were modified in response to sensory analysis results such as taste, aroma and texture. A series of sensory tests helped to refine the final recipe for customer acceptance.

4) Drying of Ingredients

The ingredients are dried in hot air oven to maintain the moisture level within the standardized limits. Drying inhibits microbiological development and increases product shelf life. Hot air ovens and dehydrators are widely utilized for drying process. Temperature and timing are carefully managed to preserve volatile oils in spices. The drying temperature is maintained at 100°C and is dried for a time period of 50 to 60 minutes. Moisture levels are measured after drying using a moisture analyser. Over drying is prevented to prevent flavour loss. The dried ingredients are cooled before blending process. Drying improves powdering efficiency in the next stage. This ensures a homogeneous and stable mixing in the finished product.

Fig 2. Drying of Ingredients



5) Grinding of Spices into Fine Powder using Pulverizer

Grinding is an important unit action in the production of biryani seasoning pellets since it directly affects the texture, consistency, and flavour release of the finished product. The major goal of this phase is to reduce the particle size of the dried whole spices to a fine, homogeneous powder that will ensure uniform mixing and pellet formation. The machine was adjusted to medium-fine settings, which ensured a balance of fine particle size and spice qualities. The ground spice powders were immediately transferred to clean, dry, airtight containers to maintain freshness and avoid moisture absorption. This homogeneous spice blend ensured a balanced distribution of flavour in each pellet and served as the foundation for subsequent processing.



Fig 3. Grinding of Dried Ingredients in Pulverizer

6) Blending of Mixture with Water, Edible Oil and Stabilizer

The grinded powder is then combining with with xanthum gum (a stabilizing agent). The fine powder is then combined with precisely measured amounts of water and edible oil. Water serves as a medium for creating a homogeneous paste. Edible oil improves mouthfeel and aids in the binding process. Proper mixing guarantees an equitable distribution of components. The consistency should be dough-like, moist but not sticky. To avoid oil separation or texture concerns, do not overmix. This step is critical to achieve proper consistency for uniform pellet formation. The mixture is then transferred for pelletization.



Fig 4. Mixing with Xanthum gum



Fig 5. Mixing with oil and water to form a Dough

7) Feeding Mixture into Pellet Pressing Machine

The mixture is passed through a pellet pressing or compression equipment. The machine compresses the mixture and forms small, homogeneous pellets. The hopper capacity is checked to ensure ongoing functioning. The operator verifies that there are no air pockets or clogged feed lines. The machine uses manual force to bind components into solid pellets. Shape and size will be consistent and uniform. Each batch's quality is evaluated based on size and texture consistency.



Fig 6. Feeding of Mixture in Pellet Machine for Pellet Formation

8) Pellet Formation

The spice combination is compressed cylindrical or spherical die holes. Pellets should be solid but breakable with slight pressure. Moisture and oil content can influence the integrity and texture of the pellets. Proper compression eliminates cracks and loose particles. Defective pellets are removed manually. Samples are analysed for hardness and moisture content. Pellets are then dried to remove moisture accordingly. Each pellet is weighed, verified for uniformity in size and recorded.

Fig 8. Pellet Formation



9) Drying of Pellets (65°C for 20 Minutes)

The pellets are then dried in hot air oven. Drying is done at 65°C for around 20 minutes to remove moisture. Proper drying maintains rigidity, inhibits microbiological development and increases shelf life. Pellets are equally distributed on trays to prevent sticking and overlapping. The drying duration and temperature are optimized to preserve taste components. Moisture levels are measured on a regular basis utilizing moisture analysers. Dried pellets should have a moisture level of 4-6%. Over drying can produce cracks while under drying shortens shelf life. The dried pellets are now ready for cooling and packaging. Each pellet weighed approximately around 1 to 1.2 grams, ensuring consistent dosing and flavour delivery per serving



Fig 9. Drying of Pellets

10) Cooling and Packing of Pellets

Dried pellets are cooled to room temperature to prevent condensation in packing. Cooling is done with fans or in a controlled atmosphere. Pellets are packaged using moisture-resistant, food-grade materials. Proper sealing protects against contamination, oxidation and aroma loss. To ensure food safety, packing takes place under sanitary circumstances. Packed products are kept at room temperature in a dry environment. Pellets are packed in airtight, food-grade containers to preserve freshness and aroma. Airtight packaging also helps to protect the pellets from moisture absorption and microbial contamination. The containers used are durable enough to prevent breakage or crushing during storage and transport.



Fig 10. Cooling and Storing it in Air tight containers

11) Quality Control and Testing

Quality tests are performed at each stage including raw material, processing and final product. Quality control was performed at all stages to guarantee that the finished product meet safety, quality and sensory criteria. Physical tests included determining the pellet's size, shape, texture, colour, and hardness. Chemical tests were carried out to determine moisture content, pH, oil content and the presence of any adulterants. Biological (microbiological) testing included yeast and mould count and pathogen detection for *E. coli* and *Salmonella*. Nutritive analysis was performed to determine calorie value, protein, carbohydrate, fat content and dietary fibre. Sensory evaluations were also performed on aroma, taste, texture and overall acceptance. Shelf life investigations are carried out under both accelerated and ambient circumstances. Continuous improvement procedures are implemented in response to QC reports.

III. RESULT AND DISCUSSION

A. ANALYSIS CONDUCTED

To evaluate the quality, safety and functional properties of biryani seasoning powder and pellets, a series of chemical, physical, biological and nutritional analysis were performed. The seasoning powder was subjected to nutritional analysis to determine its macronutrient composition, biological analysis to check for microbial contamination and chemical analysis to assess its purity and composition.

1) Chemical Analysis of Biryani Seasoning Powder

The chemical features of the created biryani seasoning were investigated to determine its composition and quality. The findings are summarised in Table [II]. The moisture content was found to be 7.01%, indicating a low water activity, which is good for shelf stability. The total ash content was 6.87 g/100g, indicating the formulation's overall mineral content. The acid-insoluble ash content was 0.15 g/100g, indicating low contamination with silica or other acid-insoluble contaminants.

The crude fibre concentration was 13.29 g/100g, which reflected the dietary fibre contribution of the seasoning ingredients. The salt concentration (as NaCl) was found to be 3.40 g/100g, indicating adequate seasoning levels. The volatile oil content, which contributes to the distinctive taste and flavour of the spice, was discovered.

TABLE II
CHEMICAL QUALITY PARAMETERS OF BIRIYANI SEASONING POWDER

S.No	PARAMETERS	RESULTS	UNITS
1.	Moisture	7.01	%
2.	Total Ash	6.87	g/100g
3.	Acid Insoluble Ash	0.15	g/100g
4.	Crude Fibre	13.29	g/100g
5.	Salt as NaCl	3.40	g/100g
6.	Volatile Oil	2.07	ml/100g
7.	Non-volatile ether Extract	9.5	g/100g

2) Physical and mechanical Analysis of Biryani Seasoning Pellets

The physicochemical and mechanical properties of the developed biryani seasoning pellets were analyzed to assess their stability and usability. The results are presented in Table [III].

The pH of the seasoning pellets was discovered to be 6.73, indicating a near-neutral pH that is beneficial for flavour stability and microbiological safety. The solubility test demonstrated that the pellets were partly soluble in water, indicating a regulated release of flavour components following hydration. The pellet's hardness was tested at 70 g, indicating structural integrity and appropriateness for handling and packing. The force required to break the pellets was recorded at 18.139g, indicating the formulation's mechanical strength. These studies emphasise the biryani seasoning pellets has ideal blend of solubility and mechanical strength, resulting in ease of usage and effective flavour dispersion in culinary applications.

TABLE III
PHYSICAL QUALITY PARAMETERS OF BIRIYANI SEASONING PELLETS

S.No	PARAMETERS	RESULTS	UNITS
1.	pH	6.73	-
2.	Solubility	Partially soluble in water	-
3.	Hardness	70	g
4.	Force	18.139	g

3) Microbial Analysis of Biryani Seasoning Powder

Tabel [IV] describes the microbial testing results of the developed biryani seasoning pellets and also useful for the shelf life analysis of the product. The absence of Escherichia coli and Salmonella proves that the product passes critical food safety criteria and demonstrates hygienic manufacturing methods. The yeast and mould count was 200 CFU/g, which is within acceptable limits for dry spice and seasoning items according to conventional regulatory criteria (such as FSSAI and Codex Alimentarius), where limits normally range between 10² to 10³ CFU/g. This shows that the product is microbiologically safe and stable for ingestion within its designated shelf life, assuming adequate storage circumstances.

TABLE IV
MICROBIAL ANALYSIS OF BIRIYANI SEASONING POWDER

S.No	PARAMETERS	RESULTS	UNITS
1.	Escherichia coli	Absent	/g
2.	Salmonella	Absent	/25g
3.	Yeast and Mould	200	CFU/g

4) Nutritional Analysis of Biryani Seasoning Powder

The nutritional composition of the designed biryani seasoning pellets was investigated to determine their macronutrient and micronutrient contents. The findings are summarised in Table [V]. The fat content was below the detectable limit (BDL), which is 0.5 g/100g, showing that the formulation is low in fat. The protein concentration was discovered to be 13.8 g/100g, which added to the seasoning's nutritional value. The carbohydrate level was 73.4 g/100g, making it the predominant macronutrient and contributing considerably to the energy value of 352.6kcal/100g.

In terms of micronutrients, the calcium (Ca) content was 63.5 mg/kg, and the magnesium (Mg) level was 126 mg/kg, both of which are necessary minerals that help with bone health and other metabolic activities.

TABLE V

NUTRITIONAL ANALYSIS OF THE BIRIYANI SEASONING POWDER

S.No	PARAMETERS	RESULTS	UNITS
1.	Fat	BDL(DL:0.5)	g/100g
2.	Protein	13.8	g/100g
3.	Carbohydrates	73.4	g/100g
4.	Energy	352.6	kcal/100g
5.	Calcium as Ca	63.5	mg/kg
6.	Magnesium as Mg	126	mg/kg

B. ANOVA FOR QUADRATIC MODEL

The Model F-value (208.34) with a p-value < 0.0001 indicates the model is statistically significant. Cumin seeds and Black pepper showed significant effects, with p-values below 0.05. However, Coriander seeds ($p = 0.6294$) were not statistically significant. Significant interaction terms (AB and AC) suggest combined effects of cumin seeds with coriander seeds and black pepper. The quadratic terms (A^2 , B^2 , C^2) were highly significant, confirming non-linear relationships. Lack of Fit ($p = 0.0653$) was not significant, indicating the model fits the experimental data well.

TABLE VI
ANOVA FOR QUADRATIC MODEL

Source	Sum Squares	df	Mean Square	F-value	p-value	
Model	34.23	9	3.80	208.34	< 0.0001	significant
A-Cumin seeds	0.7788	1	0.7788	42.66	< 0.0001	
B-Coriander seeds	0.0045	1	0.0045	0.2478	0.6294	
C-Black pepper	3.32	1	3.32	182.07	< 0.0001	
AB	1.88	1	1.88	103.17	< 0.0001	
AC	0.2170	1	0.2170	11.89	0.0063	
BC	0.0019	1	0.0019	0.1066	0.7507	
A ²	5.22	1	5.22	285.92	< 0.0001	
B ²	1.41	1	1.41	77.32	< 0.0001	
C ²	9.89	1	9.89	541.83	< 0.0001	
Residual	0.1826	10	0.0183			
Lack of Fit	0.1326	4	0.0331	3.98	0.0653	not significant
Pure Error	0.0500	6	0.0083			
Cor Total	34.41	19				

C.

CONTOUR PLOT of -AB, AC and BA

The shape and distribution of contour lines indicate the strength and direction of interaction. Circular or elliptical contour lines suggest a strong interaction between the variables, meaning that a specific combination of ingredient grams significantly impacts the final response. If the contour lines are more linear, it suggests a weaker interaction and more independent effects of the ingredients. The optimal region for achieving the best formulation is identified within the closely packed contour lines.

Factor Coding: Actual

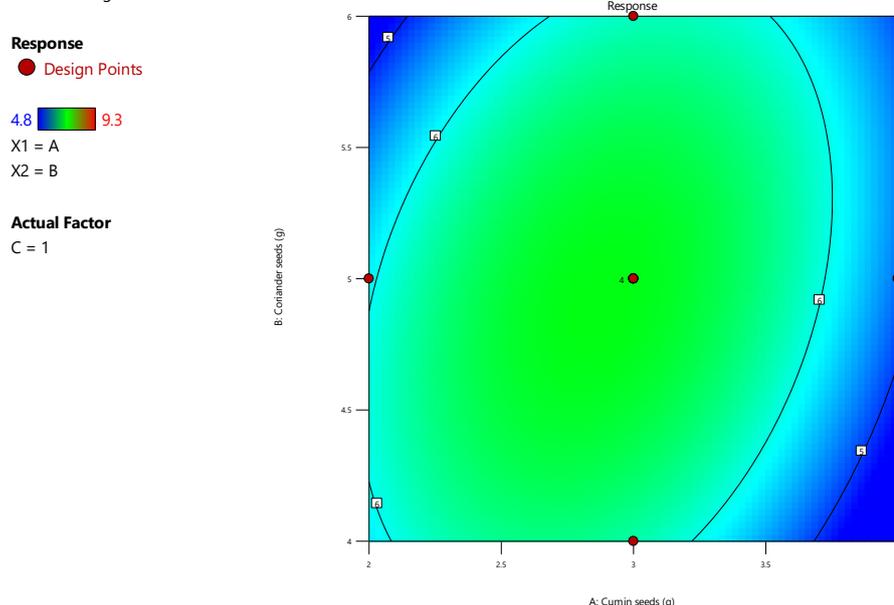


Fig.11 Contour plot-AB

Factor Coding: Actual

Response
4.8  9.3

X1 = A
X2 = C

Actual Factor
B = 4.86

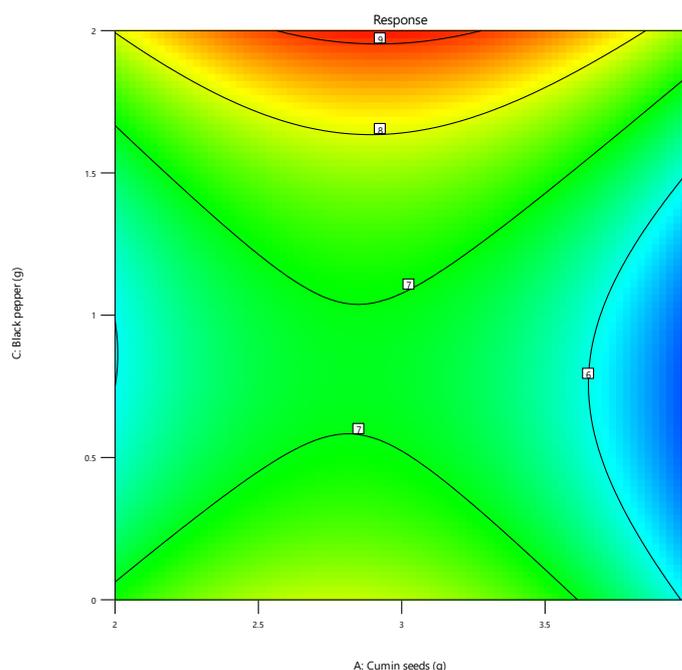


Fig.12 Contour Plot-AC

Factor Coding: Actual

Response
 Design Points

4.8  9.3

X1 = B
X2 = C

Actual Factor
A = 3

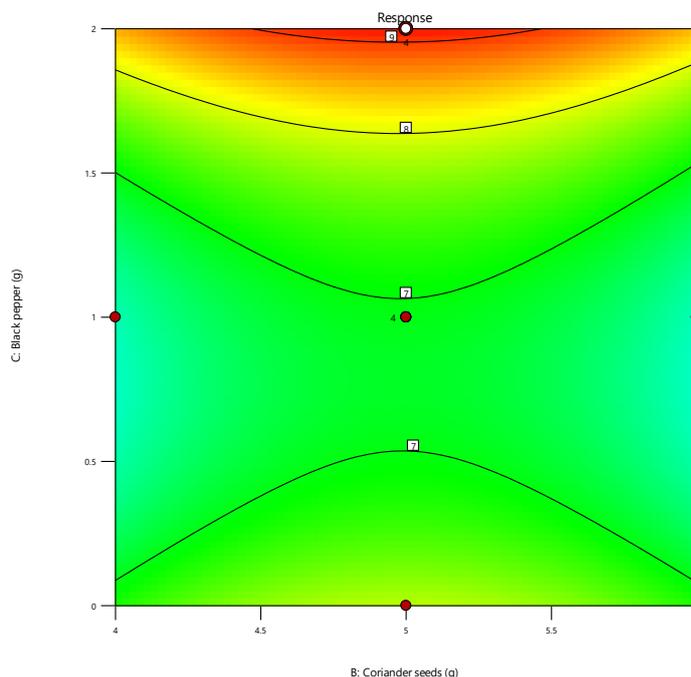


Fig. 13 Contour Plot-BC

D. RESPONSE SURFACE METHODOLOGY OF MAJOR INGREDIENTS USED

Response Surface Methodology (RSM) was used to assess and optimise the influence of three key ingredients—coriander seeds, black pepper and cumin seeds on the texture of biryani seasoning pellets. Surface plots depict the interaction between pairs of ingredients while keeping the third variable constant. The texture was considered as a crucial sensory and physical feature determining consumer acceptance of seasoning pellets.

All three graphs show that the texture of biryani seasoning pellets is strongly dependent on the amounts of coriander, black pepper and cumin seeds. The best texture was achieved when moderate amounts of coriander and black pepper were blended with low to moderate amounts of cumin seeds. The application of RSM allowed for a more detailed knowledge of these spices interaction behaviour, which guided formulation techniques to attain the desired product texture.

Factor Coding: Actual

Response

Design Points:

● Above Surface

○ Below Surface

4.8 9.3

X1 = B

X2 = C

Actual Factor

A = 3

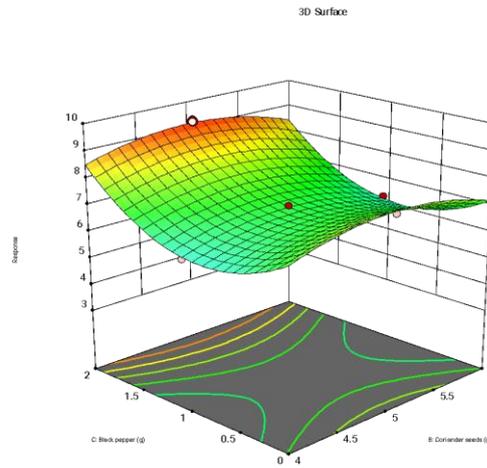


Fig.14 3d Surface Plot-AB

Factor Coding: Actual

Response

Design Points:

● Above Surface

○ Below Surface

4.8 9.3

X1 = A

X2 = B

Actual Factor

C = 1

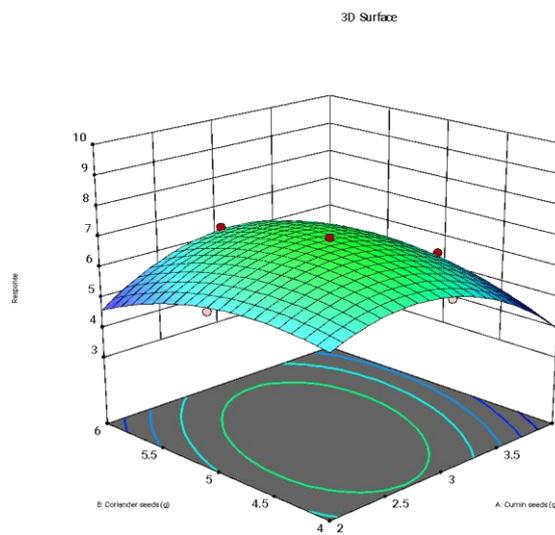


Fig.15 3d Surface Plot- AC

Factor Coding: Actual

Response

4.8 9.3

X1 = A

X2 = C

Actual Factor

B = 4.86

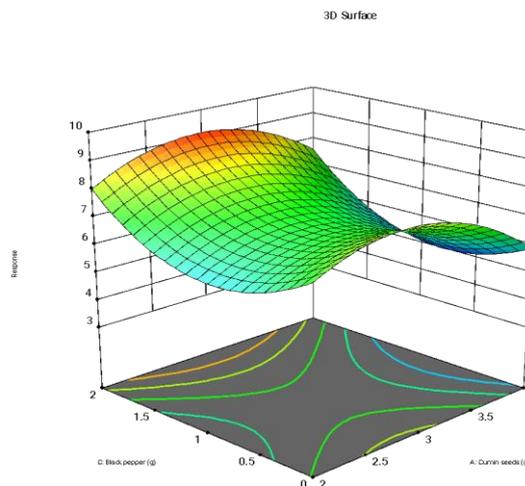


Fig.16 3d Surface Plot- BC

E. SENSORY ANALYSIS

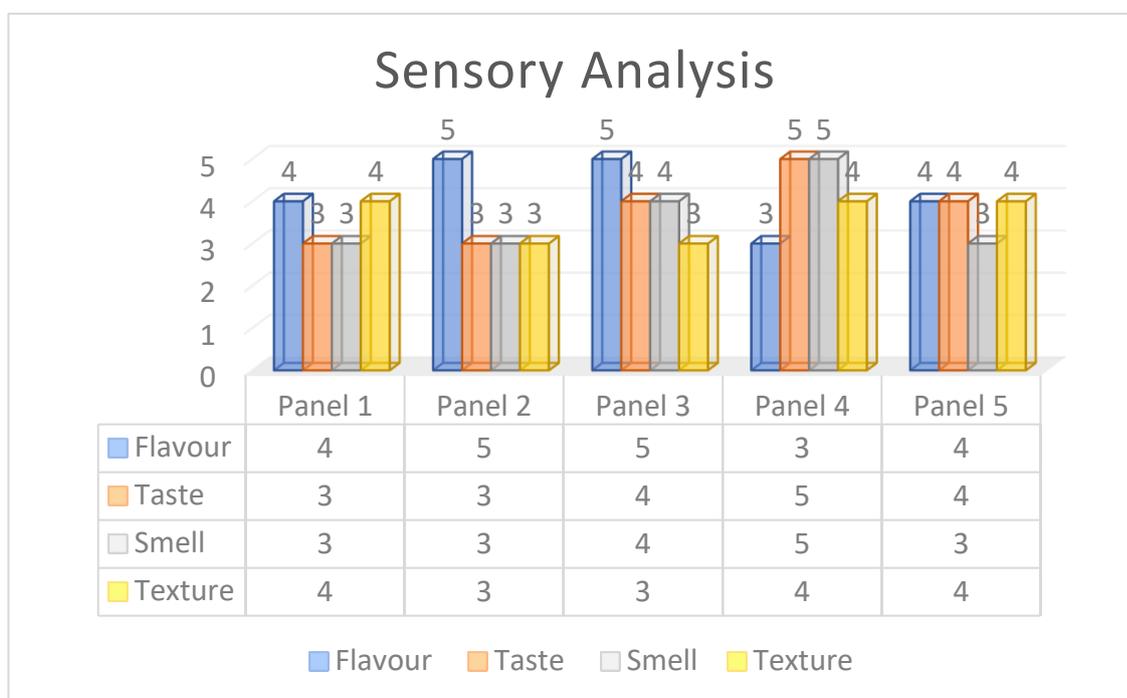
Sensory analysis was conducted using a 5-point hedonic scale to assess consumer acceptability of the biryani seasoning pellets. The scale ranged from 1 (Dislike Extremely) to 5 (Like Extremely). Five semi-trained panelists were selected to evaluate the product based on four key sensory attributes: Flavour, taste, smell and texture.

The average scores across all attributes and panelists include

- Flavour: 4.2
- Taste: 3.8
- Smell: 3.6
- Texture: 3.6

The product received its highest acceptance in flavour, confirming its alignment with traditional biryani seasoning expectations. Minor improvements may be considered for smell and taste, particularly to cater to individual preferences or enhance aroma release.

TABLE VII
SENSORY EVALUATION OF THE BIRIYANI SEASONING PELLETS



F. PREPARATION OF BIRIYANI USING BIRIYANI SEASONING PELLETS

The process begins by heating the oil to evenly distribute the seasoning pellets. Then, in proportion to the rice, biryani seasoning pellets are added providing a consistent and powerful flavour profile. A rich masala is created as the pellets dissolve with gentle mixing, releasing their spices evenly. Complete dispersion without clumps is ensured by additional heating. In order to absorb the infused flavours and contribute colour and nutrients fresh veggies are added and sautéed. After adding measured water and soaked rice, the mixture is pressure cooked to obtain a consistent texture and flavour. The end result is a fragrant, well-cooked biryani that replicates classic flavour in a more contemporary format. It has identifiable grains and well-balanced seasoning.

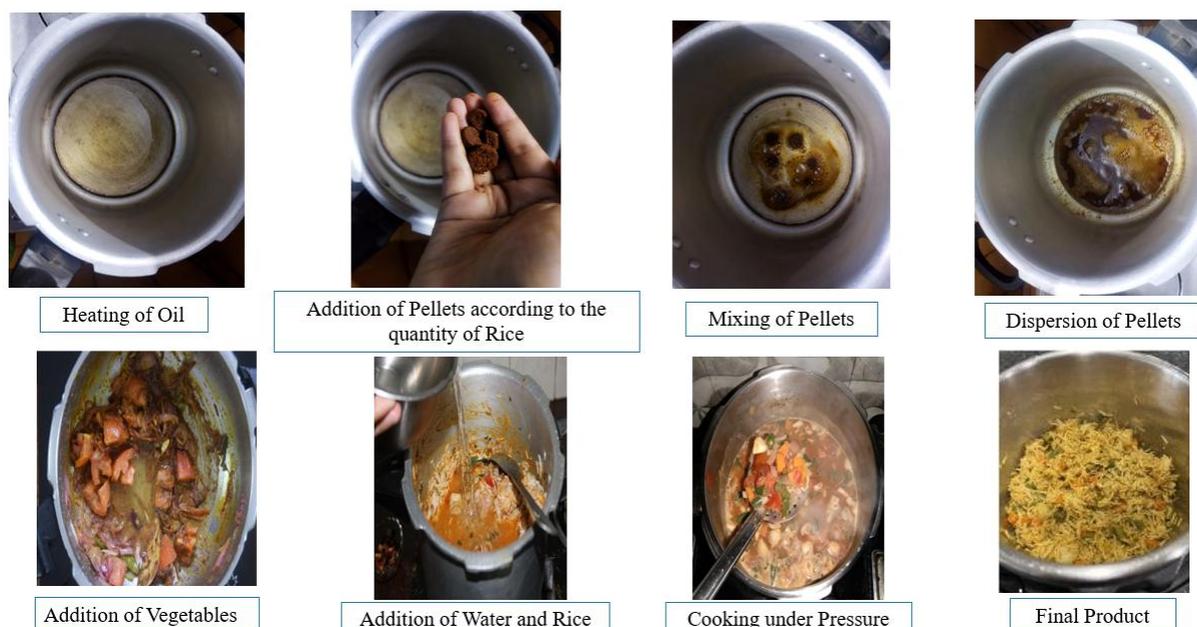


Fig.17 Stepwise preparation of Biriyani usin the sesaoning pellets

IV. CONCLUSION

The research’s key goal includes creating seasoning pellets with authentic biriyani spices, producing a binding agent that does not affect rice quality, and testing the product’s sensory and functional properties. Additionally, by streamlining the cooking procedure, these pellets allow busy people to taste homemade biriyani without compromising authenticity or nutritional benefits. The ease of pre-measured spices reduces confusion, making the product available to everyone. This innovation has enormous potential in both domestic and international markets, especially in areas where biriyani is a staple or celebrated meal. By satisfying consumer need for rapid and dependable seasoning alternatives, the product offers itself as a competitive and diverse solution in the food business.

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