Plant Archives **Vol. 25, Special Issue (ICTPAIRS-JAU, Junagadh) Jan. 2025 pp. 859-870**
e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.SP.ICTPAIRS-124

DEVELOPMENT, CHARACTERIZATION AND PHYSICOCHEMICAL EVALUATION OF TOMATO-FORTIFIED *KHAMAN*

Ulpa Patel[1]*, Navneet Kumar[2], V.K. Chandegara[3] and Anurag Singh[4]

[1]Department of Processing and Food Engineering, College of Agricultural Engineering and Technology, Anand Agricultural University, Godhra, Gujarat, India.
[2]Education System Management Division, ICAR - National Academy of Agricultural Research and Management, Hyderabad, Telangana, India.
[3]Department of Processing and Food Engineering, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh, Gujarat, India
[4]Food Technology Department, Harcourt Butler Technical University, Nawabganj, Kanpur, Uttar Pradesh, India.
*Corresponding author E-mail : ulpapatel25@gmail.com

ABSTRACT

Khaman, a traditional food, offers a promising opportunity for fortification with fruit or vegetable pulps to enhance its nutritional value. While traditional foods are already nutritionally rich, the addition of fortified ingredients brings additional health benefits and introduces new flavors to consumers. For this study, tomato pulp was incorporated in the ratio of 80-100 g per 100 g of gram flour, and response surface methodology was utilized to optimize the proportion for achieving a spongy base. The optimized product was prepared using 85.0 g of tomato pulp, 85.4 g of gram flour, 3.0 g of sodium bicarbonate and 2.0 g of salt. To achieve the desired characteristics, the quantities of sugar, mustard seeds, and curry leaves were adjusted to 8 grams of sugar, 3.92 grams of mustard seeds, and 4 grams of curry leaves. The optimized tomato fortified *khaman* exhibited favorable characteristics, including an expansion of 0.25 cm, a density of 0.365 g/cm^3, and specific color values (L*: 28.25, a*: 15.67, b*: 26.23). It showcased a pH of 8.09 and contained 7.25°Brix of Total Soluble Solids (TSS). Additionally, the tomato fortified *khaman* syrup had 21.52% total sugar, 23.65% protein content, and 29.56 mg/100g of ascorbic acid. The acidity was measured at 0.35%. Importantly, the tomato fortified *khaman* received an impressive overall acceptability score of 8.2 on a 9-point hedonic scale, indicating the high approval and satisfaction level among the testers.

Key words : Khaman, Physicochemical characteristics, Tomato pulp.

Introduction

Foods do not satisfy only hunger and satiety feelings but also provide several nutrients to improve overall mental and physical health and protect from clinical diseases. Recently, the development of steamed products using components that have functional properties beyond essential nutrition has been stimulated by consumer desire for healthier meals (Mehta *et al.*, 2018). *Khaman* is a popular Indian snack made from gram flour and steamed, offering low oil content and preserved nutrients, commonly enjoyed as a starter or tea-time treat. Food fortification can enhance traditional recipes with micronutrients and fruit or vegetable pulp, boosting their nutritional value and contributing to the health security of the population. Tomatoes (*Solanum lycopersicum*) have high respiration rates, making them perishable, with 20-50% of produce lost from field to consumption due to their high moisture content (93-95%) (Sinha *et al.*, 2019; Correia *et al.*, 2015). Widely grown in temperate regions, tomatoes are consumed raw, steamed, or cooked in various forms, from salads to sauces. Rich in nutrients like vitamin C, vitamin A, potassium, and lycopene, tomatoes contain antioxidants that help lower the risk of cancers, including prostate and digestive system cancers (Ray *et al.*, 2017). To enhance the nutritional value of traditional khaman, functional khaman was developed by incorporating tomato pulp, which provides positive health benefits. This study optimized tomato pulp incorporation and sugar syrup tempering using the response surface technique, while analyzing the physico-chemical and sensory properties of tomato-fortified khaman.

Materials and Methods

Materials

The ingredients, including gram flour, sodium bicarbonate, semolina, tomatoes (var. *Naveen*), and other essentials were purchased from the local market in Godhra, Gujarat, India. To ensure precise and reliable results, only analytical-grade chemicals were used in testing and evaluation, maintaining the quality of the research findings.

Experimental Design

Optimization of processing parameters and ingredients affecting product quality was carried out using response surface methodology, specifically employing a central composite rotatable design (CCRD) to assess the impact of key factors (Yolmeh and Jafari, 2017). For the spongy base preparation, four independent variables were explored: tomato pulp (80-100%), gram flour (80-100 g), sodium bicarbonate (2-6 g), and salt (1-5 g). Additionally, for sugar syrup preparation, three factors were optimized: sugar (2-10 g), mustard seeds (1-5 g) and curry leaves (1-5 g).

The detailed experimental designs are presented in Tables 1 and 2 for the preparation of the spongy base and sugar syrup, respectively. The following Eq. 1 illustrates how the system performed.

$$Y = \beta_0 + \sum_{j=1}^{K} \beta_j X_j + \sum_{j=1}^{K} \beta_{jj} X_{j2} + \sum_{i=1}^{K} \sum_{i<j}^{K} \beta_{ij} X_i X_j \quad (1)$$

Where, Y is the predicted response, X_i and X_j are variables (i & j = 1 to 4), intercept, linear, quadratic and interaction coefficients are represented as β_0, β_j, β_{jj} and β_{ij}. 3D surface responses were plotted to visualize the predicted response in relation to independent parameters.

Preparation of Tomato Fortified *Khaman*

The oil (10 ml), sugar (5–10 g), and citric acid (3–5 g) were mixed in a bowl, followed by the addition of 15 ml of water, and the mixture was left for 15 minutes. These ingredients were then added to gram flour, salt, and strained tomato pulp as per the formulation in Table 1 and blended with a hand whisker. Sodium bicarbonate was added just before steaming, and the batter was poured into a pre-greased mold, spread to 1.5 cm in height, and steamed for 10-12 minutes. Once cooled, the steamed gram flour sponge was cut into medium-sized cubes.

Sugar Syrup preparation

A tablespoon of oil (15 ml) was heated in a non-stick pan, followed by adding curry leaves and mustard seeds as per Table 2. After the seeds crackled, 500 ml of water and sugar were added, boiled for 3-4 minutes, then cooled to 36-40°C before being poured over the tomato-fortified *khaman*. The *khaman* was left for five minutes to absorb the sugar syrup.

Physico-chemical characteristics

The tomato-fortified *khaman* was analyzed for various physico-chemical properties to optimize both the sponge and sugar syrup ingredients. The characteristics analyzed are given below:

Expansion : The expansion of the batter was measured using a 15 cm scale, following the method by Shobha and Neena (2016). Height was recorded at the center and four corners of the batter and prepared sponge, with the difference between the batter's and sponge's height indicating the expansion.

Density : The volume of tomato-fortified *khaman* was measured using a vernier caliper, and mass was determined with an electronic balance to estimate density (g/cm^3) following Mahajan and Chattopadhyay (2000). Density was calculated by dividing the sample's mass by its volume and the process was repeated three times to obtain an average.

Color : The color of tomato-fortified *khaman* was measured using a colorimeter on the CIE color lab scale, where L* indicates lightness, and positive a* and b* values represent redness and yellowness, respectively (Hemalatha and Lakshmanan, 2021).

Moisture content : Moisture content of the tomato-fortified *khaman* was estimated using the hot air oven method at 105°C until a constant mass was achieved, with three replications for each sample (Kachhadiya *et al.*, 2018).

pH : The pH of the crushed tomato-fortified *khaman* was measured using a digital pH meter, with 10 grams of the sample added to 100 mL of distilled water, following the method by Canali *et al.* (2020) and three replications were performed for each sample.

Total soluble solids : Total soluble solids (TSS) of the tomato-fortified *khaman* were measured using a digital refractometer calibrated with distilled water, where a few drops of the sample were placed on the prism, and TSS values were directly read, ensuring the prism was cleaned before each measurement (Kachhadiya *et al.*, 2018).

Total sugar : Total sugar in the samples was determined using the phenol-sulfuric acid method after crushing 0.1 g of the sample, extracting sugar with methanol, and calculating its concentration using a spectrophotometric technique (Nielsen, 2017).

Protein : The protein content of the *khaman* was estimated using Lowry's method, where the color was developed with Folin-Ciocalteau reagent and measured at 660 nm using a spectrophotometer (Lowry *et al.*, 1951).

Ascorbic acid : The titration method reported by Rangana (2000) was used for determination of ascorbic acid by extracting 5 g tomato fortified *khaman* sample in 4% oxalic acid followed by titration and using suitable dye factor.

Titratable acidity : The titratable acidity of the tomato-fortified *khaman* samples was estimated using the method outlined by Rangana (2000), where the samples were crushed, filtered and titrated against sodium hydroxide.

Overall Acceptability : The overall acceptability (OA) of tomato-fortified *khaman* samples was evaluated using a 9-point hedonic scale by twenty semi-trained panelists from the student and faculty members, who were briefed about the product and presented with coded samples in random order for assessment.

Optimization of the Results : Design Expert software (STAT-EASE Inc., USA) was utilized for regression, response surface analysis and optimization of process parameters, prioritizing key responses through contour plots, with model adequacy validated by experiments on predicted data points.

Results and Discussion

The variation of responses on independent variables for preparation of tomato fortified *khaman* are shown in Table 1. The preparation of sugar syrup is presented in Table 2.

Effect of Independent Variables on Quality Characteristics

Expansion

The expansion of tomato-fortified *khaman* ranged from 2.34 to 2.68 cm, averaging 2.53 cm (Table 1), with a larger quantity of tomato pulp leading to reduced expansion (Fig. 1A). This finding highlights an inverse relationship between tomato pulp quantity and product expansion, impacting gas retention and the leavening action of sodium bicarbonate (Bhat and Ahsan, 2015). Sodium bicarbonate increases expansion in tomato-fortified *khaman* by releasing carbon dioxide, creating a lighter texture and boosting the batter's volume and height during steaming. Similar difference in expansion at lower concentration of sodium bicarbonate in comparison to higher concentration can also be observed from Fig. 2E and Fig. 2F, respectively. The results are in line with the decrease in expansion by the adding tomato pomace powder in cookies as reported by Bhat and Ahsan (2015).

The average expansion of syrup added tomato fortified *khaman* was 0.27cm and it varied from 0.23 to 0.33 cm (Table 2). A higher quantity of sugar was found to cause a decrease in expansion (Fig. 3A). Sugar syrup acted as a plasticizer, improving the softness, flexibility, and texture of tomato-fortified *khaman* by enhancing its sensory attributes (Slade *et al.*, 2021).

Density

The density of tomato-fortified *khaman* ranged from 0.205 to 0.254 g/cm³, averaging 0.235 g/cm³ (Table 1), with higher tomato pulp quantities increasing density due to added moisture (Fig. 1B), while sodium bicarbonate's leavening properties reduced density by promoting aeration and CO_2 release for a lighter texture. Patel *et al*. (2022). Higher density at low concentration of sodium bicarbonate in comparison to higher concentration can also be observed from Fig. 2E and Fig. 2F, respectively.

The average density of syrup added tomato fortified *khaman* 0.369g/cm^3, and it ranged between 0.322 to 0.405 g/cm^3 (Table 2). A higher quantity of sugar was found to cause a decrease in density (Fig. 3B). The increased sugar concentration in the syrup raised the density and reduced expansion by filling pores, limiting water retention in the *khaman*.

Moisture content

The moisture content of tomato-fortified *khaman* ranged from 51.61% to 54.89%, averaging 53.68% (Table 1), with higher tomato pulp quantities increasing moisture due to its water-holding capacity (Fig. 1C)., while sodium bicarbonate also contributed by releasing CO_2 and water during its reaction with citric acid. This highlights the interconnected nature of ingredients in baking, emphasizing the need for bakers and food scientists to consider both individual ingredient properties and their interactions during the process. Mehta *et al.* (2018) reported a similar increase in moisture content when tomato pomace was added to muffins and bread.

The consistent findings across studies highlight the potential of tomato-based ingredients to improve moisture retention in baked goods, which is essential for achieving the desired texture, taste, and shelf life. Moisture

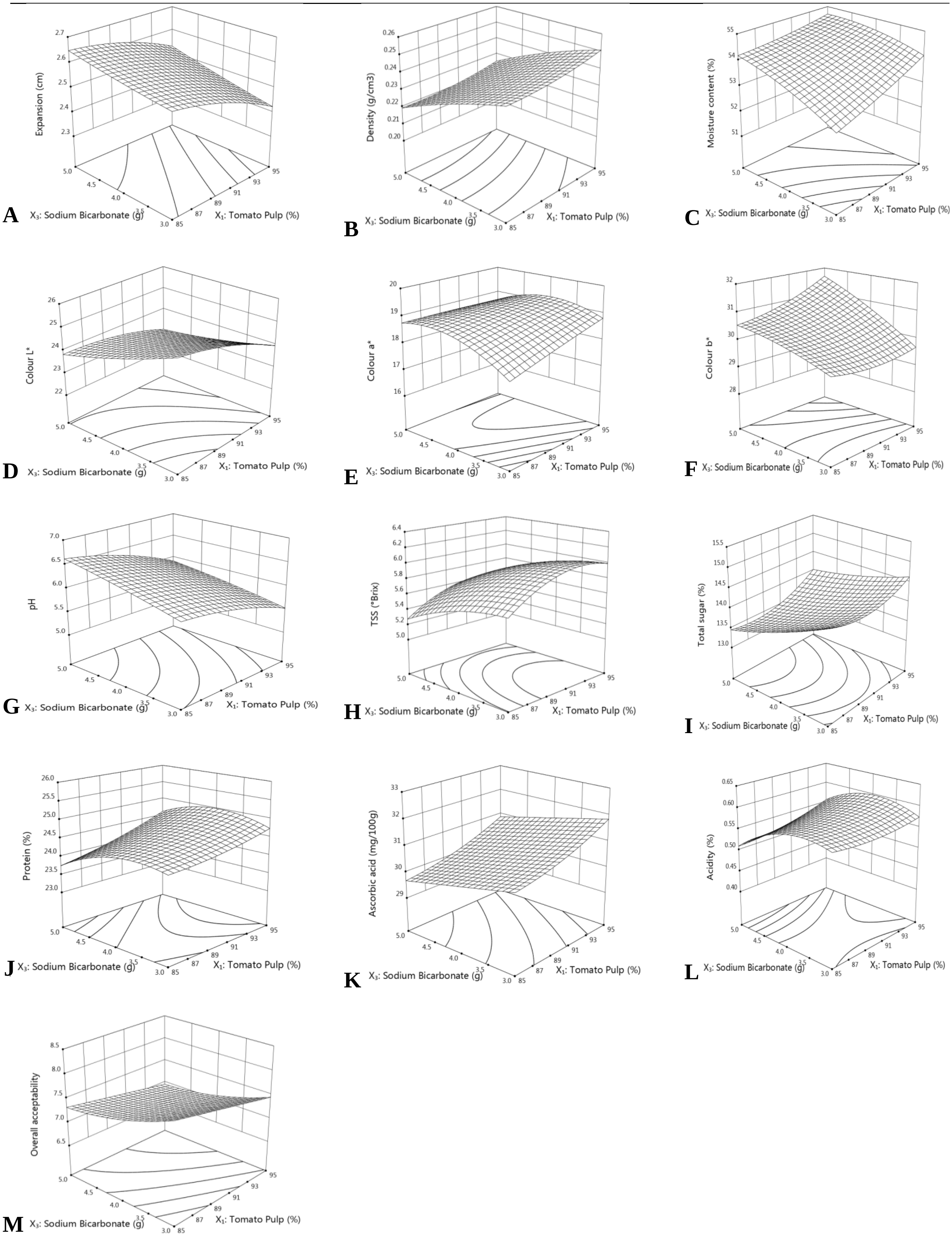

Fig. 1 : Effect of tomato pulp, gram flour, sodium bicarbonate and salt concentration on physicochemical parameter of tomato *khaman*.

significantly influences sensory attributes and the moist, succulent texture of *khaman* can be a key factor in consumer acceptance.

Colour

The colour L*, a*,& b* values of tomato fortified *khaman* varied from 22.20 to 25.87, 16.31 to 19.57 and 28.26 to 31.46,with an average value of 24.05, 18.27 and 29.77 respectively (Table 1). A higher quantity of tomato pulp was found to cause a decrease in colour L* value and an increase in colour a* and b* value (Figs. 1D, 1E, and 1F). The decrease in color L* value and increase in a* and b* values after adding tomato pulp is likely due to the presence of lycopene, carotene, and tomatine, which are strong reddish-yellow antioxidants. Ray *et. al*. (2017). Additionally, sodium bicarbonate further lowers the L* value and raises a* and b* values by accelerating the Maillard reaction, as citric acid promotes sugar hydrolysis, leading to browning during steaming in tomato-fortified *khaman*. Addition of tomato powder conferred similar decrease in colour L* in *dhokla*, muffin and cookies and bread were also reported by Ray *et al.* (2017); Bhat and Ahsan (2015); Tomic *et al.* (2016) and Mehta *et al.* (2018).

The Colour L* of syrup added tomato fortified *khaman* 27.66 and it ranged between 26.03 to 29.49 (Table 2). The L* value indicates either the lightness or darkness of a tomato fortified *khaman* tempered with sugar syrup, with higher L* values indicating a lighter colour. A higher quantity of sugar was found to cause an increment in color L* value (Fig. 3C). The increased brightness in tomato-fortified *khaman* may result from sugar addition, which dilutes the concentration of color pigments in the tomato pulp. The colour a* value of tomato fortified *khaman* tempered with sugar syrup ranged from 14.53 to 16.56, with a 15.56 average value (Table 2).

Redness is represented by the positive value of the a*. A higher quantity of sugar was found to cause a reduction in color a* value (Fig. 3D). The supplementation of sugar reduces the concentration of colour pigments present in tomato fortified *khaman*, which might have resulted in decrease of redness of the tomato fortified *khaman*. The colour b* value of tomato fortified *khaman* tempered with sugar syrup ranged from 26.12 to 27.71, with a 26.94 average value (Table 2). Yellowness is represented by +ve value of b*. A higher quantity of sugar was found to cause a decrease in color b* value (Fig. 3E). Adding sugar to tomato-fortified *khaman* may reduce color pigment concentration, potentially lowering the b* value of the *khaman*'s color.

pH

The pH of tomato-fortified *khaman* ranged from 5.16 to 6.58, averaging 6.01(Table 1), with higher tomato pulp quantities decreasing pH due to ascorbic acid (Fig. 1G), while sodium bicarbonate increased pH by breaking down into sodium carbonate, resulting in a more alkaline steamed product (Patel *et al.,* 2022). Similarly, Chung (2007) observed a trend of pH reduction with tomato powder in cookies, emphasizing the complex interplay of ingredients and their chemical compositions in food formulation.

The pH value of tomato-fortified *khaman* tempered with sugar syrup ranged from 6.05 to 8.26, averaging 7.15 (Table 2), with higher sugar quantities leading to an increase in pH (Fig. 3F). The curry leaves' feebly acidic nature, combined with sugar, create an ideal environment for sodium bicarbonate in tomato-fortified *khaman*, raising the pH and making the solution more alkaline.

Total soluble solids

The TSS of tomato-fortified *khaman* ranged from 5.03 to 6.30 °Brix, averaging 5.68 °Brix (Table 1), with higher tomato pulp quantities increasing TSS due to enhanced soluble solids (Fig. 1H), while sodium bicarbonate decreased TSS by reducing total sugar content. This alteration in TSS may stem from the chemical interactions between sodium bicarbonate and other ingredients, emphasizing the delicate balance of components in baked goods. Patel *et. al.* (2022). The average TSS of syrup added tomato fortified *khaman* was 6.50 °Brix and it ranged between 5.23 to 7.73 °Brix (Table 2). A higher quantity of sugar was found to increase in TSS (Fig. 3G). The addition of sugar syrup increased the concentration of soluble solids and total soluble solids (TSS) in *khaman*, highlighting the significant role of sweetening agents in enhancing the sensory properties of baked goods.

Total sugar

The total sugar content of tomato-fortified *khaman* ranged from 13.12% to 15.36%, averaging 14.26% (Table 1), with higher tomato pulp quantities increasing total sugar (Fig. 1I), thereby enhancing the sweetness profile and sensory appeal for consumers who favor mildly sweet confections. The parallels drawn with the study conducted by Tomic *et al.* (2016), wherein the addition of tomato pomace powder resulted in a similar increase in total sugar content in cookies. The incorporation of sodium bicarbonate raises the batter's pH and leads to a notable decrease in total sugar content. This reduction is attributed to chemical reactions during baking, particularly the fructose-lycine interaction in the elevated pH

Table 1 : Experimental design and Physicochemical and sensory parameters of tomato *khaman*.

Tre. No.	Tomato pulp (%)	Gram flour (g)	Sodium bicarbonate (g)	Salt (g)	Expansion (cm)	Density (g/cm^3)	Moisture content (%)	Colour			pH	TSS (°Brix)	Total sugar (%)	Protein (%)	Ascorbic acid (mg/100g)	Acidity (%)	Sensory
								L*	a*	b*							
1	85	85	3	2	2.64	0.244	51.76	25.21	16.81	28.35	5.49	5.57	14.86	23.50	30.72	0.58	8.2
2	95	85	3	2	2.42	0.248	52.95	24.63	17.8	28.41	5.38	6.10	15.31	23.98	32.75	0.60	8.0
3	85	95	3	2	2.62	0.245	51.61	24.86	18.34	28.30	5.47	5.60	14.74	24.94	29.57	0.47	8.5
4	95	95	3	2	2.40	0.253	53.59	23.64	19.12	28.92	5.29	6.07	14.49	25.35	31.30	0.58	7.5
5	85	85	5	2	2.60	0.218	53.43	23.53	17.81	29.79	6.55	5.23	13.26	23.27	29.57	0.47	6.8
6	95	85	5	2	2.44	0.226	53.71	23.38	17.87	31.35	5.84	6.03	13.31	23.83	31.59	0.45	6.7
7	85	95	5	2	2.66	0.224	54.04	23.24	18.57	29.60	6.50	5.03	13.12	23.87	29.86	0.43	8.2
8	95	95	5	2	2.54	0.223	54.36	23.46	17.75	31.28	5.60	5.53	14.45	25.52	32.17	0.60	7.2
9	85	85	3	4	2.52	0.250	53.74	25.72	16.66	30.160	6.46	5.63	14.26	23.58	31.88	0.62	7.7
10	95	85	3	4	2.40	0.252	54.89	23.51	18.17	29.24	5.47	6.30	15.10	23.86	32.46	0.49	7.4
11	85	95	3	4	2.42	0.246	52.74	25.76	17.93	28.78	6.42	5.67	14.71	24.76	30.72	0.47	7.8
12	95	95	3	4	2.38	0.251	54.62	23.74	18.83	29.37	5.64	5.77	14.34	25.22	32.17	0.49	7.5
13	85	85	5	4	2.64	0.221	54.38	23.58	18.26	29.74	6.48	5.30	13.35	23.72	29.86	0.53	6.7
14	95	85	5	4	2.52	0.224	54.74	22.12	19.57	30.90	5.54	5.47	13.96	23.36	30.43	0.47	7.1
15	85	95	5	4	2.58	0.222	52.89	23.82	18.35	29.56	6.49	5.40	14.70	23.77	29.57	0.47	8.2
16	95	95	5	4	2.52	0.225	54.65	22.20	17.53	30.14	6.37	5.50	15.03	25.27	30.43	0.58	7.5
17	80	90	4	3	2.62	0.229	53.63	24.82	18.41	30.76	6.53	5.03	14.66	24.44	30.72	0.60	7.6
18	100	90	4	3	2.34	0.254	54.83	22.25	19.38	31.46	5.16	5.27	15.36	25.80	32.17	0.64	6.7
19	90	80	4	3	2.46	0.238	53.42	24.27	17.62	28.92	6.34	6.27	14.08	24.07	31.88	0.51	7.3
20	90	100	4	3	2.52	0.234	53.72	24.68	18.93	28.39	6.25	5.57	15.02	25.92	31.30	0.45	7.8
21	90	90	2	3	2.50	0.249	51.66	25.87	16.31	28.26	5.69	5.90	15.00	23.86	31.59	0.49	8.2
22	90	90	6	3	2.68	0.205	54.78	23.86	17.85	31.40	6.58	5.13	13.45	23.12	29.86	0.41	7.0
23	90	90	4	1	2.58	0.23	52.62	23.56	17.46	28.54	5.45	5.77	14.17	24.44	30.43	0.55	7.3
24	90	90	4	5	2.56	0.237	53.45	24.50	18.63	29.42	6.44	6.00	14.15	24.66	31.3	0.53	6.8
25	90	90	4	3	2.54	0.236	53.87	24.47	19.33	30.63	6.20	5.63	13.47	24.59	30.43	0.62	7.5
26	90	90	4	3	2.64	0.239	54.81	24.32	19.26	30.14	6.37	6.10	14.18	25.18	30.43	0.55	7.5
27	90	90	4	3	2.54	0.231	53.21	23.64	18.58	29.42	5.91	6.10	14.01	25.11	31.30	0.58	7.6
28	90	90	4	3	2.5	0.234	54.35	23.96	19.31	30.75	6.35	5.97	14.21	24.56	30.72	0.60	7.0
29																	
30	90	90	4	3	2.64	0.234	54.26	24.77	18.97	30.96	5.88	5.77	13.38	24.11	30.43	0.58	7.4
Avg.	**-**	**-**	**-**	**-**	**2.53**	**0.235**	**53.68**	**24.05**	**18.27**	**29.77**	**6.01**	**5.68**	**14.26**	**24.39**	**30.93**	**0.53**	**7.5**

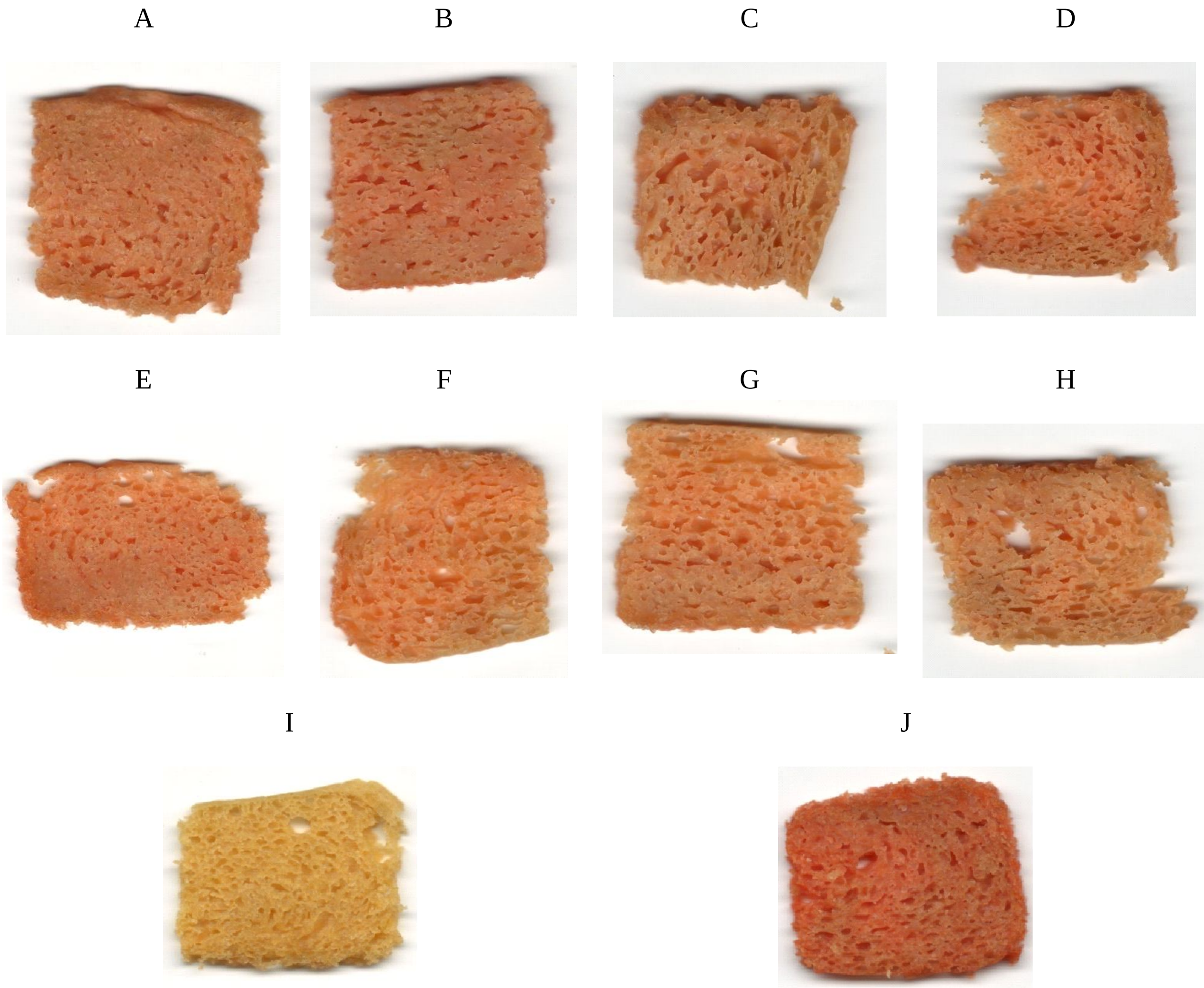

Fig. 2 : **A- B** Effect of tomato pulp concentration (A) 80% (B) 100%; **C-D** Effect of gram flour amount (C) 80 g and (D) 100 g; **E-F-** Effect of sodium bicarbonate concentration (E) 2 g and (F) 8 g; **G-H** Effect of salt concentration (G) 1 g (H) 5 g at central points of remaining factors in the design (Table 1); **I-J** Effect of tomato pulp incorporation(I) ordinary *khaman* (J) tomato pulp based *khaman*.

environment, causing a loss of fructose.

Total sugar in tomato fortified *khaman* tempered with sugar syrup ranged from 20.08 to 22.56%, with a 21.10% average value (Table 2). Notably, a higher quantity of sugar syrup led to a proportional increase in total sugar content, as illustrated in Fig. 3H. This correlation emphasizes sugar's crucial role in defining the sweetness profile of baked goods, with sugar syrup enhancing sensory sweetness perception.

Protein

The protein content in tomato-fortified *khaman* ranged from 23.12% to 25.92%, averaging 24.39% (Table 1), with higher tomato pulp quantities increasing protein levels due to the inherent protein in the pulp (Fig. 1J)., enhancing both the nutritional profile and the textural attributes of the *khaman*, similar to findings with tomato pomace powder in cookies was also reported by Bhat and Ahsan (2015). An increase in sodium bicarbonate concentration notably decreased protein content, as described by Damodaran and Parkin (2017). This reduction is due to higher pH levels that cause protein molecules to expand and unfold, leading to denaturation through intra-molecular electrostatic repulsion.

The protein of tomato fortified *khaman* tempered with sugar syrup ranged from 21.35 to 23.65%, with a 22.45% average value (Table 2). A higher quantity of sugar was found to cause a decrease in protein (Fig. 3I). The reduction in protein content is due to protein denaturation caused by high sugar concentrations and heat during baking, as noted by Oshima and Kinoshita (2013). This combined effect leads to a significant decrease in overall protein levels.

Ascorbic acid

The ascorbic acid content in tomato-fortified *khaman*

Table 2 : Experimental design and Physicochemical and sensory parameters for tomato *khaman* with tempering sugar syrup.

Tre No.	Sugar (g) Uncoded (Coded)	Mustard seed (g) Uncoded (Coded)	Curry leaves (g) Uncoded (Coded)	Expansion (cm)	Density (g/cm³)	Colour L*	Colour a*	Colour b*	pH	TSS (°Brix)	Total sugar (%)	Protein (%)	Ascorbic acid (mg/100g)	Acidity (%)	Sensory
1	4 (-1)	2 (-1)	2 (-1)	0.28	0.401	26.26	15.67	27.68	7.34	6.23	20.68	23.6	29.86	0.41	8.3
2	8 (1)	2 (-1)	2 (-1)	0.25	0.322	27.41	14.55	27.16	8.25	7.27	22.05	21.36	28.41	0.34	8.2
3	4 (-1)	4 (1)	2 (-1)	0.28	0.403	27.04	15.63	26.8	6.75	6.13	20.13	22.87	28.7	0.49	7.2
4	8 (1)	4 (1)	2 (-1)	0.25	0.365	28.25	15.58	26.54	6.98	7.73	22.11	22.46	28.41	0.36	7.5
5	4 (-1)	2 (-1)	4 (1)	0.3	0.377	26.85	15.56	27.24	6.12	6.30	21.36	22.95	30.43	0.43	8.0
6	8 (1)	2 (-1)	4 (1)	0.23	0.373	29.37	14.59	26.12	6.75	7.63	22.1	21.67	29.28	0.34	8.6
7	4 (-1)	4 (1)	4 (1)	0.30	0.361	27.08	15.69	27.08	6.86	6.70	21.51	23.42	29.86	0.45	7.3
8	8 (1)	4 (1)	4 (1)	0.25	0.359	28.19	15.71	26.18	8.26	7.50	21.45	23.62	29.57	0.34	8.2
9	2.64 (-	3 (0)	3 (0)	0.33	0.405	27.26	15.68	27.71	6.05	5.23	20.08	23.65	30.43	0.51	7.1
10	9.36 (1.68)	3 (0)	3 (0)	0.23	0.352	29.49	14.53	26.47	8.08	7.67	22.56	21.35	28.12	0.3	8.0
11	6 (0)	1.32 (-1.68)	3 (0)	0.23	0.361	26.03	14.56	26.68	7.72	6.77	22.48	21.49	29.57	0.38	8.1
12	6 (0)	4.68 (1.68)	3 (0)	0.25	0.37	26.16	15.72	26.41	8.11	5.90	22.06	23.63	29.57	0.49	7.3
13	6 (0)	3 (0)	1.32 (-1.68)	0.30	0.377	26.81	15.63	27.28	6.63	7.07	20.16	21.88	28.99	0.43	8.0
14	6 (0)	3 (0)	4.68 (1.68)	0.30	0.367	27.53	15.68	26.51	6.12	6.43	20.21	23.52	30.14	0.41	8.2
15	6 (0)	3 (0)	3 (0)	0.25	0.375	27.76	16.56	27.26	7.64	5.57	20.12	21.77	29.86	0.47	8.1
16	6 (0)	3 (0)	3 (0)	0.28	0.356	28.49	15.7	27.34	6.64	5.87	20.16	21.42	30.14	0.45	7.6
17	6 (0)	3 (0)	3 (0)	0.25	0.374	28.34	15.64	27.56	7.38	6.20	20.75	22.15	29.86	0.43	8.0
18	6 (0)	3 (0)	3 (0)	0.28	0.361	28.16	16.45	26.78	6.55	5.40	20.46	22.35	28.99	0.49	8.3
19	6 (0)	3 (0)	3 (0)	0.25	0.354	27.64	15.72	26.66	7.16	6.10	21.19	21.46	29.28	0.43	7.5
20	6 (0)	3 (0)	3 (0)	0.25	0.359	29.11	16.35	27.26	7.53	6.30	20.29	22.38	29.57	0.53	7.6
Avg	-	-	-	**0.27**	**0.369**	**27.66**	**15.56**	**26.94**	**7.15**	**6.50**	**21.10**	**22.45**	**29.45**	**0.42**	**7.9**

ranged from 29.57 to 32.75 mg/100g, averaging 30.93 mg/100g (Table 1), with higher tomato pulp quantities leading to increased ascorbic acid levels due to the high ascorbic acid content in tomatoes (Fig. 1K), enhancing the *khaman*'s nutritional and antioxidant properties (Ali *et al.*, 2020). Ray *et al*. (2017) also reported similar increase in ascorbic acid by addition of tomato powder in dhokla. The addition of sodium bicarbonate significantly decreased ascorbic acid content, as noted by Damodaran and Parkin (2017), due to the hydrolysis of L-dehydroascorbic acid (DHAA) to 2,3-diketogulonic acid in alkaline conditions. The stability of DHAA decreases as pH increases, thereby leading to a reduction in ascorbic acid content.

The ascorbic acid content in tomato-fortified *khaman* tempered with sugar syrup ranged from 28.12 to 30.43 mg/100g, averaging 29.45 mg/100g (Table 2), with higher sugar quantities resulting in decreased ascorbic acid levels due to the dilution effect of sugar (Fig. 3J). As a result, the incorporation of sugar syrup leads to lower levels of ascorbic acid in the final product.

Acidity

The acidity of tomato-fortified *khaman* ranged from 0.41 to 0.64%, averaging 0.53% (Table 1), with a higher quantity of tomato pulp resulting in increased acidity (Fig. 1L), likely due to the citric and malic acids present in the pulp. Ray *et al.* (2017). These organic acids impart a tangy flavor profile to the *khaman*, thereby enhancing its sensory appeal and complexity. The results are in line with the acidity increase by adding tomato powder in *dhokla* was also reported by Ray *et al.* (2017). The addition of sodium bicarbonate decreased acidity by raising the pH of the tomato-fortified *khaman*. Its alkaline nature neutralizes the acidity, leading to a milder flavor and a more balanced sensory experience for consumers.

The average acidity of syrup-added tomato-fortified *khaman* was 0.42%, ranging from 0.30 to 0.51% (Table 2), with a higher quantity of sugar leading to decreased acidity due to the diluting effect of sugar on acidic compounds in the *khaman* (Fig. 3K). This results in a milder and sweeter flavor profile for the tomato fortified *khaman*.

Table 3: Analysis of variance for physicochemical and sensory parameter for tomato *khaman*

Description	Expansion F	Expansion P	Density F	Density P	Moisture content F	Moisture content P	Colour L* F	Colour L* P	Colour a* F	Colour a* P	Colour b* F	Colour b* P	pH F	pH P
x_1 (Tomato pulp)	60.23	1x10^{-4}	21.06	4x10^{-4}	21.21	3x10^{-4}	47.55	1x10^{-4}	10.62	5.3x10^{-3}	11.28	4.3x10^{-3}	41.81	1x10^{-4}
x_2(Gram flour)	0.08	0.78	4.7x10^{-3}	0.95	0.04	0.85	4.6x10^{-3}	0.95	11.51	4x10^{-3}	2.32	0.15	0.11	0.74
x_3(Sodium bicarbonate)	25.79	1x10^{-4}	272.73	1x10^{-4}	26.20	1x10^{-4}	58.74	1x10^{-4}	8.17	0.01	72.88	1x10^{-4}	22.91	2x10^{-4}
x_4 (Salt)	3.31	0.09	1.80	0.20	13.02	2.6x10^{-3}	0.03	0.86	3.96	0.07	3.32	0.09	16.76	1x10^{-3}
$x_1.x_2$	1.12	0.31	1.8x10^{-3}	0.97	2.18	0.16	0.02	0.89	6.83	0.02	0.97	0.34	0.67	0.43
$x_1.x_3$	0.67	0.42	0.22	0.65	3.02	0.10	3.24	0.09	9.22	0.01	8.00	0.01	0.42	0.53
$x_1.x_4$	4.97	0.04	0.31	0.59	0.48	0.50	11.05	4.6x10^{-3}	1.66	0.22	2.35	0.15	0.97	0.34
$x_2.x_3$	2.33	0.15	0.04	0.85	0.05	0.82	0.49	0.49	17.27	8x10^{-4}	0.06	0.81	0.32	0.58
$x_2.x_4$	3.10	0.10	0.70	0.41	5.30	0.04	1.62	0.22	5.74	0.03	2.13	0.16	2.11	0.17
$x_3.x_4$	4.97	0.04	0.26	0.62	6.12	0.03	1.84	0.19	2.23	0.16	10.29	0.01	4.36	0.05
x_1^2	8.08	0.01	7.29	0.02	0.57	0.46	7.84	0.01	0.13	0.72	6.01	0.03	4.94	0.04
x_2^2	6.43	0.02	0.65	0.43	0.94	0.35	0.02	0.90	6.63	0.02	29.21	1x10^{-4}	0.08	0.79
x_3^2	0.29	0.60	6.13	0.03	3.54	0.08	1.82	0.20	46.86	1x10^{-4}	2.70	0.12	0.38	0.55
x_4^2	0.01	0.94	0.01	0.93	5.62	0.03	1.58	0.23	11.54	4x10^{-3}	19.05	6x10^{-4}	2.78	0.12
R^2	0.8897		0.9543		0.8540		0.9013		0.8986		0.9192		0.8671	
Adjusted R^2	0.7868		0.9117		0.7177		0.8091		0.8040		0.8438		0.7431	
Adeq. Precision	11.0634		19.4935		9.9233		13.0907		11.7012		11.8249			

Description	TSS F	TSS P	Total sugar F	Total sugar P	Protein F	Protein P	Ascorbic acid F	Ascorbic acid P	Acidity F	Acidity P	Sensory F	Sensory P
x_1 (Tomato pulp)	15.73	1.2x10^{-3}	6.20	0.03	15.54	1.3x10^{-3}	49.45	1x10^{-4}	7.07	0.02	14.61	1.7x10^{-3}
x_1 (Gram flour)	6.29	0.02	5.28	0.04	46.10	1x10^{-4}	5.06	0.04	5.19	0.04	13.47	2.3x10^{-3}
x_2 (Sodium bicarbonate)	24.89	2x10^{-4}	30.46	1x10^{-4}	4.29	0.06	31.68	1x10^{-4}	17.45	8x10^{-4}	25.46	1x10^{-4}
x_3 (Salt)	0.10	0.76	1.12	0.31	0.02	0.89	0.71	0.41	0.58	0.46	2.83	0.11
$x_1.x_2$	1.59	0.23	0.40	0.54	3.62	0.08	0.48	0.50	42.40	8110^{-4}	6.87	0.02
$x_1.x_3$	0.07	0.80	1.31	0.27	1.16	0.30	5x10^{-06}	1.00	3.46	0.08	0.14	0.71
$x_1.x_4$	2.70	0.12	0.01	0.91	0.57	0.46	7.62	0.01	13.85	2x10^{-3}	1.72	0.21
$x_2.x_3$	0.01	0.93	10.52	0.01	0.47	0.50	7.59	0.01	21.63	3x10^{-4}	12.66	2.9x10^{-3}
$x_2.x_4$	0.22	0.65	2.03	0.17	0.14	0.72	5x10^{-06}	1.00	0.87	0.37	0.14	0.71
$x_3.x_4$	0.05	0.82	7.30	0.02	1.1x10^{-14}	1.00	11.87	3.6x10^{-3}	7.79	0.01	5.05	0.04
x_1^2	23.52	0.76	15.83	1.2x10^{-3}	1.06	0.32	5.07	0.04	4.99	0.04	-	1.00
x_2^2	0.05	0.82	5.32	0.04	0.38	0.55	7.34	0.02	32.31	1x10^{-4}	3.85	0.07
x_3^2	5.87	0.03	1.26	0.28	18.48	6x10^{-4}	2.7x10^{-07}	1.00	56.41	1x10^{-4}	4.87	0.04
x_4^2	3.5x10^{-3}	0.95	0.79	0.39	0.70	0.42	0.20	0.66	4.12	0.06	0.24	0.63
R^2	0.8426		0.8480		0.8631		0.8934		0.9347		0.8596	
Adjusted R^2	0.6957		0.7061		0.7353		0.7940		0.8738		0.7286	
Adeq. Precision	9.7829		10.0342		9.3589		10.4235		10.2289		9.4906	

Overall acceptability

The overall acceptability of tomato-fortified *khaman* ranged from 6.7 to 8.5, with an average of 7.5 (Table 1), and the optimal combination of 85% tomato pulp, 3 g sodium bicarbonate, 95 g gram flour, and 2 g salt yielded the highest acceptability, highlighting the influence of tomato pulp and sodium bicarbonate on panelists' preferences. Higher quantities of tomato pulp and sodium bicarbonate led to decreased overall acceptability (Fig. 1M), with the 85% tomato pulp sample performing better than the 95% variant due to a stronger sour taste and darker color, while excessive sodium bicarbonate contributed a bitter taste that further reduced acceptability.

The average acceptability for all sugar-added samples was 7.9, ranging from 7.1 to 8.6 (Table 2), with the highest overall acceptability observed for the combination of 8 g sugar, 2 g mustard seeds, and 4 g curry leaves, highlighting the importance of sensory measurements in product acceptance and the impact of sugar concentration on panelists' preferences in tomato-fortified *khaman*. The sample with 8 g of sugar outperformed the one with 4 g, indicating that a higher sugar quantity increases overall acceptability (Fig. 3L), while higher concentrations of mustard seeds led to a decrease in overall acceptance.

Modelling and Tomato Fortified *Khaman* optimization

The independent variables, including tomato pulp, gram flour, sodium bicarbonate and salt, were optimized using Design Expert software. The statistical parameters of developed quadratic models for describing the behaviour of responses, R^2 ranged between 0.8426 to 0.9543, adjusted R^2 ranged between 0.6957 to 0.9117 and adequate precision ranged between 9.3589 to 19.4935 (Table 3). The models developed can be used for prediction of various responses viz. expansion, density, moisture content, colour- L*, a* and b* values, pH, TSS,

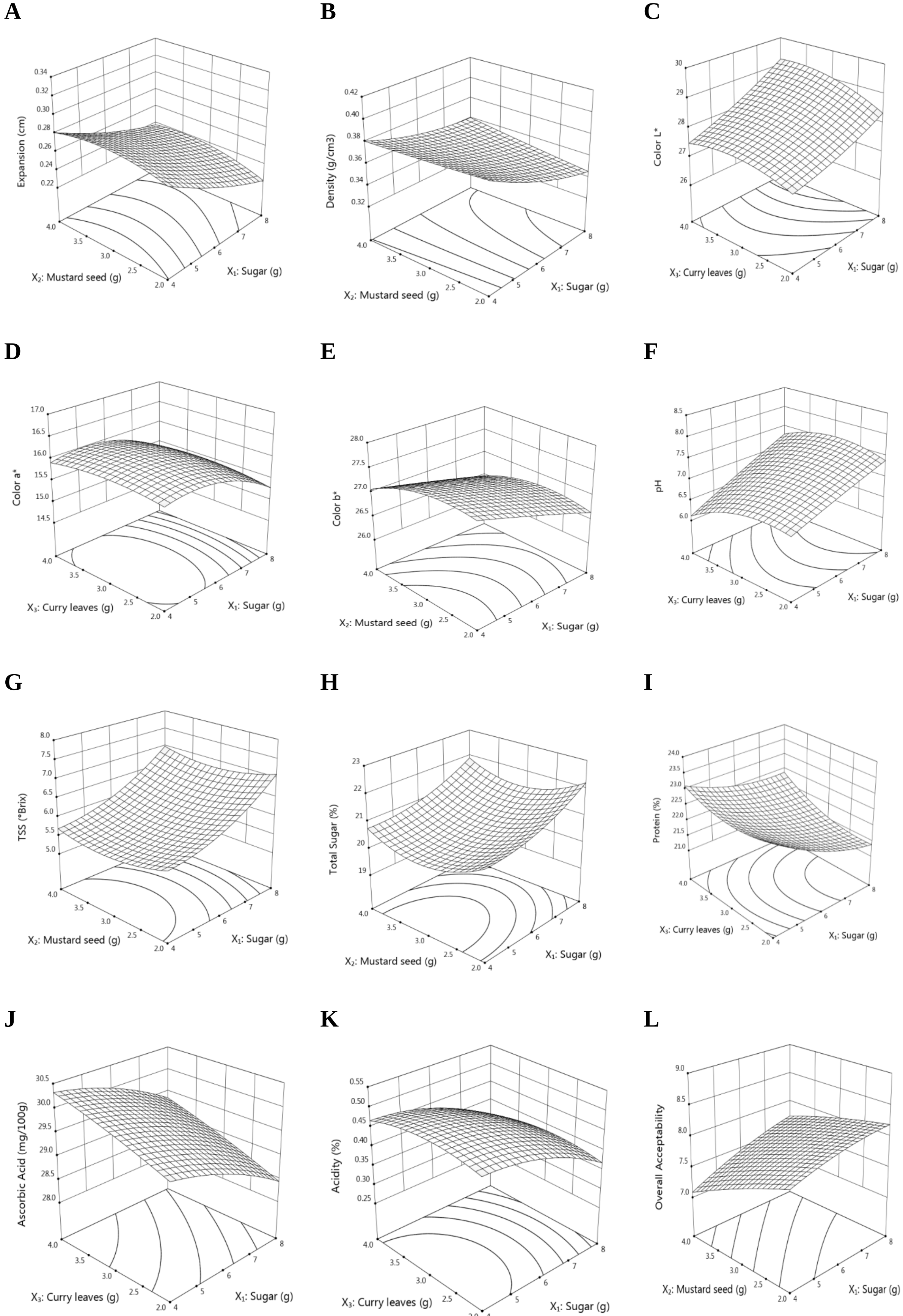

Fig. 3 : Effect of sugar, mustard seed and curry leaves concentration on physicochemical parameter of tomato *khaman* with tempering sugar syrup.

total sugar, protein, ascorbic acid, acidity and overall acceptability. The main objective of the experiment was to increase the expansion, protein content, ascorbic acid content, and overall acceptance scores of the product. The optimized solution was tomato pulp at 85%, gram flour at 85g, sodium bicarbonate at 3g, and salt at 2 g, with the highest desirability value of 0.70. At the optimized conditions, the tomato fortified *khaman* exhibited the following characteristics: expansion of 2.63 cm, density of 0.241 g/cm^3, moisture content of 51.76%, color values (L*: 25.11, a*: 16.48, b*: 28.40), pH of 5.60, total soluble solids (TSS) at 5.61°Brix, total sugar content of 15%, protein content of 23.80%, ascorbic acid content of 30.64 mg/100g, acidity of 0.60% and an impressive overall acceptability score of 8.2. The colour of tomato fortified *khaman* was more reddish in comparison to conventional *khaman* too (Fig. 2I and Fig. 2J). These values indicate the successful optimization of independent variables using Design Expert software, resulting in a tomato-fortified *khaman* with desirable characteristics and high consumer acceptance, as the experimental values aligned closely with the predicted values, remaining within 10% of the actual results.

Modelling and Tempering Sugar Syrup optimization

For optimization of tempering sugar syrup, a tomato fortified *khaman* made with an optimized proportion of ingredients was taken. Using design expert software, the independent variables were numerically optimized. The statistical parameters of developed quadratic models for describing the behaviour of responses, R^2 ranged between 0.8277to 0.9146, adjusted R^2 ranged between 0.6726to 0.8378 and adequate precision ranged between 6.9235 to 14.6645 (Table 4). The models developed can be used for prediction of various responses viz. expansion, density, moisture content, colour-L*, a* and b* values, pH, TSS, total sugar, protein, ascorbic acid, acidity and overall acceptability. Increasing the expansion, protein, ascorbic acid, acidity and overall acceptance scores was the experiment's goal. In the optimization process, the syrup prepared with 8g of sugar, 4g of mustard seeds and 4g of curry leaves resulted in the highest desirability

Table 4:Analysis of variance for physicochemical and sensory parameter for tomato *khaman* with tempering sugar syrup

Description	F	*P*	F	*P*	F	*P*	F	*P*	F	*P*	F	*P*
	Expansion		Density		Colour L*		Colour a*		Colour b*		pH	
x_1 (Sugar)	65.16	1x10^{-4}	53.07	1x10^{-4}	30.37	3x10^{-4}	12.19	5.8x10^{-3}	26.49	4x10^{-4}	21.37	9x10^{-4}
x_2 (Mustard seed)	2.49	0.15	1.02	0.34	0.25	0.63	13.03	4.8x10^{-3}	4.68	0.06	0.54	0.48
x_3 (Curry leaves)	0.35	0.57	1.59	0.24	4.48	0.06	0.03	0.86	9.05	0.01	2.36	0.16
$x_1.x_2$	0.59	0.46	3.70	0.08	1	0.34	5.37	0.04	0.44	0.52	6.8x10^{-3}	0.94
$x_1.x_3$	5.31	0.0	24.66	6x10^{-4}	0.88	0.37	0.06	0.81	2.91	0.12	0.67	0.43
$x_2.x_3$	0.59	0.46	11.22	7.4x10^{-3}	3.61	0.09	0.09	0.78	3.71	0.08	14.21	3.7x10^{-3}
x_1^2	2.34	0.16	5.76	0.04	1.06	0.33	14.58	3.4x10^{-3}	0.04	0.84	0.04	0.85
x_2^2	8.10	0.02	0.04	0.84	28.81	3x10^{-4}	13.46	4.3x10^{-3}	9.30	0.01	7.63	0.02
x_3^2	19.76	1.2x10^{-4}	1.49	0.25	5.53	0.04	2.16	0.17	1.49	0.25	6.76	0.03
R^2	0.9146		0.9107		0.8834		0.8506		0.8518		0.8466	
Adjusted R^2	0.8378		0.8304		0.7785		0.7161		0.7184		0.7085	
Adeq. Precision	11.0290		14.6645		11.2153		7.2585		9.2054		8.6862	

Description	F	*P*	F	*P*	F	*P*	F	*P*	F	*P*	F	*P*
	TSS		Total sugar		Protein		Ascorbic acid		Acidity		Sensory	
x_1 (Sugar)	28.93	3x10^{-4}	34.91	1x10^{-4}	24.11	6x10^{-4}	25.68	5x10^{-4}	33.76	2x10^{-4}	13.11	4.7x10^{-3}
x_2 (Mustard seed)	0.25	0.63	1.49	0.25	16.99	2.1x10^{-3}	1.07	0.32	5.78	0.04	22.63	8x10^{-4}
x_3 (Curry leaves)	0.03	0.86	1.22	0.29	7.08	0.02	16.71	2.2x10^{-3}	0.38	0.55	1.83	0.21
$x_1.x_2$	7x10^{-4}	0.98	0.03	0.86	7.82	0.02	3.59	0.09	0.76	0.40	1.03	0.33
$x_1.x_3$	0.16	0.70	6.32	0.03	1.74	0.22	0.07	0.79	-	1	3.61	0.09
$x_2.x_3$	6.3x10^{-3}	0.94	1x10^{-4}	0.99	2.98	0.12	0.66	0.44	0.76	0.40	0.67	0.43
x_1^2	5.47	0.04	10.26	9.5x10^{-3}	4.29	0.07	2.29	0.16	8.16	0.02	1.10	0.32
x_2^2	3.97	0.07	43.53	1x10^{-4}	5.18	0.05	0.24	0.64	2.61	0.14	0.29	0.60
x_3^2	10.51	8.8x10^{-3}	0.73	0.41	7.44	0.02	0.24	0.64	5.97	0.03	3.24	0.10
R^2	0.8223		0.9067		0.8822		0.8341		0.8476		0.8277	
Adjusted R^2	0.6623		0.8227		0.7762		0.6848		0.7105		0.6726	
Adeq. Precision	6.9235		9.3493		9.3081		8.2364		8.4247		7.4947	

value of 0.80. The tomato fortified *khaman* tempered with sugar syrup, based on this optimized formulation, exhibited the following characteristics: an expansion of 0.25cm, a density of 0.365g/cm^3, color values (L*: 28.25, a*: 15.67, b*: 26.23), a pH of 8.09, and 7.25°Brix of Total Soluble Solids (TSS). The tomato fortified *khaman* tempered with sugar syrup contained 21.52% total sugar, 23.65% protein, and 29.56 mg/100g of ascorbic acid. Its acidity was measured at 0.35%. Moreover, the *khaman* received a high overall acceptability score of 8.2, indicating favorable taste and sensory attributes. The achievement of these optimized responses demonstrates the successful attainment of the intended product characteristics during the optimization process. The sample of tomato fortified *khaman* tempered with sugar syrup was prepared at the optimized conditions to validate the model. The experimental values were found in coherence to the predicted values and remained within 5% to actual values.

Conclusion

This investigation demonstrated that tomato pulp, sodium bicarbonate, gram flour and salt significantly affected all selected responses. To retain maximum expansion, protein, ascorbic acid, and sensory qualities, the optimized amounts of tomato pulp, gram flour, sodium bicarbonate and salt were determined as 85%, 85g, 3g, and 2g, respectively. For tempering the sugar syrup, the optimized values of sugar concentration, mustard seeds, and curry leaves were found to be 8g, 4g and 4g, respectively, with a best fit desirability of 0.80. The recommended approach can create value-added products with enhanced nutritional benefits compared to traditional *khaman*, while the appealing light red color of tomato fortified *khaman* contributes to consumer acceptance. Moreover, this strategy promotes increased utilization of nutritional products and market diversification.

Acknowledgement

The authors are grateful to Anand Agricultural University, Anand for providing facilities for conducting the research.

References

Ali, M.Y., Sina A.A., Khandker S.S., Neesa L., Tanvir E.M., Kabir A., Khalil M.I. and Gan S.H. (2020). Nutritional composition and bioactive compounds in tomatoes and their impact on human health and disease: A review. *Foods*, **10(1)**, 1-32.

Bhat, M.A. and Ahsan H. (2015). Physico-chemical characteristics of cookies prepared with tomato pomace powder. *J. Food Process Technol.*, **7**, 1-4.

Canali, G., Balestra F., Glicerina V., Pasini F., Caboni M.F. and Romani S. (2020). Influence of different baking powders on physico-chemical, sensory and volatile compounds in biscuits and their impact on textural modifications during soaking. *J. Food Sci. Technol.*, **57**, 3864-3873.

Chung, H.J. (2007). Quality attributes of cookies prepared with tomato powder. *J. Food Sci. Nutr.*, **12**, 229-233.

Correia, A.F.K., Loro A.C., Zanatta S. and Spoto M.H.F. (2015). Effect of temperature, time, and material thickness on the dehydration process of tomato. *Int. J. Food Sci.*, 1-7.

Damodaran, S. and Parkin K.L. (2017). *Fennema's Food Chemistry* (5th ed.). London, New York: Boca Raton.

Hemalatha, G. and Lakshmanan S.S. (2021). Enhancing the nutritional, textural and sensory characteristics of horsegram dhokla mix. *Int. J. Curr. Microbiol. Appl. Sci.*, **10**, 1267-1275.

Kachhadiya, S., Kumar N. and Seth N. (2018). Process kinetics on physico-chemical and peroxidase activity for different blanching methods of sweet corn. *J. Food Sci. Technol.*, **12**, 4823-4832.

Lowry, O.H., Rosebrough N.J., Farr A.L. and Randall R.J. (1951). Protein measurement with Folin phenol reagent. *The J. Biological Chem.*, **193**, 256-275.

Mahajan, P.V. and Chattopadhyay P.K. (2000). Development of a chemically leavened cereal legume-based instant mix (Dhokla). *J. Food Sci. Technol.*, **37**, 459-464.

Mehta, D., Prasad P., Sangwan R.S. and Yadav S.K. (2018). Tomato processing byproduct valorization in bread and muffin: improvement in physicochemical properties and shelf life stability. *J. Food Sci. Technol.*, **55(7)**, 2560-2568.

Nielsen, S.S. (2017). Total carbohydrate by phenol-sulfuric acid method. In : *Food Analysis Laboratory Manual* (pp. 137-141). CRC Press.

Oshima, H. and Kinoshita M. (2013). Effects of sugars on the thermal stability of a protein. *The J. Chemical Physics*, **138**, 245101-245112.

Patel, U., Kumar N. and Modi S.K. (2022). Development of protein-enriched gram flour steamed cake and characterization of processing parameters. *J. Food Processing and Preservation*, **46(2)**, 1-16.

Rangana, S. (2000). *Manual of analysis of fruits and vegetable products*. New Delhi, India: Tata McGraw Hill Publishing Co. Ltd.

Ray, S., Saha R., Raychaudhuri U. and Chakraborty R. (2017). Characterization and analysis of dhokla with incorporated tomato powder. *Nutrafoods*, **16**, 223-229.

Shobha, D. and Neena J. (2016). Evaluation of maize dhokla for physical, sensory, and functional parameters. *Int. J. Agricult. Sci.*, **8(36)**, 1755-1758.

Sinha, S.R., Singha A., Faruquee M., Jiku M.A.S., Rahaman M.A., Alam M.A. and Kader M.A. (2019). Post-harvest assessment of fruit quality and shelf life of two elite tomato varieties cultivated in Bangladesh. *Bull. National Res. Centre*, **43**, 185.

Slade, L., Kweon M. and Levine H. (2021). Exploration of the functionality of sugars in cake-baking and effects on cake quality. *Crit. Rev. Food Sci. Nutr.*, **61**, 283-311.

Tomic, J.M., Belovic M.M., Torbica A.M., Pajin B.S., Loncarevic I.S., Petrovic J.S. and Fistes A.Z. (2016). The influence of the addition of dried tomato pomace on the physical and sensory properties of whole grain rye flour cookies. *Food and Feed Research*, **43**, 145-152.

Yolmeh, M. and Jafari S.M. (2017). Applications of response surface methodology in the food industry processes. *Food and Bioprocess Technology*, **10**, 413-433.