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Optimization and development of plant based meat analogue formulations

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ABSTRACT

A meat analogue is a meat-like substance made from plants and made to look, taste, smell and feel like meat. The main function of meat analogue is to replace meat in the diet. This study was aimed at introducing the potential of soybean, chickpea, mushrooms and jackfruit to develop a healthy meat analogue. The central composite design of response surface methodology (RSM) was used for designing the 24 experimental formulations for the development of meat analogues with said protein sources and coded as S1 to S24. The steaming method was used to texturize all the 24 formulations produced. All the texturized samples were then examined for various textural properties using texture analyzer. On the basis of overall textural properties (hardness, adhesiveness, cohesiveness, springiness, gumminess and chewiness) of textured samples comparing with controlled sample (goat meat) 16 samples were screened out. The selected 16 samples were then analyzed for proximate composition (moisture content, fat content, ash content, fiber content, protein content and carbohydrate) and 8 samples were selected comparing with controlled sample (goat meat) on the basis of protein content for further screening of samples as per sensory evaluation. The sensory evaluation of chosen 8 samples was carried out using 9 point Hedonic scale with semi-trained panel. Eventually samples S2, S8, S19, and S22 were screened out on the basis of sensory evaluation. The work thus concludes that if formulated properly, it is possible to prepare acceptable quality meat analogue using defatted Soy flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour as vegetarian protein source. The selected samples S19, S2, S8 and S22 can be used as goat meat replacer as carries good texture, high protein and acceptable organoleptic characteristics.

Keywords: Soybean, Mushroom, Jackfruit, Chickpea, Response surface methodology, Texture

INTRODUCTION

A meat analogue is a plant-based meat substitute, also known as vegan meat, fake meat, mock meat, meat alternative, imitation meat, or vegetarian meat. Meat analogues are goods that perform similarly to meat, have similar physical and sensory characteristics, and can be prepared by consumers just like meat. Meat analogue provide good source of protein and amount of protein vary from product to product. In many nations, a combination of population health awareness and sustainable food has led to the development of plant protein-based meat analogue. In terms of sustainability, meat production has aided environmental change and resource depletion. Animal diseases, healthier diets, a high need for healthful and holy food, and economic concerns have all influenced the usage of vegetable proteins in food items over time (Joshi & Kumar, 2015).

Many strategies have been created to help people cut back on their meat consumption; the first strategy is to substitute vegetables, beans, pulses, and/or nuts for meat in a meal. The second strategy relies on the creation of structured products. Tofu, tempeh, and seitan, which have been produced and consumed for generations in East Asia, are examples of goods with a traditional structure. However, in western nations, consumer acceptability of these products is lower. As a result, a new class of structured items known as meat analogues has arisen. Recently, there have been increased studies of plant- based meat analogue as an alternative protein source to substitute the traditional animal-based food in various parts of the world. This may be due to the rising world population and limited natural resources, causing animal meat production to be an unsustainable practice (Dekkers *et.al.*, 2018). Some plant proteins, particularly soybean protein, are already used in meat products. Despite being one of the most popular legumes in the world and an excellent, affordable source of high-quality protein, relatively little research has been done on the use of chickpea flour in meat preparations. Additionally, protein products from animal-based sources such as milk and eggs and from new sources such as fungi (mushroom) and bacteria are available now a day's (Wild *et.al.*, 2014). In meat products, jackfruit was used instead of chevon in proportions of 10%, 20%, and 30% weight to weight (Verma *et.al.*, 2015).

The aim of this study is to optimize the formulations using plant based protein sources like defatted Soy flour, Kabuli Chickpea flour, Jackfruit flour ankd Button Mushroom for the development of meat analogue.

MATERIALS AND METHODS

Procurement of raw materials

Raw materials used for the preparation of meat analogue were Kabuli Chickpea, Jackfruit, white button Mushroom purchased from local market of Jalgaon, Maharashtra India. Defatted Soy cake received from Sanjay Soy Pvt. Ltd. Industry, Avdhan MIDC, Dhule Maharashtra India, to make Defatted Soy flour. Binding agent carrageenan of brand IAMPURE and guar gum of brand NATURE'S HARVEST were used in the formulation.

Proximate analysis of raw protein sources

Proximate analysis of Defatted Soy flour, Kabuli Chickpea, Button Mushroom and Jackfruit were carried out as per AOAC method for moisture, protein, fat, ash, crude fiber and carbohydrate (AOAC, 2000).

Processing of Protein Sources

Major raw material Defatted Soy flour, Kabuli Chickpea and Jackfruit were used in the form of flour.

Defatted Soy flour

Defatted Soy coarse flour was ground in lab grinder into fine flour to make Defatted Soy flour.

Kabuli Chickpea flour

Kabuli Chickpea flour process was made by modifying a method given (Ravi & Harte, 2009). Around10% water was added to Kabuli Chickpea seeds and mixed thoroughly for uniform moisture penetration into the cotyledons, followed by an equilibrium period of about 2 hrs. The moistened seeds were then dried at 45–50°C for 6 hrs in lab hot air oven. Splitting of seeds was carried out by

milling with household dhal mill and separated by manual winnowing into different fractions such as dhal, partially dehulled whole grains, husk, broken seeds and some flour. The obtained dhal (dehulled grain) is then milled to obtain fine flour.

Jackfruit flour

Jackfruit flour was made by process mentioned (Hyndavi *et.al.*, 2022). The collected tender Jackfruit was thoroughly cleaned with 0.1 % KMS to remove any dirt or dust particles adhered to the surface. Outer green rind was removed by knife manually and tender Jackfruit was rnade into slices. Tender Jackfruit slices then were blanched in boiling water for one minute. The tender jackfruit slices were dried by using tray drying method at 60°C in hot air oven till it dried and dried slices were then finely ground to obtained flour.

Mushroom paste

Mushroom paste was made by process mentioned by previous research study (Mishra & Mani, 2019; Kumar *et.al.*, 2014; Rosli & Solihah, 2014; Rosli *et.al.*, 2011). The white button Mushroom was first rinsed with water and subjected to blanching (in boiling water for 5 min.) and chopped coarsely and ground to paste in lab grinder.

Experimental method

Experimental design Central composite rotatable design (CCRD) (Ahirwar *et.al.*, 2015) was applied to determine the best formulation of Mushroom paste, Jackfruit flour, kabuli chickpea flour and defatted soy flour to optimize the ingredients combination for the development of meat analogue using software State–Ease (Design Expert version 13.0.0.5) as shown in Table 1. Mushroom, Jackfruit flour, Kabuli Chickpea flour and Defatted Soy flour were taken as independent variables and protein content, cohesiveness, adhesion, hardness, gumminess, springiness, chewiness and overall acceptability as responses. RSM of central composite design helped to illustrate the factor interactions and influence of percentage of defatted Soya flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour on texturized meat analogue formulations

Preparation of the product

All the raw materials were weighed according to formulation obtained by Experimental Design and mix together by adding binding agent carrageen and guar gum and some amount of water to make into dough. After dough making, the meat analogue formulations were texturized by steaming method for 20 min. and cooled (Mishal *et.al.*, 2022; Kumar *et.al.*, 2012). All the textured meat analogue formulations were then subjected for further analysis.

Texture profile analysis (TPA)

The textural characteristics of the 24 textured meat analogue formulations in terms of hardness, chewiness, springiness, cohesiveness, adhesiveness and gumminess were established using cylindrical probe of Texture Analyzer (Texture Pro CT V1.7 Build 28 Brookfield Engineering Labs. Inc.). Out of these 24 meat analogue formulations, 16 meat analogue samples were chosen based on the comparison of textural parameters with control S0 (goat meat).

Proximate analysis of textured meat analogue formulations

The AOAC method was used to determine the proximate composition of 16 selected meat analogue samples for moisture, protein, fat, carbohydrate, and total ash. On the basis of protein content 8 meat analogue samples were screened out comparing with control S0 (goat meat).

Sensory Evaluation

Sensory evaluation of preferred 8 meat analogue samples were carried out by 10 semi-trained panelists on a 9 point Hedonic scale (9-like extremely to 1-dislike extremely) as mentioned (Ranganna, 1999), to establish the overall acceptability of the products. On the basis of overall acceptability 4 meat analogue samples were selected.

Response surface design plot

The effect of composition of plant based meat sources (defatted Soy flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour) in the formulations on the various characteristics (texture, protein content and overall acceptability) of developed meat analogues was qualitatively studied using Response surface methodology (central composite design) that demonstrated the factor interactions and influence of the composition of defatted Soya flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour on the various textural parameters (hardness, adhesiveness, cohesiveness, springiness, gumminess and chewiness), proximate composition (protein content) and sensory (overall acceptability) of developed meat analogue.

RESULTS AND DISCUSSION

Table 1 is representing the design of experiment for the development of meat analogue and shows experimental levels of independent variable in terms of actual and coded factors. The code assigned for protein sources were, A: Defatted Soy flour, B: Kabuli Chickpea flour, C: Mushroom paste, D: Jackfruit flour. The different formulations had been coded from S1 to S24.

Independent variables	Factor levels				
	Min.	Max.	low	High	Mean
A:Defatted soy flour	25	50	12.5	62.5	37.5
B:Chickpea flour	25	50	12.5	62.5	37.5
C:Mushroom paste	25	50	12.5	62.5	37.5
D:Jackfruit flour	25	50	12.5	62.5	37.5

Table 1 : Design of experiment for the development of meat analogue formulations

Run	Sample Code	Factor 1 A:Defatted soy flour	Factor 2 B:Chickpea flour	Factor 3 C:Mushroom paste	Factor 4 D:Jackfruit flour
1	S1	25	25	25	25
2	S2	50	25	25	25
3	S3	25	50	25	25
4	S4	50	50	25	25
5	S5	25	25	50	25
6	S6	50	25	50	25
7	S7	25	50	50	25
8	S8	50	50	50	25
9	S9	25	25	25	50
10	S10	50	25	25	50

Run	Sample Code	Factor 1 A:Defatted soy flour	Factor 2 B:Chickpea flour	Factor 3 C:Mushroom paste	Factor 4 D:Jackfruit flour
11	S11	25	50	25	50
12	S12	50	50	25	50
13	S13	25	25	50	50
14	S14	50	25	50	50
15	S15	25	50	50	50
16	S16	50	50	50	50
17	S17	12.5	37.5	37.5	37.5
18	S18	62.5	37.5	37.5	37.5
19	S19	37.5	12.5	37.5	37.5
20	S20	37.5	62.5	37.5	37.5
21	S21	37.5	37.5	12.5	37.5
22	S22	37.5	37.5	62.5	37.5
23	S23	37.5	37.5	37.5	12.5
24	S24	37.5	37.5	37.5	62.5

*Above formulation include binding agent (carrageenan and guar gum) 0.5% each and water (as per need)

The above protein sources composition of formulations (S1 to S24) were converted into percent (%) and are shown in Table 2.

Table 2: Percent Composition of protein sources in meat analogue formulations

Run	Sample code	Factor 1 A:Defatted soy flour	Factor 2 B:Chickpea flour	Factor 3 C:Mushroom paste	Factor 4 D:Jackfruit flour
1	S1	25	25	25	25
2	S2	40	20	20	20
3	S3	20	40	20	20
4	S4	33.3	33.3	16.7	16.7
5	S5	20	20	40	20
6	S6	33.3	16.7	33.3	16.7
7	S7	16.7	33.3	33.3	16.7
8	S8	28.6	28.6	28.6	14.2
9	S9	20	20	20	40
10	S10	33.3	16.7	16.7	33.3
11	S11	16.7	33.3	16.7	33.3
12	S12	28.6	28.6	14.2	28.6
13	S13	16.7	16.7	33.3	33.3
14	S14	28.6	14.2	28.6	28.6

Run	Sample code	Factor 1 A:Defatted soy flour	Factor 2 B:Chickpea flour	Factor 3 C:Mushroom paste	Factor 4 D:Jackfruit flour
15	S15	14.2	28.6	28.6	28.6
16	S16	25	25	25	25
17	S17	10	30	30	30
18	S18	35.71	21.43	21.43	21.43
19	S19	30	10	30	30
20	S20	21.43	35.71	21.43	21.43
21	S21	30	30	10	30
22	S22	21.43	21.43	35.71	21.43
23	S23	30	30	30	10
24	S24	21.43	21.43	21.43	35.71

Result of Proximate analysis of raw protein sources

The result of proximate analysis of raw protein sources is shown in Table 3. The results of proximate analysis of defatted Soy flour, Kabuli Chickpea, Mushroom and Jackfruit, showing highest moisture content in Mushroom & Jackfruit, whereas lowest in Kabuli Chickpea and defatted Soy flour. Kabuli Chickpea found to contain high fat (8.6%) and Jackfruit shown low fat (0.6%). High protein content observed in Defatted Soy flour (38.1 %) and Kabuli Chickpea (18.2 %), whereas Jackfruit and Mushroom shown low protein content due to their high moisture. Also because of high moisture content Mushroom and Jackfruit were showing less carbohydrate fiber as compared to Defatted soy flour and Kabuli chickpea. However all the considered vegetarian protein source were found to be the good sources of mineral as revealed in ash content.

Table 3 : Result of proximate analysis of raw protein sources

Parameters	Defatted Soy flour	Kabuli Chickpea	Mushroom	Jackfruit
Moisture (%)	5.87± 0.30	7.08 ±0.10	86.68± 4.4	79.29 ±4.7
Fat (%)	4.95± 0.20	8.60 ±1.00	1.56 ±0.6	0.6 ±0.1
Protein (%)	38.10 ±2.00	18.20 ±2.14	1.31 ±0.09	8.2 ±0.2
Ash (%)	3.48 ±0.10	8.83 ±0.05	4.75 ±1.8	1.5 ±0.5
Fibre (%)	3.97 ±0.10	6.56 ±1.66	5.2± 2.0	3.9 ±0.2
Carbohydrate	43.8 ±0.50	51.42 ±1.0	0.50± 0.7	11.8 ±3.8

*Above values are averages of three determinants ± standard deviation

Selection of Meat analogue formulations on the basis of texture profile analysis

The texture profile analysis results are shown in Table 4. It was found that most of the important textural properties like hardness, chewiness, springiness, gumminess values of meat analogue formulations S1, S2, S4, S5, S6, S7, S8, S10, S11, S12, S15, S19, S20, S21, S22 and S23 were near and comparable to textural properties of

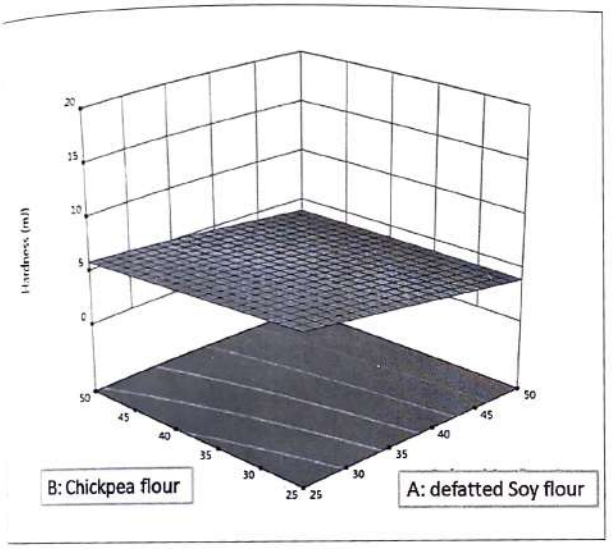
controlled sample (goat meat) (deformation at hardness: 8.52 mJ, adhesiveness: 2.18 mJ, cohesiveness: 2.14, springiness: 6.12 mm, gumminess: 212 g and chewiness: 8.92 mJ), the results showed a significant decrease in hardness (1.8mJ), springiness (1.82mm), chewiness(37mJ) and gumminess(0.7g) by increasing amount of defatted Soy flour (30%), Kabuli Chickpea flour(30%), Mushroom paste (30%) and decreasing amount of Jackfruit flour (10%) in the formulation, whereas increase in deformation at hardness(18.3 mJ) by decreasing amount of defatted Soy flour (16.7%), Kabuli Chickpea flour(16.7%) and increasing amount of Mushroom paste (33.3%) and Jackfruit flour (33.3%) in the formulation, thus it is considered textured meat analogue formulations had meat like texture. Hence formulation S1, S2, S4, S5, S6, S7, S8, S10, S11, S12, S15, S19, S20, S21, S22 and S23 were selected for further screening on the basis of proximate evaluation.

Table 4 : Result of texture profile analysis of meat analogue formulations

Sample Code	Responses					
	Deformation at Hardness	Adhesivenss	Cohesiveness	Springiness	Gumminess	Chewiness
	mm	mJ		Mm	g	mJ
Controlled sample (S0)	8.52	2.18	2.14	6.12	212	8.92
S1	5.2	0.6	1.09	4.1	342	13.7
S2	5.2	0.7	0.52	3.02	142	4.2
S3	5.6	0.5	0.53	2.05	162	3.2
S4	3.9	0.5	0.84	2.84	202	5.6
S5	6.2	0.6	0.72	3.85	254	9.6
S6	2.8	0.2	0.55	3.23	100	3.2
S7	9.2	0.5	0.97	4.15	521	21.2
S8	3.9	0.6	0.87	3.81	209	7.8
S9	3.9	0.5	0.83	3.97	188	7.3
S10	4.8	0.9	1	4.12	340	13.7
S11	3.6	0.4	0.64	3.15	134	4.1
S12	4.7	0.6	0.63	2.09	174	3.6
S13	18.3	0.1	0.29	1.6	328	5.1
S14	5.8	0.8	0.76	4.08	268	10.7
S15	10.2	1.3	1.24	4.35	791	33.7
S16	4.5	0.6	0.41	1.98	101	2
S17	5.6	0.7	0.51	2.84	164	4.6
S18	4.5	0.7	0.4	2.12	96	2
S19	2.1	0.2	0.46	1.95	54	1
S20	2.6	0.4	0.39	1.97	56	1.1
S21	3.3	0.6	0.72	3.44	142	4.8
S22	3.1	0.5	0.51	2.9	87	2.5
S23	1.8	0.4	0.42	1.82	37	0.7
S24	3.1	0.6	0.88	4.06	161	6.4

*mJ: mega Joule, mm: millimeter, g: gram

Figure 1, 2, 3, 4, 5 and 6 is demonstrating the effect of composition of plant based meat sources (defatted Soy flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour) in the formulations on the various textural characteristics (hardness, adhesiveness, cohesiveness, springiness, gumminess and chewiness) of developed meat analogues. The Response surface design plot helped to understand the interactions and influence of the composition of defatted Soya flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour on the various textural parameters (hardness, adhesiveness, cohesiveness, springiness, gumminess and chewiness) which formed the basis for screening the 24 samples to judge and select the said best 16 samples on the basis of various textural parameters.



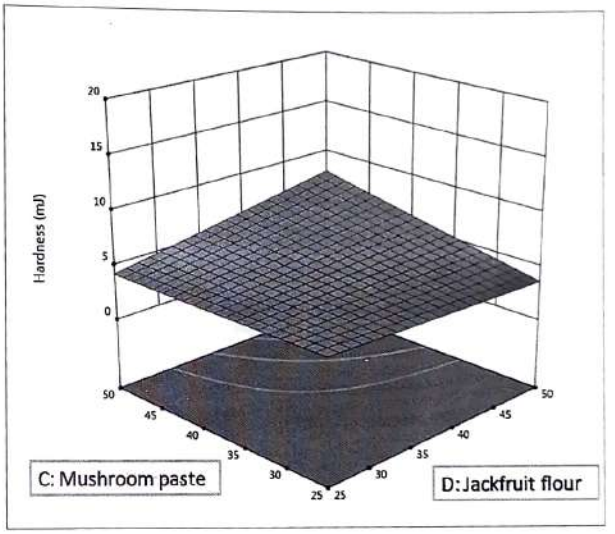
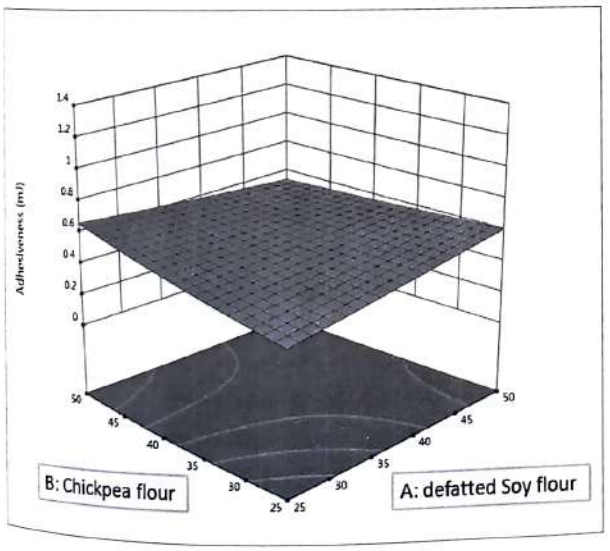


Figure 1: Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on hardness.



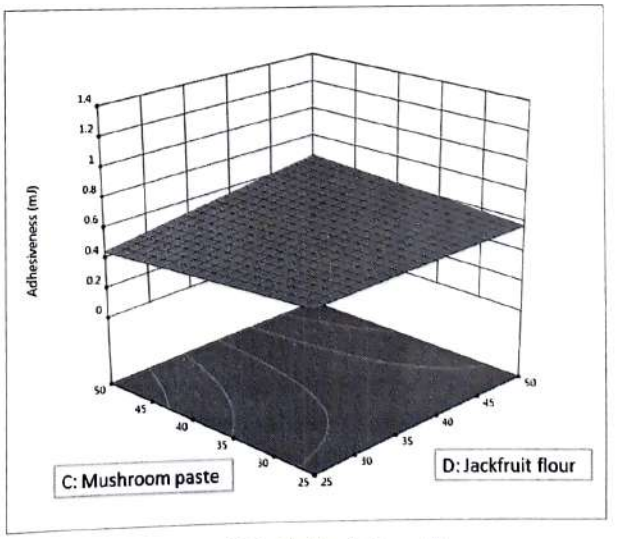


Figure 2: Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on adhesiveness.

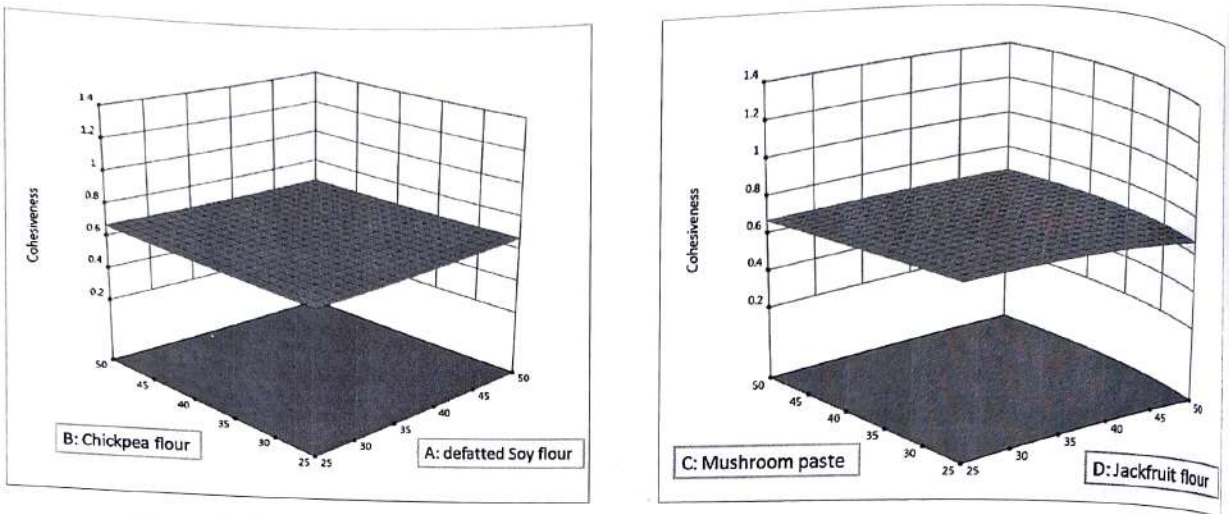


Figure 3: Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on cohesiveness.

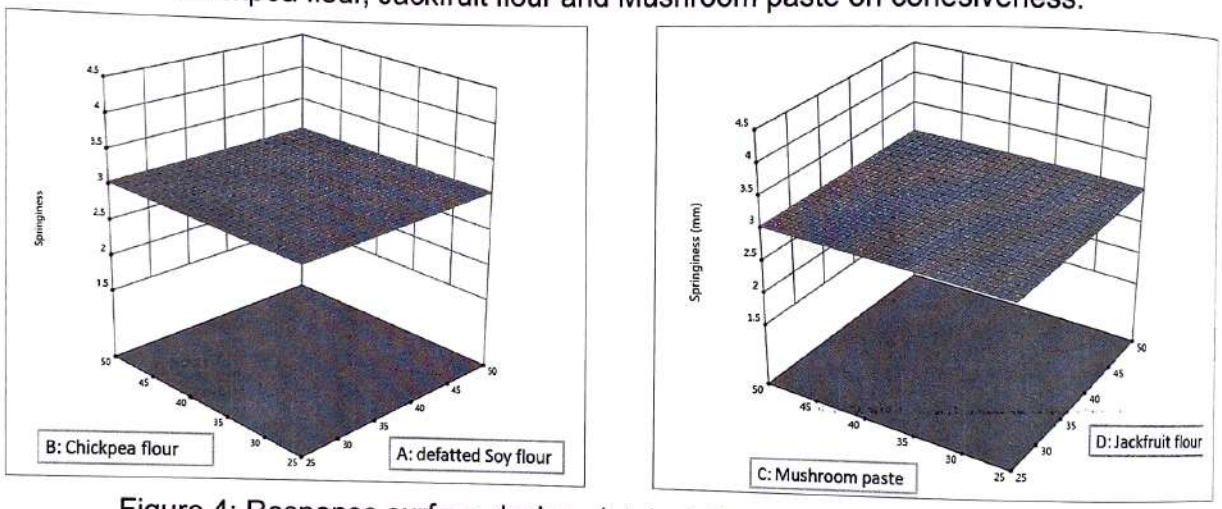


Figure 4: Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on springiness.

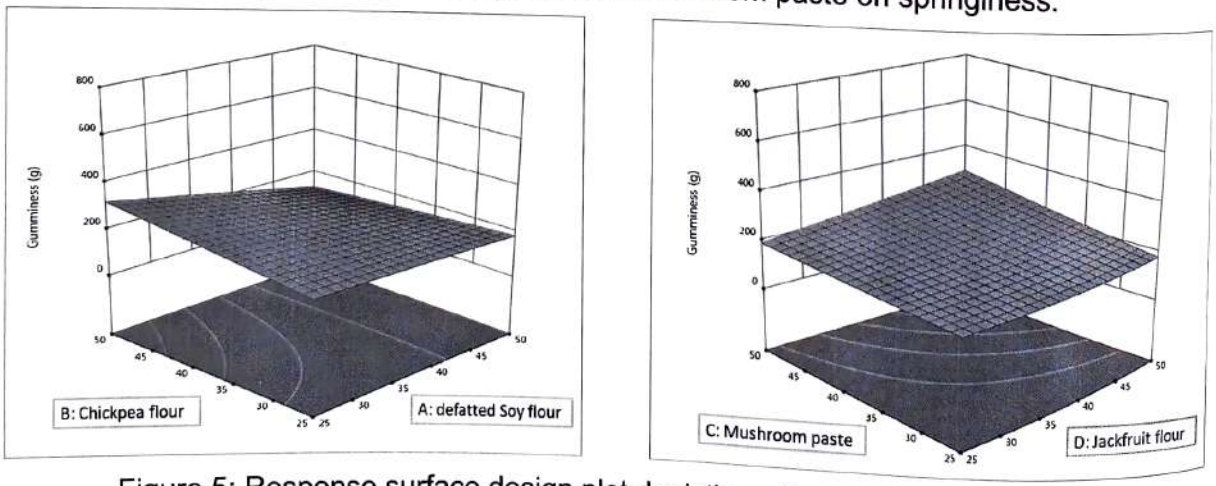


Figure 5: Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on gumminess.

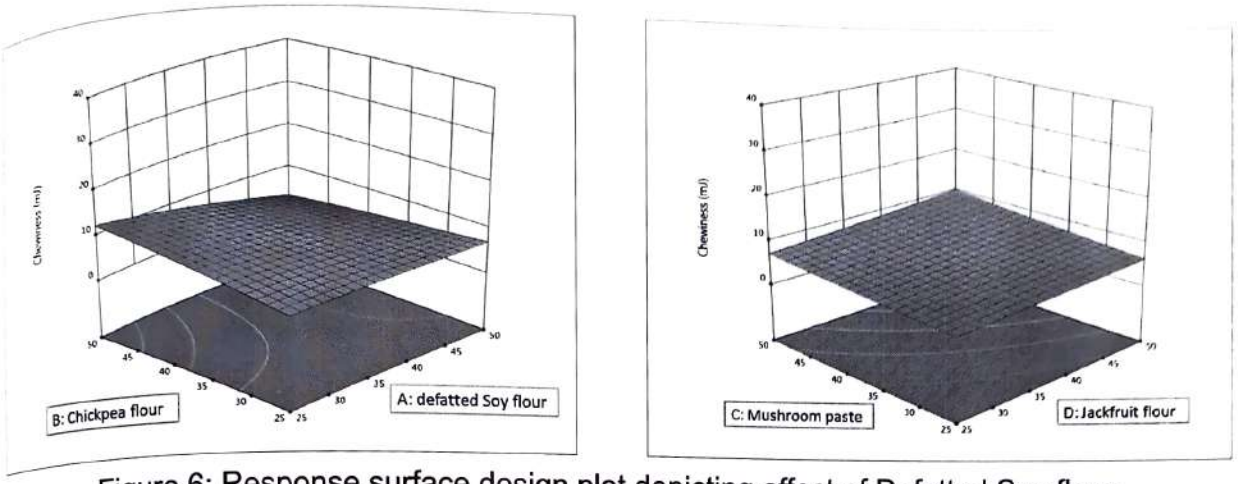


Figure 6: Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on chewiness.

Selection of Meat analogue formulations on the basis of proximate composition

Table 5 is showing proximate analysis result of selected meat analogue formulations (S1, S2, S4, S5, S6, S7, S8, S10, S11, S12, S15, S19, S20, S21, S22, and S23). The result revealed that proximate composition of meat analogue formulations S2, S6, S8, S10, S12, S19, S20 and S22 were closer to proximate composition of controlled sample (goat meat) having protein content: 25.2 %, fiber content: 0.4 % and carbohydrate 23.1 %. As different formulations has variation in amount of protein sources (defatted Soy flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour) the protein content will vary accordingly, because only defatted Soy flour and Kabuli Chickpea flour contains high protein content than Mushroom paste and Jackfruit flour. Hence formulation S2, S6, S8, S10, S12, S19, S20 and S22 were selected for further screening on the basis of sensory evaluation.

Table 5 : Result of proximate analysis of meat analogue formulations

Sr. no.	Sample code	Moisture Content (%)	Protein content (%)	Fat Content (%)	Ash Content (%)	Fiber Content (%)	Carbohydrate (By Difference)
Controlled sample	S0	16.8	25.2	19.4	15.1	0.4	23.1
1	S1	31.27	16.42	0.89	4.09	0.4	46.93
2	S2	38.18	18.35	1.09	2.97	0.1	39.31
3	S4	47.34	16.36	0.29	2.87	0.3	32.84
4	S5	51.8	15.73	0.49	2.89	0.3	28.79
5	S6	51.34	17.72	2.23	2.98	0.4	25.33
6	S7	48.31	15.44	8.94	2.7	0.2	24.41
7	S8	38.31	18.38	2.37	2.9	0.3	37.74
8	S10	48.41	17.97	5.27	3.19	0.5	24.66
9	S11	45.43	15.58	3.87	2.98	1.3	30.84

Sr. no.	Sample code	Moisture Content (%)	Protein content (%)	Fat Content (%)	Ash Content (%)	Fiber Content (%)	Carbohydrate (By Difference)
10	S12	45.9	16.92	4.47	2.08	0.5	30.13
11	S15	51.39	15.35	5.25	5.68	0.5	21.83
12	S19	51.9	19.37	5.09	2.86	0.8	19.98
13	S20	46.51	17.18	4.27	4.17	0.5	27.37
14	S21	48.85	16.84	4.39	2.87	0.5	26.55
15	S22	49.85	18.43	2.48	2.98	0.4	25.86
16	S23	50.79	16.69	5.05	2.09	1	24.38

Figure 7 is demonstrating the effect of composition of plant based meat sources (defatted Soy flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour) in the formulations on the protein content of developed meat analogues. The Response surface design plot helped to understand the interactions and influence of the composition of defatted Soya flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour on the protein content which formed the basis for screening the 16 samples to judge and select the said best 8 samples on the basis of protein content.

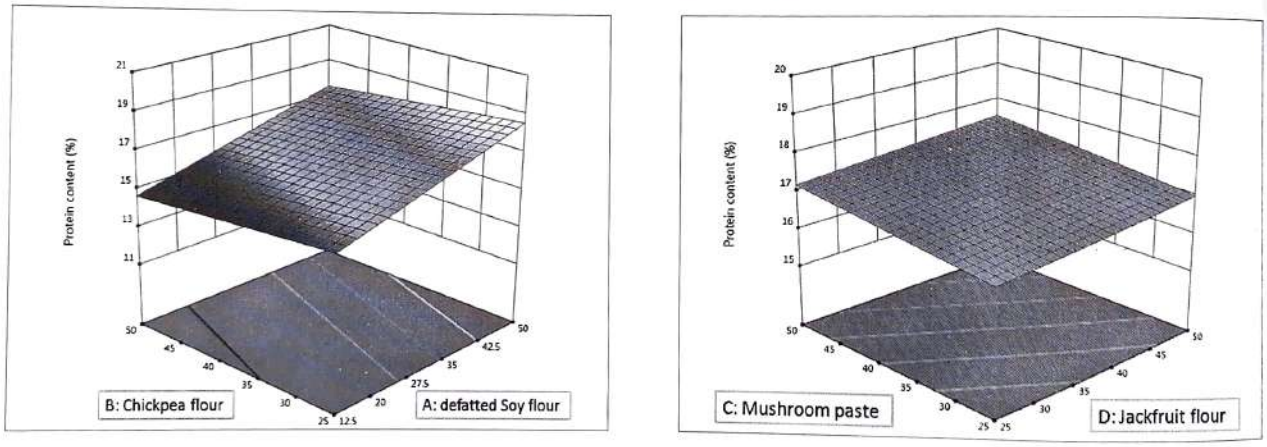


Figure 7: Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on protein content.

Selection of meat analogue formulations on the basis of sensory analysis

Table 6 is representing the sensory evaluation result of selected meat analogue formulations (S2, S6, S8, S10, S12, S19, S20 and S22). It can be seen from the sensory result that the formulated samples S6, S10, S12, and S20 obtain low score as compared to another due to taste and mouthfeel whereas S2, S8, S19 and S20 received satisfactory sensory score as this study was conducted only for optimization and development of meat analogue formulation, flavor and colour were not added in the formulation while texturization resulting low overall score and hence selected for further development as part of future research. On the basis of overall acceptability the ranking of sleeted samples were S19 > S2 > S8 > S22.

Table 6 : Result of sensory evaluation of selected meat analogue formulations

Sr.no.	Sample code	Colour	Taste	Mouthfeel	Texture	Overall Acceptability
1	S2	6±0.47	6.3±0.67	6.1±0.57	6.4±0.52	6.1±0.32
2	S6	5.2±0.63	4.4±0.52	4.2±0.42	5.2±0.63	4.9±0.57
3	S8	6.1±0.57	6±0.67	5.8±0.92	6.3±0.67	6.1±0.57
4	S10	5±0.67	4.6±0.52	4.3±0.48	5.2±0.42	5±0.00
5	S12	5.1±0.74	4.7±0.48	4.3±0.48	5.3±0.67	4.9±0.32
6	S19	6±0.00	6.9±0.32	6.7±0.48	7±0.00	6.9±0.32
7	S20	5.3±0.82	4.5±0.71	4.4±0.52	5.5±0.53	5.1±0.57
8	S22	6±0.00	5.8±0.63	5.7±0.67	6.2±0.42	6±0.00

*Above values are averages of ten determinants ±standard deviation

Figure 8 is demonstrating the effect of composition of plant based meat sources (defatted Soy flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour) in the formulations on the overall acceptability of developed meat analogues. The Response surface design plot helped to understand the interactions and influence of the composition of defatted Soya flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour on the overall acceptability which formed the basis for screening the 8 samples to judge and select the said best 4 samples on the basis of overall acceptability.

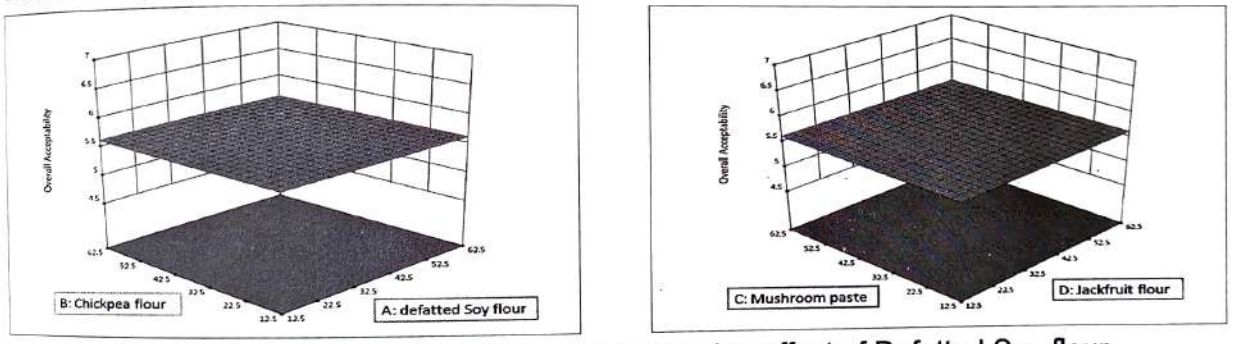


Figure 8 Response surface design plot depicting effect of Defatted Soy flour, Chickpea flour, Jackfruit flour and Mushroom paste on overall acceptability.

CONCLUSION

The present work concludes that the good quality of meat analogue can be prepared from combinations of defatted Soy flour, Kabuli Chickpea flour, Mushroom paste and Jackfruit flour without compromising the protein content, textural and sensory characters in comparison to the control meat (goat meat). Out of 24 formulations developed the meat analogue formulations S2 (defatted Soy flour 40 % + Kabuli chickpea flour 20 % +Mushroom paste 20 % + Jackfruit flour 20 %), S8 (defatted Soy flour 28.6 % + Kabuli chickpea flour 28.6 % + Mushroom paste 28.6 % + Jackfruit flour 14.2 %), S19 (defatted Soy flour 30 % + Kabuli chickpea flour 10 % + Mushroom paste 30 % +Jackfruit flour 30 %), and S22 (defatted Soy flour 21.43 % + Kabuli chickpea flour 21.43 % + Mushroom paste 35.71 % + Jackfruit flour 21.43 %) were better in terms of protein content, texture and sensory. The preferred four meat analogue sample shown ranking as S19> S2> S8> S22. The selected samples S19, S2, S8 and S22 can be the good source of textured protein and can replace meat.

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CONFLICT OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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