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Optimization of Instant Wheat Bran Upma Mix by Response Surface Methodology

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Abstract

One of the traditional breakfasts in South India was found to be upma. Hence the study focused to formulate and optimize instant upma mix encultured with wheat bran and rice flakes. Therefore, the developed product was optimized using Response Surface Methodology (RSM). Hence the optimized product was evaluated for its physical properties, microbial examination, proximate composition, sensory evaluation, and shelf-life quality of the instant upma mix. The optimized product was found to be within the microbial limit and it is safe for consumption. The sensory evaluation of upma prepared from the instant upma mix was evaluated using a 9-point hedonic scale. The result of optimized acceptance of developed instant upma mix including Wheat bran 79gm and Rice flakes 35gm, appearance 7, colour 7.7, flavour 7.9, taste 8, and overall acceptability 8, and the desirability index was 1. The developed product was found to be high in protein (35±2.1g), and low in carbohydrates(7.8±1.06g) whereas the moisture content (4.7±1.02%) was found to be very low, therefore it helps in increasing the storage stability. The storage study of the optimized product was evaluated for up to 60 days. Therefore, the formulated instant upma mix was found to be highly nutritious.

***Key words*:** Physical properties, Response Surface Methodology, Wheat bran, Rice flakes, Nutritional composition

A highly nutritious breakfast alternative is upma. It is mostly a south Indian dish that is well-liked in Tamil Nadu. Convenience foods, sometimes known as ready-to-eat items, are partially cooked when they are packaged (Brunner, 2015). People do not have to skip meals and risk compromising their health when there is ready-to-eat food available. It is incredibly portable and takes only two to three minutes to prepare with hot water. As a result of their high vitamin and energy content, ease of preparation, and short processing time, instant mixes and Ready to Eat (RTE) foods have seen a significant surge in popularity. Convenience food is commercially prepared food designed for ease of consumption. Products designated as convenience foods are often prepared foodstuffs sold as hot, ready-to-eat dishes, room-temperature, shelf-stable products, or refrigerated or frozen products that require minimal preparation (typically just heating) (Brunner, 2015). Increasing urbanization, industrialization, and the resulting changes in People's eating habits have resulted in the introduction of instant dry mixes and ready-to-eat convenience foods (Vasan M, 2019).

Instant foods can and are produced commercially via spray-drying preblended mixtures, or utilization of freeze-drying, drum-drying, or extrusion (Luallen, 2017). Foods of this type generally contribute to product functionality and characteristics. Foods that require little to no preparation or cooking before consumption are referred to as convenience foods since they make eating easier for the consumer. Upma, a popular breakfast of south Indian origin, is traditionally made from semolina. Generally, it is prepared afresh each time and takes 15–25 min depending on quantity to be prepared at the household level. Convenience mixes reduce the time for preparation by eliminating several steps of cooking. Depending on individual preferences, various seasonings, and vegetables are often added during cooking (Dhumketi *et al.*, 2018).

Wheat Bran is a cheap and plentiful source of dietary fiber that has been connected to better gut health and potential illness prevention, including colon cancer (Stevenson *et al.*, 2012). Additionally, it has bioactive substances such as phenolic acids, arabinoxylans, alkylresorcinol, phytosterols, minerals, vitamins, and other nutrients. It has been proposed that these substances can help prevent noncommunicable diseases like cardiovascular disease (Onipe *et al.*, 2015). Nutritionally, bran fractions produced by milling are rich in fiber, minerals, vitamin B6, thiamine, folate, vitamin E, and some phytochemicals, in particular, antioxidants such as phenolic compounds (Shewry, 2009). "Breakfast cereal" was defined to include ready-to-eat breakfast cereal (RTEC), oats/porridge, and muesli (Williams, 2014). The role of breakfast cereals in a balanced diet has been recognized for many years (A. Jarzebowska and B. McKevith, 2010). Dietary guidelines note that the high nutrient density of breakfast cereals (especially those that are whole grain or high in cereal fiber) makes them an important source of key nutrients. Rice flake (RF) is the most popular breakfast cereal consumed throughout the country.

Rice flakes also known as aval and poha area paddy-based product of India that is high in iron and fiber (Ramaswamy and Koshy Mathew, 2015). Rice flakes of 4 distinct thicknesses had an available iron content ranging from 7% to 26%. Red rice flakes (Oryza sativa) are well-known for being extremely nutritious and wholesome. Rice flakes function as probiotics as well. It is easily digestible and produces a lot of energy. So that gastrointestinal issues like bloating are not noticed. Red rice flakes help adolescents eliminate constipation, allergies, and primary and secondary coronary disease. They also improve digestion (Arun *et al.,* 2017). Response Surface Methodology (RSM) is an optimization tool used in experiments and research investigations to detect interrelationships between variables. RSM is a series of mathematical and statistical techniques for examining the relationships between a set of dependent and independent variables. RSM can be used to optimize using the Design Expert software (Amin *et al.,* 2015). RSM was used in conjunction with optimization to determine how the inputs' correlation affected the response. RSM offers multiple regression strategies and will cut down on the number of trials.

Hence, the main aim of the study is the formulate a nutrient-rich instant upma mix (IUM) using wheat bran and rice flakes. The objective is to use RSM to create an optimized formulation of instant upma mix containing wheat bran and rice flakes and to identify the optimal levels for instant upma mix responses. The formulated and developed instant wheat bran upma mix was evaluated for microbial examination, organoleptic evaluation, and proximate composition and shelf-life evaluation.

MATERIALS AND METHODS

Procurement of Raw Materials: The fundamental components like wheat bran, rice flakes, carrot, beans, black gram dhal, Bengal gram dhal, mustard seeds, curry leaves, coriander leaves, and green chili were procured from the local grocery store.

Figure 1 Optimized instant wheat bran upma mix

Pre-preparation Process: The procured raw materials were cleaned and used in the preparation of instant wheat bran upma mix. Wheat bran and Rice flakes were cleaned, roasted, and ground into semolina/coarse powder separately. Carrot, beans, curry leaves, coriander leaves and green chili were cleaned, washed, and blanched in a solution containing 0.1% sodium bicarbonate, 0.1% magnesium oxide, and 0.02% potassium metabisulphite and dried at 70ºC in a cabinet tray dryer (Premavalli *et al.,* 1987).

Formulation of Instant Upma Mix

In a non-stick pan, oil was heated, then the mustard seeds, black gram dhal, and Bengal gram dhal were added and roasted until it turns golden brown. Switch off the flame then add the pre-processed wheat bran and rice flakes. Then add salt, red chili powder, and dehydrated vegetables into the pan and mixed properly (Maske *et al.,* 2020). The samples were cooled, packed in a container, and stored at room temperature. The same procedure was followed for the control.

Experimental design and statistical information

RSM was used to investigate the simultaneous impacts of wheat bran and rice flake inclusion on instant upma mix. A central composite design was used in this experiment's response surface methodology (RSM) design. RSM was applied to Central Composite Design (CCD) to analyze the interrelationship of process variables (Bezerra *et al.,* 2008). Table 1 displays the CCD design matrix as well as the testing outcomes for reactions like the instant upma mix's sensory parameters.

Table 1 Real and coded values of experimental design

Independent variables		Coded value -1	0	+1	Coding
Real value	Wheat bran	30	55	80	Actual
	Rice flakes	10	25	40	Actual

The quantities of rice flakes ranged from 10–40g and wheat bran from 30–80g. The upper and lower limits of these variables were defined after a preliminary process. The quantity of wheat bran (X1) and the quantity of rice flakes (X2) were two quantitatively controlled parameters (independent variables). The dependent variables, appearance (Y1), colour (Y2), flavour (Y3), taste (Y4), and overall acceptability (Y5), were chosen as responses to represent the key components of instant upma mix (Nazni *et al.,* 2014). The upper & lower limits for independent variables are defined following the exploratory experiment. For each response variable, the empirical data were fitted to a quadratic model.

"$Y = \beta + X_1 + X_2 + X_1^2 + X_2^2 + X_1 X_2$ ……….. (1)

Whereas

Y = responses, β = constant, X_1, X_2 = linear regression, X_1^2, X_2^2 = quadratic regression,

X_1X_2 = interaction regression, X_1, X_2 = independent variables

The coefficient of determination, R^2, F-value, and model p-value at the 0.1 significance level was used to assess the model's suitability. Utilizing Design Expert with (2022, V 12; Stat Ease Inc.) software, the statistical analysis RSM for instant upma mix was completed. The analysis of variance was used to fit the altered variables and responses to the quadratic model. The relevance of the quadratic model's lack of fit, the implications of the experimental findings, and the impact of interactions among the altered variables and responses were all examined.

Preparation of Upma from Formulated Instant Upma Mix

200 ml of hot water was used to rehydrate 100 g of dry mixes of modified upma, and it was agitated on a low flame

until the necessary consistency was reached (began to emerge from the pan) (Dhumketi *et al.,* 2018).

Sensory evaluation of upma from developed instant upma mix

The ultimate indicator of a food product's quality from the perspective of the consumer is typically its organoleptic evaluation (Preeti Rathi *et al.,* 2013). 25 panelists participated in a sensory assessment of the instant upma mix at Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women in Chrompet, Tamil Nadu. All samples were reviewed by panelists, who were also given a cup of water to neutralize the taste before moving on to the next sample. The instant upma mix's appearance, colour, flavour, taste, texture, and overall acceptability were all scored on a 9-point hedonic scale (1 = extremely dislike; 9 = extremely like) (Dhumketi *et al.,* 2018).

The wheat bran and rice flakes are considered as independent variables and sensory properties like appearance, colour, flavour, taste, and overall acceptability are chosen as dependent variables. 13 different concentrations were evolved using response surface methodology. The response falls into the following categories: 5–7 appearances, 4–8 colours, 5–8 flavours, 5–8 tastes, and 5–8 overall acceptability.

Table 2 Experimental value of response for instant upma mix

	Independent Variables		Dependent Variables				
Run	Wheat bran (gm)	Rice flakes (gm)	Appearance	Colour	Flavour	Taste	Overall acceptability
1	55	25	7	8	8	8	8
2	80	40	7	8	8	8	8
3	90.35	25	7	6	7	7	7
4	80	10	5	5	6	5	5
5	55	3.78	5	5	7	5	5
6	55	25	7	8	8	8	8
7	55	46.21	7	7	7	7	7
8	19.64	25	5	4	5	5	5
9	55	25	7	8	8	8	8
10	55	25	7	8	8	8	8
11	55	25	7	8	8	8	8
12	30	40	6	7	5	7	7
13	30	10	5	6	5	5	5

Determination of physical properties

Physical properties such as cooking time, water uptake, solids in the cooking water, and rehydration ratio were assessed according to Tamilselvi *et al.,* 2015. As a result, according to the study by Ketki Dhumketi *et al.*, 2018, these physical properties were used to assess the upma mix's cooking quality.

Cooking Quality

According to Tamilselvi *et al.*, 2015, the cooking quality of the upma mix was evaluated by measuring the cooking time, water uptake, solids in the cooking water, and rehydration ratio.

Cooking time

By boiling 2.0g of the sample in 20 ml of distilled water, extracting a few samples at varying stages during cooking, and pressing the samples between two glass plates until no white cores were present, the cooking time was calculated (Tamilselvi *et al.*, 2015).

Water uptake

The water uptake ratio was evaluated by cooking 2.0 grams of the sample in 20 ml of distilled water for a minimum cooking period in a boiling water bath and extracting the superficial water from the cooked sample. Tamilselvi (2015) states that the cooked sample was properly weighed, and the water uptake ratio was computed as the sample's ratio of final cooked weight to uncooked weight and transformed into a percentage.

$$\text{Water uptake} = \frac{\text{weight of cooked sample}}{\text{weight of uncooked sample}} \times 100 \;\ldots\ldots\ldots (2)$$

Solids in cooking water

This was detected by drying a sample of the cooking water and allowing it to evaporate. It noted the weights of the petri dish when it was empty (W1) and the dish when it had an aliquot (W2). The dried aliquot in the petri dish was noted as (W3). According to Tamilselvi *et al.*, 2015, the amount of solids in cooking water was determined as

$$\text{Solids in cooking water} = (\text{W3} - \text{W1}) \ldots\ldots. (3)$$

Rehydration ratio

Rehydration ratio (RR), a measure of water absorption by the dehydrated product was calculated using the following equation as given by(Basantpure et al., 2003).

$$R = {}^{Wr}/_{Wd} \;\ldots\ldots\ldots (4)$$

$Where$:

$Wr\ (g)\ weight\ of\ the\ rehydrated\ upma\ mix$

$Wd\ (g)\ weight\ of\ the\ dry\ upma\ mix\ used\ for\ rehydration$

2g of the dried instant upma mixtures were rehydrated in 20 ml water in a water bath at a constant temperature, which was agitated at a constant speed (100rpm). The sample was taken from the bath after 10 minutes and weighed after being blotted with tissue paper in order to remove the excess solution. The rehydration ratio was defined as the ratio of the weight of rehydrated samples to the dry weight of the sample.

Water absorption capacity

Sample (1g) was weighed into conical graduate centrifuge tubes of known weights and mixed with 10 ml of distilled water for one minute with a glass rod. The tubes were then centrifuged at 500 rpm for 30 min. The volume of free water (the supernatant) was discarded and each tube together with its content was reweighed as water absorbed per gram of sample. The gain in mass was the water absorption capacity of the instant upma mix sample. The volume difference gave the of water absorbed by 1g of the test sample. According to Onwuka *et al.,* (2005), Absorption capacity is expressed in grams of water absorbed per gram of sample.

$$Water\ absorption\ capacity = \frac{\text{Density of water+Volume absorbed}}{\text{weight of sample}} \;\ldots\ldots\ldots (5)$$

Microbial Examination of the Instant Upma Mix (IUM)

The ideal quality assessment method used in food product quality analysis is microbiological examination. Total Plate Count (TPC), Total Yeast, and Mold were investigated in a study of microbiological quality**.** The total plate count was determined by using Nutrient agar and the total yeast and mould count was determined by using Potato Dextrose Agar (PDA) and the streak plate technique was used for the isolation of the media (Vidyapeeth *et al.,* 2017).

Proximate Composition of the Instant Upma Mix (IUM)

The proximate composition of the instant upma mix was analyzed for both macronutrients and minerals composition. Macronutrients such as ash {Gravimetric Method (AOAC 2012)}, moisture (AOAC 2012), energy (AOAC 2007), protein {Kjeldahl Method (AOAC 2007)}, fat {Gravimetric Method (AOAC 2007)}, carbohydrate {Differential Method (AOAC 2006)}, and dietary fiber {Differential Method (AOAC 2007)}. A mineral composition such as calcium (AAS Method 2003), iron (AAS Method 2003), phosphorus (Spectrophotometry 2003), magnesium (AAS Method 2003), potassium (Flame Photometer 2003), manganese (AAS Method 2003), and sodium (Flame Photometer 2003).

Shelf-Life Evaluation of the Instant Upma Mix (IUM)

The developed instant wheat bran upma mix was assessed for storage stability for 60 days at regular intervals. Shelf-life parameters such as peroxide value, free fatty acid, and microbial examination (Seth and Singla, 2020) in which the total plate count and total yeast and mould count will be assessed on the 0^{th} day, 1^{st} day, 15^{th} day, 30^{th} day, 45^{th} day, and 60^{th} day (Baby Latha et al., 2014). The evaluated results were presented in the given table 5. Moisture content was estimated using AOAC 2000 Method. Whereas the Peroxide value and Free fatty acid were estimated using AOAC 2003. For Microbial Examination, the Total Plate count and the Total Yeast Mould count were evaluated using Nutrient Agar media, Potato dextrose Agar (PDA), and the streak plate technique (Vidyapeeth *et al.,* 2017).

RESULTS AND DISCUSSION

Sensory evaluation of upma prepared from instant upma mix

A scientific discipline used to evoke, measure, analyze, and interpret reactions to those qualities of foods as well as materials that can be perceived by the senses of sight, smell, taste, touch, and hearing is sensory evaluation, according to the Institute of Food Technologists' Sensory Division (IFT, 1981b). Tests for sensory evaluation may be used in research, development, quality assurance, and shelf-life studies. Results obtained from the experimental design for sensory parameters like appearance, colour, flavour, taste, and overall acceptability of the instant upma mix with different concentrations of wheat bran and rice flakes were generated by RSM was given in (Table 2).

Figure 2 Upma prepared from Optimized Instant upma Mix

Regression Coefficient for independent variables:

All responses received after several experimental procedures are analyzed using the regression method which involves fitting the response into the polynomial model, for instance, the second-order polynomial model presented in the equation which was given below:

$$y = \beta_0 + \sum\beta_i X_{i4i} = 1 + \sum\sum\beta_{ij} X_{i4j} = 14i = 1X_j + \sum\beta_{ii} X_{i24i} = 1 \quad ......(6)$$

where y represents the independent responses; $\beta 0$, βi, βii, and βijrepresent the regression coefficient of the process variables for the intercept, linear, quadratic, and cross-product terms, respectively (Prakash Maran *et al.*, 2017). For the reliability test, analysis of variance (ANOVA) must be carried out where it evaluates the fitness of the model through the response by the coefficient of R square and also the F-test for lack of fit. The regression coefficients representing the independent variables (wheat bran and rice flakes), as well as interactions with the response variables, are displayed in (Table 3).

Table 3 Regression coefficient for response variable of the wheat bran and rice flakes encultured instant upma mix

Factors	Regression Coefficient				
	Y1	Y2	Y3	Y4	Y5
Model	6.8	8	8	8	8
X_1	0.47	0.35	0.85	0.47	0.47
X_2	0.72	0.85	0.25	0.97	0.97
X_1^2	-0.46	-1.25	-1.125	-0.937	-0.9375
X_2^2	-0.46	-0.75	-0.625	-0.937	-0.9375
X_1X_2	0.25	0.5	0.5	0.25	0.25

Table 4 Analysis of variance of the response variable

Response	Source	Sum of Square	df	Mean Square	F value	Prob>F	R^2 Value
Y1	Model	8.96	5	1.79	9.31	0.005	0.86
	Lack of fit	0.54	3	0.18	0.91	0.51	-
	Pure error	0.8	4	0.2	-	-	-
	Total	10.30	12		-	-	-
Y2	Model	21.13	5	4.2	9.32	0.005	0.86
	Lack of fit	3.17	3	1.05	-	-	-
	Pure error	0	4	0	-	-	-
	Total	24.30	12		-	-	-
Y3	Model	17.75	5	3.55	21.21	0.0004	0.93

	Lack of fit	1.17	3	0.39	-	-	-
	Pure error	0	4	0	-	-	-
	Total	18.92	12		-	-	-
Y4	Model	20.55	5	4.11	25.4	0.0002	0.94
	Lack of fit	1.13	3	0.37	-	-	-
	Pure error	0	4	0	-	-	-
	Total	21.69	12		-	-	-
Y5	Model	20.55	5	4.11	25.41	0.0002	0.94
	Lack of fit	1.13	3	0.377	-	-	-
	Pure error	0	4	0	-	-	-
	Total	21.69	12		-	-	-

According to C. N. Vatsala *et al.*, 2001, the primary factors to consider when evaluating a product's quality are its appearance, colour, flavour, taste, texture, and overall acceptance. The sensory analysis aids in defining the product attribute that is crucial in terms of acceptability. The sum of the square, P-value, F-value, and R2 value for the coded form for the process of the sensory response of the instant upma mix is shown in (Table 4). The sensory qualities of wheat bran and rice flakes were found to have a significant effect in the analysis of variance (ANOVA) for each response. To develop predictive models for instant upma mix qualities based on different quantities of wheat bran and rice flakes, the experimental data of each response variable is shown in equations 7-16. Graphical representation of the Response Surface model and their interaction between the variables are shown in (Fig 3-7).

Effect of independent variables on the sensory response (dependent variables)

Appearance

The first thing that the human senses notice about something is its appearance, which is crucial for identifying and selecting food in the end (Sharief *et al.*, 2017). The result showed that the quadratic model B has a significant effect ($p<0.05$) on the appearance of the upma prepared from the formulated instant wheat bran and rice flakes upma mix. The model with an F-value of 9.32 (Table 4) implies the model is significant. There is only a 0.53% chance that an F-value this large could occur due to noise. The Prob>F value is less than 0.0500 indicating model terms are significant. The Lack of fit F-value for the appearance of 0.91 implies that the Lack of Fit is not significant relative to the pure error. Non-significant lack of fit is considered good (Sivamani *et al.*, 2014), and we desire that the model fit. For appearance, the Lack of Fit seems to be not significant. The Predicted R^2 value is 0.5017, which is not as close to the Adjusted R-Squared value of 0.7760. Adequate Precision is the measure of the signal-to-noise ratio. A ratio that is greater than 4 is desirable. The ratio of Adequate Precision is 8.34 which indicates an adequate signal. The R^2 percentage of appearance response seems to be 86%. The predicted combination of 79 gm of wheat bran and 35 gm of rice flakes has a mean score for appearance were 7. This model can be used to navigate design space.

An equation in terms of coded factors:

$$Appearance = 6.8+0.47X_1+0.72X_2 - 0.46\,X_1^2 - 0.46X_2^2+0.25X_1X_2 \text{ ... . (7)}$$

An equation in terms of uncoded (actual) factors:

$$Appearance = 1.92+0.083X_1+0.11X_2 - 0.00\,X_1^2 - 0.00X_2^2 + 0.00X_1X_2 \text{ .... (8)}$$

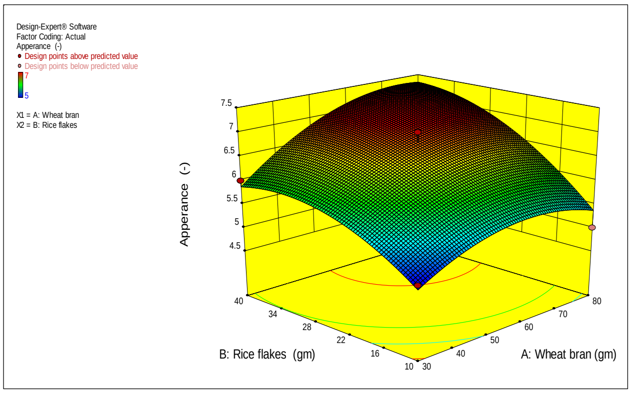

Figure 3 Response Surface model, the graph shows the appearance of the instant wheat bran and rice flakes upma mix

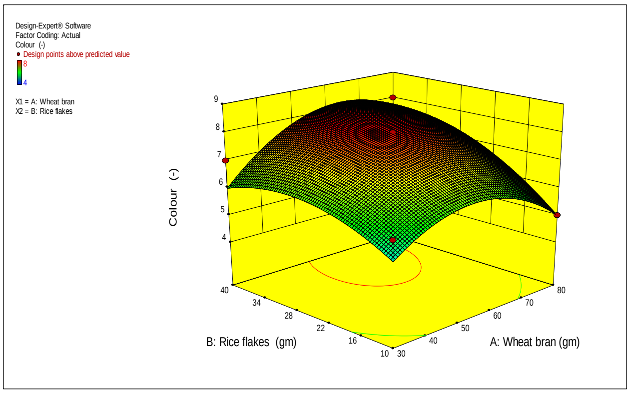

Figure 4 Response Surface model, the graph shows the colour of the instant wheat bran and rice flakes upma mix

Colour

One of the key elements that pique almost everyone's appetite for food is colour (Shakerardekani *et al.*, 2013). The result showed that the quadratic model A^2 has a significant effect ($p<0.05$) on the colour of the upma prepared from the formulated instant wheat bran and rice flakes upma mix. The model F-value of 9.33 (Table 4) implies that the model is significant. The Prob>F value is less than 0.0500 indicating that the model terms are significant. The Predicted R-Squared value is 0.0722, which is not as close to the Adjusted R-Squared value of 0.7763. The Adequate Precision ratio is 6.560, which indicates an adequate signal. The R^2 percentage of colour response seems to be 86%. The mean score for colour was 7.8. This model can be used to navigate design space.

An equation in terms of coded factors

$$Colour = 8+0.35X_1+0.85X_2 - 1.25X_1^2 - 0.75X_2^2 + 0.5X_1X_2 \text{ .... (9)}$$

An equation in terms of uncoded (actual) factors:

$$Colour = -0.50+0.20X_1+0.15X_2 - 0.00X_1^2 - 0.00X_2^2 + 0.00X_1X_2 \text{............ (10)}$$

Flavour

The term "flavour" refers to a sensory phenomenon that includes scent, taste, and mouthfeel sensations. It consists of the interaction of flavour, aroma, and texture. One of the key elements that determines whether a food product is appreciated or despised is its flavour. Aromatic molecules that are interpreted by the tongue as well as nose and conceptualised by a mix of taste plus odour make up flavouring agents. Food products that are more delightful to eat (Monteleone *et al.*, 2017). The result showed that the quadratic model A, A^2, and B^2 has a significant effect ($p<0.05$) on the flavour of the upma prepared from the formulated instant wheat bran and rice flakes upma mix. The model F-value of 21.21 (Table 4) implies that the model is significant. The Prob>F value is less than 0.0500 indicating that the model terms are significant. The Predicted R-Squared value is 0.5597, which is not as close to the Adjusted R-Squared value of 0.8939. The Adequate Precision ratio is 12.439 which indicates an adequate signal. The R^2 percentage of the flavour response is 93%. The mean score for flavour were 7.9. This model can be used to navigate design space.

An equation in terms of coded factors

$$Flavour = 8 + 0.85X_1 + 0.25X_2 - 1.125\,X_1^2 - 0.625X_2^2 + 0.5X_1X_2 \;.....\;(11)$$

An equation in terms of uncoded (actual) factors

$$Flavour = 0.35 + 0.198X_1 + 0.082X_2 - 0.00\,X_1^2 - 0.00X_2^2 + 0.00X_1X_2 \;......\;(12)$$

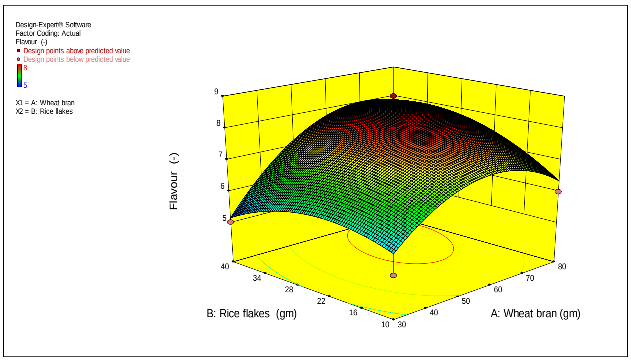

Figure 5 Response Surface model, the graph shows the flavour of the instant wheat bran and rice flakes upma mix

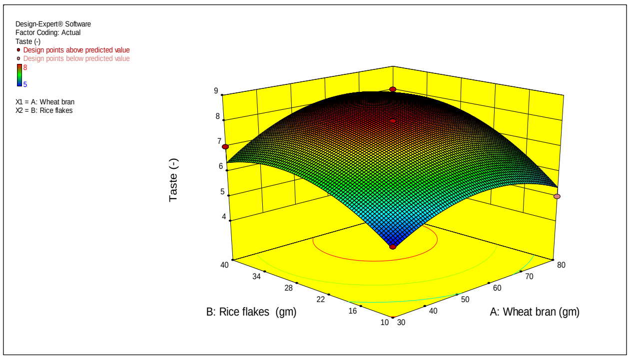

Figure 6 Response Surface model, the graph shows the taste of the instant wheat bran and rice flakes upma mix

Taste

Taste is a crucial factor in the consumer acceptability of a food product and one of the most important factors to take into account when evaluating an organoleptic product. Taste buds located superficially on the tongue and in other parts of the mouth or gullet have taste receptors that detect substances once they have been disintegrated in saliva, oil, and even water (Araujo *et al.*, 2003). The result showed that the quadratic model B has a significant effect ($p<0.05$) on the taste of the upma prepared from the formulated instant upma mix. The model F-value is 25.42 (Table 4) which implies the model is significant. The Prob>F is less than 0.0500 indicating that the model term is significant. The Predicted R-Squared value of 0.6288 is not as close to the Adjusted R-Squared value of 0.9105. The Adequate Precision ratio of 11.927 and indicates an adequate signal. The R^2 percentage of the taste response is 94%. The mean score for taste were 8. This model can be used to navigate design space.

An equation in terms of coded factors

$$Taste = 8 + 0.47X_1 + 0.97X_2 - 0.93\,X_1^2 - 0.93X_2^2 + 0.25X_1X_2 \;........\;(13)$$

An equation in terms of uncoded (actual) factors

$$Taste = -0.90 + 0.16X_1 + 0.23X_2 - 0.00\,X_1^2 - 0.00X_2^2 + 0.00X_1X_2 \;.......\;(14)$$

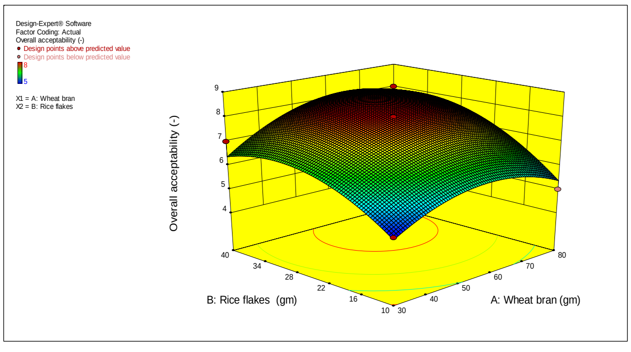

Figure 7 Response Surface model, the graph shows the overall acceptability of the instant wheat bran and rice flakes upma mix

Overall acceptability

Overall acceptability indicates the 4 characteristics of the upma (colour, flavour, taste, and appearance) (Preeti Rathi and R. Mogra, 2013). The result showed that the quadratic model B, A^2 has a significant effect ($p<0.05$) on the overall acceptability of the upma prepared from the formulated instant upma mix. The model F-value is 25.42 (Table 4), which implies the model is significant. There is only a 0.02% chance that an F- value this large could occur due to noise. The Prob>F value is less than 0.0500 indicating that the model terms are significant. The Predicted R-Squared value of 0.6288, is not as close to the Adjusted R-Squared value of 0.9105. The Adequate Precision ratio is 11.927 and it indicates an adequate signal. The R^2 percentage of the overall acceptability response shows 94%. Overall acceptability scores for 13 distinct concentrations range from 5-8 (Table 2). With a mean score of 8, the predicted combination of 79 gm of wheat bran and 35 gm of rice flakes were determined to be more palatable. This model can be used to navigate design space.

An equation in terms of coded factors

$$Overall\ acceptability = 8 + 0.47X_1 + 0.97X_2 - 0.9375X_1^2 - 0.9375X_2^2 + 0.25X_1X_2 \;..........\;(15)$$

An equation in terms of uncoded (actual) factors

$$Overall\ acceptability = -0.90 + 0.16X_1 + 0.23X_2 - 0.00X_1^2 - 0.00X_2^2 + 0.00X_1X_2 \;.......\;(16)$$

In terms of sensory qualities, all of the independent factors have a beneficial effect on wheat bran and rice flakes. Wheat bran and rice flakes have a good effect on the interactive aspects of appearance, colour, flavour, taste, and overall acceptability. According to sensory factor appearance shows that the lack of fit seems not significant.

At a 5% level of significance ($p<0.05$), the quadratic mean appearance model, colour model, flavour model, and mean overall acceptability model have all been determined to be statistically significant. Each of the model variables were statistically significant, according to the Analysis of Variances (ANOVA).

Optimization process through the desirability function

Parameters of the optimization process for such instant wheat bran and rice flakes upma mix: appearance, colour, flavour, taste, and overall acceptability are shown in (Table 5). Based on customer demand, the immediate upma mix quality attributes (responses) chosen for the optimization process with their respective weight. The optimization process was based on the desirability multiple-response method. The best optimal concentrations were achieved on WB 79g and RF 35g by using the desirability function.

Table 5 Optimization process of instant wheat bran upma mix

Factors (F) and Responses (R)	Goal	Lower Limit	Upper Limit	Importance	Optimum	Desirability
Wheat bran (F)	is in range	30	80	3	78.7	
Rice flakes (F)	is in range	10	40	3	35.4	
Appearance (R)	maximize	5	7	3	7.2	
Colour (R)	is in range	4	8	3	7.7	1
Flavour (R)	is in range	5	8	3	7.9	
Taste (R)	maximize	5	8	3	8	
Overall acceptability (R)	is in range	5	8	3	8	

The optimization procedure was based primarily on the desirability function, which is expressed as D = $d_1 \times d_2 \times d_3 \times \dots \dots \dots . d_n$ where d1=0 is regarded as the least desired and n is generally specified as the number of responses applied (Subasshini *et al.*, 2021).

For synchronous optimization, every response must be assigned a lower and higher value for each target. For answers, the 'goal' field must be any of five options: 'none, maximum, minimum, target, or in range.' By default, factors are always incorporated in the optimization at the maximum or minimum of the objective goal, or within their design range. The response won't be used for optimization if the aim is none (Manohar *et al.,* 2013). The values of the desirability factor (objective function) are range from 0 (least value) to one (most desired value). The formulation's estimated desirability was 1. The overall acceptability is 8 at these concentrations. The instant mix was much more palatable at the concentrations.

Physical properties

Foods' composition and structure have a direct impact on their physical characteristics (Gowen *et al.*, 2011). According to Dr. Alina Szczesniak. The physical characteristics of food are "those that adapt themselves to description and quantification by physical rather than chemical techniques," A food product's physical attributes are connected to many of the traits that characterize its quality (such as texture, structure, and appearance) and durability (such as water activity) (Berk and Berk, 2018). As a result, according to the study by Ketki Dhumketi *et al.,* 2018, cooking time, water uptake, solids in cooking water, rehydration ratio, and water absorption capacity are the physical properties were used to assess the upma mix's cooking quality.

Cooking characteristics were presented in the given table 6. cooking time was calculated for the optimized sample which consists of 79 gm of wheat bran and 35gm of rice flakes. Cooking time was found to be 7.03±0.50. According to the study (Dhumketi *et al.*, 2018) cooking time of the formulated foxtail millet and soy upma mix Was found to be similar. Whereas the cooking time for for wheat semolina was found to be 5 minutes. As a result anticipated that the statisical analysis of mean score was found to be -1.89 with SD of ±0.19. The p-value was found to be 0.004. hence, it depicted that the a statistically siginificant. As a resuts shows that the water uptake percentage for the instant wheat bran upma mix was found to be 225.23±0.79 which slightly lower when compared to the study(Singh Vishwavidyalaya *et al.*, 2017) where instant mix was formulated using soy grits and foxtail millet semolina. The p-value of water uptake was found to be 0.000 which depicted that it is a highly significant.

Table 6 Physical Properties of Instant Upma Mix (IUM)

Physical properties	Control	IUM	P-Value
Cooking time (min)	5.14^{c}±0.69	7.03^{c}±0.50	0.004 ^{S*}
Water uptake (%)	196.99^{a}±0.76	225.23^{a}±0.79	0.000 ^{S**}
Solids in cooking water (%)	4.26^{d}±0.61	3.38^{d}±0.55	0.002 ^{S*}
Rehydration ratio	2.72^{e}±0.35	3.26^{e}±0.68	0.132 ^{NS}
Water absorption capacity (%)	89.19^{b}±1.21	90.03^{b}±1.00	0.028 ^{S*}

Paired t-test, S** - Highly Significant, S* - Significant, NS – Not Significant

Solids in cooking water was found to be 3.38±0.55 and rehydration ratio was found to be 3.10. The rehydration ratio is slightly lower than the formulated product by (Dhumketi *et al.*, 2018) using foxtail millet and soy. As a result, depicted that the statistical analysis of the solids in cooking water was found to be statistically significant where the p-value was found to be 0.002.

The higher the rehydration ratio indicates that the more water availability due to more time for reconstitution to get correct consistency. According to the Stela et al., 2009 rehydration ratio, dried materials have the capacity to store soluble solids and absorb water. Also, it is employed as a quality feature of the dried product and is regarded as a key attribute of many items that are later prepared for ingestion (Velić *et al.*, 2004). Rehydration of the optimized product was found to be 3.26±0.68 which is slightly lower than the (Dhumketi *et al.,* 2018) upma mix incorporated with foxtail millet and soy for nutritional security were as the rehydration ratio was found to be 3.35. The p-value of rehydration ratio was found to be 0.132 which depicted that it is not significant.

Water absorption capacity (WAC) or water holding capacity (WHC) is determined by adding water or an aqueous solution to a material, centrifugation, and quantification of the water held by the pelleted material in the centrifuge tube (Köhn *et al.*, 2015). According to Wang *et al.,* (2006), high water absorption capacity values are essential to sustaining product moisture content. Water absorption capacity of the developed product was found to be 90.03±1.00. The criteria used to define the instant mix's hydration characteristics are WAC. After the starch granules have swelled in excessive water, WAC measures their volume (Yousf *et al.,* 2017). The p-value of water uptake was found to be less than 0.005 (0.028) which depicted that it is a statistically significant.

Microbial Quality of the Instant Upma Mix (IUM)

Total viable counts were used to determine the microbiological quality in relation to the levels of microbial contamination in general. Table 7 reveals the microbial quality of the developed instant upma mix.

Table 7 Microbial Quality of Instant Upma Mix

Total bacterial Count cfu/gm	Total Yeast and Mould Count cfu/gm
85.24±0.66	Nil growth
83.3±0.62	Nil growth

A microbial examination was conducted for the best instant upma mix sample. The result revealed that the total bacterial count was found to be 85.24±0.66cfu/gm for the control and 83.3±0.62cfu/gm for the sample. A similar result was found in the study (Vidyapeeth *et al.,* 2017) which was incorporated with guar gum composite flour. Whereas, the total yeast and mould were found to be nil growth. Hence the study states that the microbial quality of the instant upma mix was within the acceptable limit (Bolton *et al.,* 2009).

Proximate Composition of the Instant Upma Mix (IUM)

The macronutrients moisture, protein, total fat, total carbohydrate, total fiber, and ash are referred to as "proximate components" (USDA 2021). The nutritional composition of the instant wheat bran upma mix was carried out by the method described in (Table 3) (V Maske*et al.,* 2020)(Gul and Safdar, 2009). Microminerals were also evaluated for the instant mix (Gupta *et al.,* 2016). The data obtained on the nutritional composition of the instant wheat bran upma mix is given in (Table 8).

Table 8 Macronutrient composition of instant upma mix (IUM)

Nutrient	Control	Instant upma mix	P-value
Ash (%)	2.06±0.085	4.78±1.36	0.026*
Moisture (%)	40.44±0.69	3.68±1.32	0.000**
Energy (Kcal)	257±1.2	220.33±2.51	0.000**
Protein (g)	11.6±0.57	35.11±2.10	0.000**
Fat (g)	6.41±0.52	5.45±1.40	0.015*
Carbohydrate (g)	38.44±0.84	7.87±1.56	0.000**
Dietary Fiber (g)	9.3±0.73	3.58±1.65	0.001**

Paired t-test, S** - Highly Significant at 1% level, S* - Significant at 5% level,NS – Not Significant

Ash is the inorganic residue that remains after all of the organic components of food have burned up or completely oxidized. A food's ash content is a gauge of how many minerals it contains overall. As a result, the anticipated that the ash content of the optimized instant wheat bran upma mix was found to be 4.78±1.36 and for control (2.06±0.085). According to the study (Dhumketi *et al.,* 2018) the ash content of instant upma mix incorporated with foxtail millet and soy was found to be 3.55/100g. Hence, ash content was higher when compared to another study. The losses may be due to volatilization or some interactions between constituents.

The amount of water that is present in a food product is considered the moisture content of that product. It has an impact on the weight, shelf life, flavour, texture, and appearance of food products. The physical and chemical properties of a product can be negatively impacted by even small variations in the moisture level. As a result, the anticipated moisture content of the optimized instant wheat bran upma mix was 3.68±1.32/100gm, which was compared to the study (Singh Vishwavidyalaya *et al.,* 2017) the moisture content was found to be 37.57/100gm of instant upma encultured with foxtail millet semolina and soy grits which is higher than the instant wheat bran upma mix. However, with the lower moisture content, the shelf-life of the products can be increased.

The estimated energy content of the developed product was found to be 220.33±2.51/100gm, which was compared to the study (V Maske *et al.,* 2020) the energy was found to be 376kcal/100gm of instant mix with the incorporation of Bengal gram and soy flour which is higher than the developed product. "Low-calorie foods" were first introduced to the market to meet specific dietary and slimming needs. This food category was created for diabetics and people suffering from specific medical conditions such as obesity and heart disease.

Proteins have a variety of functions in the life process that are essential for survival. As one of the most crucial nutrients, protein should therefore be consumed in sufficient amounts (Wu *et al.,* 2014). The protein content of the optimized product was found to be 35.11±2.10. The protein content was very high when compared to other studies (V Maske *et al.,* 2020), the protein was found to be 13gm in the developed instant upma mix with the incorporation of Bengal gram and soy flour.

Fat is required for a variety of purposes in our body, making it an essential component of a healthy diet. It shortens the duration it takes for the stomach to empty and enhances the flavour of the food. For the absorption and utilization of fat-soluble vitamins like vitamin A and carotene, dietary fat is required (Lhachimi *et al.,* 2020). The fat content of the optimized product was found to be 5.45±1.40 which was compared to the study (Sm Rodge *et al.,* 2018) the fat content was found to be 13.63/100g of instant upma mix incorporated with Foxtail millet and Garden cress seeds.

Dietary carbohydrates encompass sugar alcohols as well as other compounds that can be metabolized or absorbed and transformed immediately into glucose or pyruvate. The carbohydrate content of the optimized instant wheat bran upma mix was 7.87±1.56. The carbohydrate content (38.44 gm) was very low when compared to the instant upma mix which is incorporated with Wheat semolina (Dhumketi *et al.,* 2018). Hence it was observed that the carbohydrate content of the instant upma mix was lower due to the addition of wheat bran which was a low glycemic index (53.81 GI) (Balasubramanian *et al.,* 2019). Low GI food consumption is unquestionably linked to a decline in modern lifestyle diseases like obesity, diabetes, some types of cancer, and heart disease (Kaur *et al.,* 2016). Hence it was observed low carbohydrate content in the developed instant wheat bran upma. Dhingra *et al.,* 2012, study claims that dietary fiber is essential for the prevention of a number of diseases, such as diverticulosis, constipation, irritable bowel syndrome, cancer, and diabetes. The dietary fiber of the optimized instant wheat bran upma mix was found to be 3.58±1.65. According to the study (Sm Rodge *et al.*, 2018), the fiber content was found to be 4.07/100g of instant upma encultured with foxtail millet and garden cress seeds.

Table 9 Mineral Composition of Instant Upma Mix (IUM)

Nutrient	Control	Instant upma mix
Calcium (mg)	150±0.89	178.43±3.05
Iron (mg)	3.69±0.71	87.63±2.26
Phosphorus (mg)	24±0.67	34.90±1.67
Potassium (mg)	116.99±1.73	120.63±2.15
Magnesium (mg)	0.45±0.08	41.15±1.14
Manganese (mg)	0.12±0.01	0.43±0.004
Sodium (mg)	127.62±1.18	1933.8±3.05

Miller *et al.*, 2001, states that calcium is an essential nutrient, which requires for certain biological processes like nerve conduction, muscle contraction, cell adhesion, mitosis, blood coagulation, and structural support of the skeleton. Reduced hypertensive disorders of pregnancy, lower blood pressure, particularly in younger people, mitigation of osteoporosis and colorectal adenomas, lower cholesterol levels, and lower blood pressure in children of mothers who consumed enough calcium during pregnancy are just a few of the health benefits associated with adequate calcium intake (Cormick *et al.*, 2021) (Beto, 2015). The calcium content was found to be 178.43mg in the formulated instant upma mix and whereas the calcium content of (Sethy and Mogra, 2020) ready-to-cook Dalia mix was found to be 58.30±0.20 mg/100g which was lower when compared to the instant wheat bran upma mix.

Iron requires to complete a variety of metabolic functions in all living things, such as the transportation of oxygen and the production of DNA and electrons. Iron is a key component of haemoglobin, a type of protein found in red blood cells that aid in the transportation of oxygen from the lungs to every area of the body. Therefore, it also aids in the development, growth, and regular synthesis and operation of hormones and cells (Abbaspour *et al.*, 2014). As a result, anticipated that the developed instant mix has 87.63mg of iron which is significantly higher when compared to the (Geetha *et al.*, n.d.) ready-to-use millet-based composite mix where the iron content was found to be 1.42±0.04 mg/100g.

Phosphorus (P) is a crucial nutrient that plays important roles in both skeletal and non-skeletal tissues as well as in the synthesis of energy. Moreover, phosphorous triggers intricate physiological reactions and functions as a signaling molecule. It is understood that maintaining phosphorus homeostasis is essential for well-being (Bird and Eskin, 2021). The formulated instant wheat bran upma mix was evaluated for phosphorus content and the results obtained were 34.90±1.67 mg/100g.

Magnesium (Mg) is a necessary nutrient that is involved in almost all of the key metabolic and biochemical processes that take place inside the cell. Magnesium is necessary for bone development, DNA repair, oxidative, immunological, and neuromuscular processes, as well as cell proliferation. Moreover, it is critical for maintaining electrolyte balance as well as calcium, sodium, and potassium homeostasis, all of which are crucial for maintaining excitable membrane stability. There is evidence that a lack of magnesium increases the risk of osteoporosis, metabolic syndrome, type 2 diabetes, and cardiovascular disease (Costello and Rosanoff, 2020; Sakaguchi, 2022). The magnesium content of the instant upma mix was found to be 41.15±1.14 mg/100g which has significantly high when compared to the study (Sg Rodge *et al.*, 2022) incorporated with popped sorghum upma mix (0.789 mg/100g).

Manganese (Mn) has many different roles in the human body, and modest dietary needs of 1.8 and 2.3 mg per day for normal healthy women and men, respectively, have been established. Dietary Mn insufficiency is not a public health concern, but excessive exposure to Mn does occur and can have serious neurological effects due to its abundance in the earth's crust and widespread industrial use. Mn buildup in the brain, particularly in the basal ganglia, interferes with neurotransmitter systems, leading to cognitive and movement impairments resembling Parkinson's disease as a result (Erikson and Aschner, 2019). The manganese content of the formulated instant mix was found to be 0.43±0.1mg/100g.

Sodium, which is found in the extracellular fluid and regulates both plasma volume and cellular transport, is crucial to health. Many physiological processes are performed by it, including nutrition absorption and fluid balance maintenance (Cook *et al.*, 2020). Sodium content was found to be 1933.8±3.05 mg/100g for the developed instant upma wheat bran upma mix. The recommendation of the sodium content for a healthy adult according to WHO 2012 was found to be 2000mg/day (Nutrient requirements for Indians – ICMR-NIN, 2020 - Metabolic Health Digest). Hence, the developed product helps to meet the daily requirements of the healthy adult.

Potassium (K) is one of the essential minerals for human health. From a physiological standpoint, it is crucial for muscular contraction, vascular function, and the transmission of electric impulses by nervous system cells (Cruz *et al.*, 2018). The potassium content for the developed instant wheat bran upma mix was found to be 120.63±2.15 mg/100g. Therefore, the recommendation of potassium content of a normal healthy adult according to WHO 2012, was found to be 3510mg/day (Nutrient requirements for Indians – ICMR-NIN, 2020 - Metabolic Health Digest).

Shelf-life Evaluation of the Instant Upma Mix (IUM)

One of the most significant processes in food production is evaluating the storage stability of the developed product. The term "Shelf-Life" refers to the period of time during which a product maintains a satisfactory level of sensory quality and safe quality to consume. Food products are more suspectable to cross-contamination, deterioration, and decay during the storage period (Das *et al.*, 2020). Table 10 depicted the shelf-life properties which include moisture content, peroxide value, and free fatty acids of the optimized instant upma mix.

Table 10 Shelf-life evaluation of instant upma mix

Day	Moisture content (%)	Peroxide value (mEq/kg)	Free fatty acid % (oleic acid)
0th day	0.31±0.10	Non detectable	0.38±0.36
1st day	3.5±0.73	0.57±0.13	0.23±0.11
15th day	3.78±1.2	0.63±0.16	0.30±0.16
30th day	3.83±1.14	0.76±0.13	0.32±0.10
45th day	4.3±0.55	0.88±0.10	0.41±0.06
60th day	4.48±0.42	0.95±0.05	0.54±0.10

During the storage period, the moisture content ranges from 0.31% to 4.48%. on the 0th day, it was found to be 0.31 and on the 15th day, the result was obtained as 3.78% whereas the anticipated result was found to be 4.48% on the 60th day. The moisture content for the stored upma mix till the 60th day was found to be within the safer limit. The moisture content should be maintained under 10% to prevent contamination (microbial growth) and also to increase the shelf-life of the product (Vera Zambrano *et al.,* 2019).

Peroxide forms during fat oxidation (Mora-Escobedo *et al.*, 2015). The determination of peroxide helps in indicating the deterioration of fats (Shobha *et al.*, 2011). Whereas the peroxide value was found to be 0mEq/kg on the 0th day and slightly increases on the 15th day (0.63mEq/kg). On the 30th it was found to be 0.76mEq/kg, whereas the peroxide value from the 0th day to the 45th it was found to be 0.88 mEq/kg, and on the 60th day, peroxide value was found to be 0.95mEq/kg. The Peroxide value of the instant upma mix was lower when compared to the study (Sethy and Mogra, 2020) ready-to-cook Dalia mixes (4.10 mEq/kg). Peroxide value should not exceed 10mEq/kg. So, the peroxide value of the developed instant wheat bran upma mix was found to be within the safer limit. The determination of free fatty acid during storage is to find out the rancidity. The increased content of free fatty acid during storage may be due to the breakdown of hydroperoxide because thermal processing denatures lipases (Khan *et al.,* 2012). Free fatty acid was evaluated for the instant wheat bran upma mix for 60 days on 15 days intervals. On the 0th day it was found to be 0.38%, 1st day it was 0.23%, 15th day it was found to be 0.30%, and on the 30th day, 45th day, and 60th day it was found to be 0.32%, 0.41%, and 0.54%. The free fatty acid content was similar to the study (Kumar Sharma, 2008) using soy-fortified instant upma mix.

Microbial examination during storage stability is one of the most important and crucial processes because it is influenced by microorganisms (Noah *et al.,* 2017). Table 11depicted the microbial quality of the stored instant upma mix tillthe 60thday. In the present investigation, the formulated and standardized instant wheat bran upma mix was kept at room temperature in a zipper pouch for 60 days at regular intervals while being tested for storage stability. The total bacterial count was discovered to be 83cfu/gm on day zero, and there has been no growth in the total yeast and mould count. The total bacterial count gradually increases from day 0 to day 60, and on day 15, the total yeast and mould count was found to be 2 and 5 cfu/g, respectively. Bacterial growth was discovered to be 210cfu/g and 25fcu/g on the 45th and 60th days, respectively. When compared to the first day, there is a marginal increase in the yeast and mould count, but it is still within safe limits (Bolton *et al.,* 2009). This might be a result of the inclusion of wheat bran. The blend was discovered to be within the safer limit up until the very final day of the storage investigation.

Table 11 Microbial quality during shelf-life

Day	Total bacterial Count (Cfu/gm)	Total Yeast Count (Cfu/gm)	Total Mould Count (Cfu/gm)
0th day	83.23±0.70	Nil	Nil
1st day	105.29±0.69	Nil	Nil
15th day	130.39±1.18	2.30±1.45	5.14±1.17
30th day	150.53±1.21	8.29±0.62	5.37±1.20
45th day	210.01±0.97	10.01±0.98	12.23±0.68
60th day	250.15±0.78	14.30±0.60	20.26±0.64

Table 12 Cost estimation of instant upma mix

Ingredients	Rate (Rs) Per Kg	Instant wheat bran upma mix	
		Quantity (G)	Cost (Rs)
Raw material cost (A)			
Wheat bran	24	79	1896
Rice flakes	80	35	2800
Carrot	125	20	2500
Beans	125	20	2500
Green chili	80	0.50	40
Curry leaves	10	0.20	2
Coriander leaves	15	0.20	3
Mustard seeds	140	0.50	70
Black gram dal	155	5	775
Bengal gram dal	100	5	500
Turmeric powder	230	0.50	115
Red chili powder	450	0.50	225
Salt	15	3	45
Total raw materials cost			11,471
Processing cost (B)			
Electricity	10/unit		20
Processing fee	1500	1kg	37.5
Labor cost	300/8 hours	2 hours	75
Total processing cost			132.5
Total cost A+B			11603.5
Cost Rs/kg			116.03
Cost of 100/gm			11.6

Cost calculation

The cost was estimated for the formulated and standardized instant wheat bran upma mix. The (Table 12) shows the costs associated with producing cost of the instant wheat bran upma mix. The cost of raw materials and processing was calculated. According to (Kumar Jain *et al.*, 2018) the cost of raw materials was noted as Cost A and the cost of processing was noted as Cost B. Processing cost for the developed product includes the cost calculation of electric charges, processing fee, and labor cost. For manufacturing 1kg of instant upma mix on average, the total cost was Rs. 116.03 Per kg. The total cost of the developed product is Rs. 11.6 Per 100g whereas the commercial instant upma mix ranges from 25 to 70 per 100g. Hence the developed product not only contains dense nutrients and also a cost-efficient product and can be affordable by lower socioeconomic populations.

CONCLUSION

Nowadays instant mixes are preferred by most consumers. Instant mixes can become an alternative food for breakfast because of their high energy and nutrient content, ease of preparation, and minimum serving time. A good quality instant upma mix was made by the combination of Wheat bran 79gm and Rice flakes 35gm.The present investigation, concludes that the Response Surface Methodology was successfully used for the optimization. The mix was found to be organoleptically accepted with the highest sensory score. It was more accepted by the panel members. It has an excellent nutritional profile that is rich in protein, energy, calcium, and iron and contains low carbohydrates with a low-fat profile. Low GI food consumption is unquestionably linked to a decline in modern lifestyle diseases like obesity, diabetes, some types of cancer, and heart disease. Consuming enough amount of calcium helps in lowering multiple fractures, osteoporosis, and diabetes. The developed instant upma mix was also assessed for microminerals, showing significant results. The microbial quality was within the safer limits. When compared to the commercial mix the developed was found to be cost-efficient. This could be the introduction of a new product from wheat bran and rice flakes that also contribute to health benefits and cost efficient. Hence, the developed instant mix could be an alternative to ready-to-eat breakfast cereals.

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