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FOOD SCIENCE

Optimization of anjeer, chicory and oats concentration for the preparation of prebiotic burfi

Yogesh Patel[1], Prity Singh[1*], Satya Prakash Yadav[1], Smita Singh[1], Dinesh Chandra Rai[1]

Department of Animal Husbandry & Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005,UP,India

*Corresponding author e-mail: pspritysingh3@gmail.com

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ABSTRACT

The present research work was carried to prepare a special anjeer, chicory, oat *Burfi* with improved product characteristics and consumer acceptability. Levels of different component were optimized using response surface methodology. Besides that, physico-chemical properties such as moisture, fat, carbohydrate, protein, ash and energy content were also analysed. Sensory evaluation of product was done on a 9 point hedonic scale by a panel of experts for color, body and texture, flavor, sweetness and overall acceptability. Fat, Protein, carbohydrate and ash content was respectively 16.6%, 11.55%, 57.86% and 3.06%. Per gram of *Burfi* provides 317kcal of energy. The color, body and texture, flavor, sweetness and overall acceptability of product was respectively 81.25%, 82.5%, 80.00%, 86.25% and81.25%.

HIGHLIGHT

- A mixed proportion of anjeer, chicory and oats alongwith the richness of milk provides the essential nutrients as well as energy as required by the body.

Key Words: *Burfi*, Anjeer, Chicory, Oat, sensory evaluation, overall acceptability, RSM.

Burfi is one of the most popular traditional dairy based sweet in Indian market. *Burfi* is prepared by heating special type of khoa called dhapkhoa with sugar to a homogenous consistency (Chetna *et al.* 2009). The market for traditional Indian milk-based sweets like kajukatli, patisa, mysorepak, badamhalwa, gulabjamun and many more alone is estimated at $500m. Moreover the sweet market is growing annually at a rate of 15%. Among all sweets *Burfi* is the most preferred one as they are premium sweets and also have a long shelf life of around 10 days (Vijayalakshmi *et al.* 2005) or more. People are now more aware of health and health risks. Thus, there is a need to develop sweet products fortified with health beneficiary fruits and cereals.

Depending on the ingredients mixed with it, there are many varieties of Burfi available in market viz., kajuburfi, pista Burfi and fruits and spices added to it, viz., coconut Burfi, mango Burfi and cardamom Burfi etc. (Navale *et al.* 2014). However, Burfi prepared with combination of anjeer, chicory and oat have not been tried so far.

Anjeer (*Ficuscarica*) is a very nourishing fruit as it is rich in vitamins, mineral elements, water, and fats (Baby *et al.* 2011) and used in many industrial products. Anjeer is a rich source of fiber, copper, manganese, magnesium, potassium, calcium and vitamin K, according to the USDA data. Figs are often recommended to nourish and tone the intestines and act as a natural laxative because of their high fibre content. They are also a good source of polyphenols and flavonoids (Vinson *et al.* 1999)

Chicory (*Cichoriumintybus*) roots are baked, grounded and used as coffee substitute (Pazola and Ciesbak, 1979) and additives as it contains high amount of inulin~15-20% and oligofructose~5-10%

(Kathy,1999). According to FAO (2010) the coverage of area under chicory production is 0.159 million hectares with a productivity of 6.23 t/ha in India (Acharya *et al.* 2013). It possess a number of highly desirable attributes, such as safe for diabetics, low calories, no carigenicity, selective source of dietary fiber, and strong bifidus-stimulation. They further add to the functionality in food products by adding texture, taste, mouthfeel and can help replace sugar and fat (Bryan, 2009). It has been reported that roasted chicory extracts posses antihyperglycemic and antidyslipidemic effects alongwith the improved bowel movement (Nishimura *et al.* 2015). One of the studies has also revealed that oral chicory supplementation improves iron homeostasis in patients with beta thalassemia (Farhangi *et al.* 2016).

Oat (Avena sativa) is a healthy, wholegrain ingredient. They provide carbohydrate, protein, fibre, vitamins and minerals, as well as antioxidants and other important nutrients. Oat contains beta-glucans, a type of soluble fibre. Studies have indicated that consumption of oats may lower bloodpressure (Keenan *et al.* 2002). Wholegrain cereals like oat with low glycemic index and high dietary fibre diets are associated with reduced risk of development of type 2-diabetes and heart disease (Liu *et al.* 1999; Wolk *et al.* 1999). Besides these, the plants like bamboo possess prebiotic properties due to the presence of non-digestible dietary fibres as well as carotenoids, phenolic compounds and phytosterols (Singh *et al.* 2012). The objective of our study was to develop a value-added prebiotic burfi with taste and health.

Materials and Methods

Materials

Milk was taken from Dairy Farm of Animal Husbandry and Dairying department, IAS, BHU to prepare khoa. Anjeer, sugar, Kellog's oat and Britannia Ghee was purchased from local market of Varanasi while roasted Chicory root was purchased from Meerut.

Preparation of Burfi

2 litres of milk was continuously heated and stirred at mid flame to prepare a thick semi solid mass, khoa then sugar @5% was added to prepare control. For conducting the experimental trial of *burfi* different concentrations of anjeer, chicory and oat were added before adding sugar as per levels suggested by RSM (Table 1). The material was spread on a plate greased with ghee and allowed to cool for some time, and then cut into rectangular shaped *Burfi*. *Burfi* of each formulation were made three separate times.

Experimental Design

Response surface methodology which involves design of experiments, selection of levels of variables in experimental runs, fitting mathematical models and finally selecting variable levels by optimizing the response (Khuri and Cornell, 1987) was employed in the study. A central composite rotatable design (CCRD) was used to design the experiments comprising of three independent variables (Table 1). Twenty experiments were performed taking into account three factors, viz., anjeer, chicory and oat.

Statistical Analysis

Statistical analysis was done by central composite Rotatable Design method using a commercial statistical software package design expert 9.0.5. Analysis of variance (ANOVA) was performed on experimental data for fitting the model represented by equation 1 to examine the statistical significance of model terms. Data obtained from Anova is shown in Table3.

$$Yk = f(A, B, C) \quad \ldots\ldots (1)$$

Where A is Anjeer (%), B is Chicory (%) and C is Oat (%).The response were represented as Y_1 (Color and appearance), Y_2 (flavor), Y_3 (Body and texture), Y_4 (sweetness), and Y_5 (OOA). The general assumption for optimization is Yk where, K is (1,2,3,4, 5,6) is function of independent parameters shown by the above equation. The most common used model for denoting response as a function of independent parameter is a second order polynomial equation of the form described below.

$$Yk = \beta o + \sum \beta i\, Xi + \sum \beta ii + X^2 + \sum \beta ij Xi Xj$$

Where,Yk = Response,

βo , βi , βii and βij= constant, linear, quadratic and cross product regression coefficients.

Xi's = actual value of the independent variables

Mathematical model was evaluated for each response using multiple regression analysis.

Table1: Experimental runs and actual values of factors used in central composite rotatable design

Trial No.	Factors			Sensory Responses				
	Anjeer(%)	Chicory(%)	Oat(%)	Color& appearance	Body and texture	Sweetness	Flavor	OAA
1	1	1	0.5	8	9	8	8	9
2	3	0.625	1	9	9	8	8	8
3	1	0.25	0.5	8	9	9	9	9
4	3	0.625	1	9	8	7	8	9
5	5	1	0.5	8	9	8	9	9
6	3	0.625	1	9	8	9	9	9
7	5	0.25	0.5	8	7	9	8	8
8	1	0.25	1.5	8	9	9	8	9
9	6.36359	0.625	1	8	9	9	9	9
10	3	0.625	0.159104	9	9	9	9	8
11	1	1	1.5	7	8	8	8	8
12	3	-0.00567231	1	7	8	7	8	7
13	3	0.625	1	8	8	9	8	8
14	3	0.625	1.8409	8	9	8	8	9
15	3	0.625	1	9	8	8	9	9
16	3	1.25567	1	7	8	9	8	8
17	5	1	1.5	9	8	8	9	9
18	0.363586	0.625	1	8	9	7	8	7
19	5	0.25	1.5	9	7	8	9	8
20	3	0.625	1	9	7	7	9	7

The modeling was started with quadratic model including linear, square and interaction terms. Significant term in the model for each response were found by analysis of variance (ANOVA) and significance was judged by F statistic calculated from the experimental data. Model adequacies were checked by R^2, Adj-R^2, pred-R^2. After model fitting, residual analysis including the examination of diagnostic plots and calculation of case statistics were conducted to validate assumption used on each response and to fit polynomial model to experimental data. Statistical significance ($p<0.05$) of all main effect was determined and regression coefficient of proposed model were calculated.

Sensory Analysis

Sensory evaluation of optimized ACO *Burfi* was performed by the panel of 10 judges from the Department of Animal Husbandry & Dairying and Food Science and Technology at Institute of Agricultural Science BHU, Varanasi. Hedonic rating where 1 represented 'dislike extremely' and 9 represented 'like extremely' (Larmond, 1997) was used for color, body and texture, flavor, sweetness and overall acceptability.

Chemical Analysis

Fat was determined by Gerber method using a cheese butyrometer (IS: 1224 1958). Protein content of Burfi was determined by the Kjeldahl method as prescribed by Devis and McDonald (1953). Ash and moisture content was calculated as per the method of AOAC (1995). Carbohydrate content was calculated by differences.

Results and Discussions

The statistical significance of the model term was examined with the help of regression analysis and analysis of variance (ANOVA). It was observed that the lack-of-fit test (F values) for all the models were insignificant (Fcal<Ftab), implying that the models were accurate enough to predict the responses (Table 2).

Table 2. Predicted score of the suggested formulation of prebiotic Fibres Anjeer Burfi by design expert 9.0.5

Factors				Sensory Responses				
Trial No.	Anjeer (A)	Chicory (B)	Oat (C)	Color& appearance	Body and texture	Sweetness	Flavor	OAA
1	3.000	0.625	1.000	8.3	9	8.3	8.6	9
2	5.000	1.000	1.500	9	9	8.7	8.4	8.3
3	1.000	1.000	0.500	8.2	9	9	9	9
4	1.000	0.250	0.500	9	8.2	7.6	8.4	9
5	5.000	1.000	0.500	8.4	9	8.2	9	9
6	1.000	0.250	1.500	9	8.5	9	9	9
7	5.000	0.250	1.500	8.6	8	9	8.2	8.5
8	5.000	0.250	0.500	8.5	9	9	8.5	9
9	1.000	1.000	1.500	8.4	9	9	9	9
10	3.782	0.433	0.571	9	9	9	9	8.4

Table 3: ANOVA for different predicted models for responses

Source	Degree of freedom	F-Value				
		Color & appearance	Flavor	Body & Texture	Sweetness	OAA
Model	9	3.29	1.18	1.79	0.24	0.52
Anjeer (A)	1	2.68	4.14	3.00	0.45	0.57
Chicory (B)	1	0.30	1.850E-015	0.75	0.011	0.73
Oat (C)	1	0.14	0.86	0.75	0.57	0.047
AB	1	0.51	2.08	5.12	0.14	1.56
AC	1	4.57	2.08	6.815E-015	0.14	0.17
BC	1	0.51	3.701E-015	1.28	0.14	0.17
A^2	1	2.84	0.084	2.44	0.027	6.714E-003
B^2	1	19.26	1.17	0.34	0.027	0.50
C^2	1	0.11	0.084	2.44	0.75	0.76
Residual	10					
Lack of Fit	5	1.96	0.60	0.95	1.30	1.16
Pure Error	5	-	-	-	-	-

Table 4: Constraints and criteria for optimization for burfi

Name	Constraints	Goal	Lower Limit	Upper Limit	Lower weight	Upper weight	Importance
A:Anzir	is in range	1	5	5	1	1	3
B:Chicory	is in range	0.25	1	1	1	1	3
C:Oats	is in range	0.5	1.5	1.5	1	1	3

Optimization

The numerical optimization technique of the Design-Expert software (9.0.5) was used for simultaneous optimization of the multiple responses. The constraints have been listed in Table 4. The desired goals for each factor and response were chosen. Responses obtained after each trial were analyzed to visualize the interactive effect of various parameters on sensory attributes of *Burfi*. Optimized solutions obtained from the Design Expert Software for the sensory is given in Table 4. Out of 10 suggested formulations, formulation no. 7 had a good combination of sensory properties. Hence formulation no 7 was prepared as optimized product. Further studies for the chemical compositions of only optimized Burfi were done.

Sensory Evaluation

Color and Appearance

In the present study effect of Anjeer(A), Chicory(B) and Oat(C) on color and appearance could be described by the following quadratic equation.

Color and appearance = +8.82+0.22 * A-0.073 * B-0.050 * C+0.13 * AB+0.38 * AC-0.12 * BC-0.22 * A^2-0.57 * B^2-0.044 * C^2

ANOVA F-value was determined to examine the goodness of fit for the developed model (Table3). The F-value for the model for color and appearance was significant (P<0.0388). The co-efficeint of estimation of color and appearance of *burfi* showed that color was enhanced with anjeer concentrations while increasing chicory level decreased the appearance of *burfi*. The response shown is given in Fig.1.

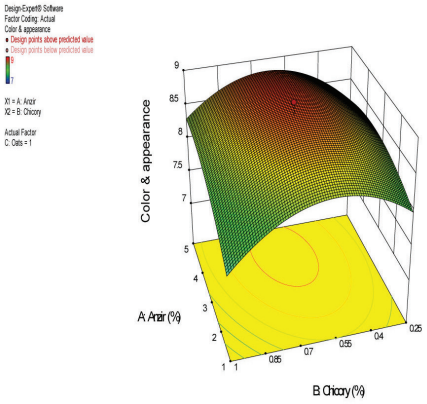

Fig. 1: Effect of anjeer, chicory root and oat on colour and appearance

Body and texture

In the present study effect of Anjeer(A), Chicory(B) and Oat(C) on body and texture could be described by the following quadratic equation.

Body and texture = + 8.01 - 0.29 * A + 0.15 * C + 0.50 *AB + 1.689E - 015 *AC - 0.25 * BC + 0.26 * A^2-0.096 * A^2 - 0.096 C + 0.26* C^2

It was found that body and texture of Burfi varied accordingly. The F-value for the model for Body and texture was significant (P<0.1893). The optimized product score was 8. Increasing chicory level decreased the texture of *burfi*. The response shown is given in Fig.2.

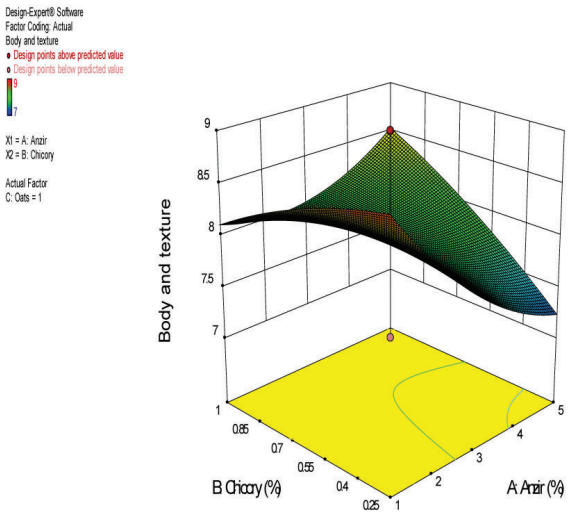

Fig. 2: Effect of anjeer, chicory root and oat on body and texture

Sweetness

In the *Burfi* 5% of milk sugar was added. In Anjeer it contains some extra sweet and in Chicory it naturally contains extra sweetness due to presence of high amount of fructose. In the present study effect of Anjeer(A), Chicory(B) and Oat(C) on sweetness could be described by the following quadratic equation

Sweetness = +7.99 +0.17*A +0.027*B -0.20*C _0.13*AB -0.12*AC+ 0.13*BC +0.042*A^2 +0.042*B^2 +0.22*C^2

ANOVA F-value was determined to examine the goodness of fit for the developed model (Table3). The F-value for the model for sweetness was

significant (P<0.9773). Effect of concentrations of anjeer, chicory and oat on sweetness of *Burfi* is shown in Fig.3.

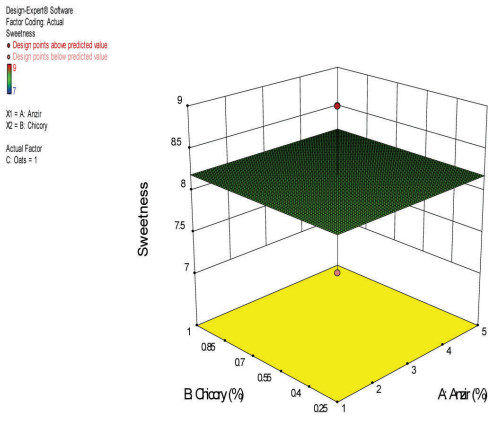

Fig. 3: Effect of anjeer, chicory root and oat on sweetness

Flavor

Effect of anjeer, chicory and oat on taste and flavor of *Burfi* is explained by following equation.

Flavor = + 8.49 + 0.29 * A- 2.709E *B - 0.12 * C + 0.25 * AC + 1.432E - 015 * BC + 0.037 * A^2 -0.14 * B^2 + 0.037 * C^2

ANOVA F-value was determined to examine the goodness of fit for the developed model (Table3). The F-value for the model for flavor was significant (P<0.3973). Flavor score was 8, though increasing concentrations have positive impact on flavor but other qualities were reduced. Effect of concentrations of anjeer, chicory and oat on flavor of *Burfi* is shown in Fig.4.

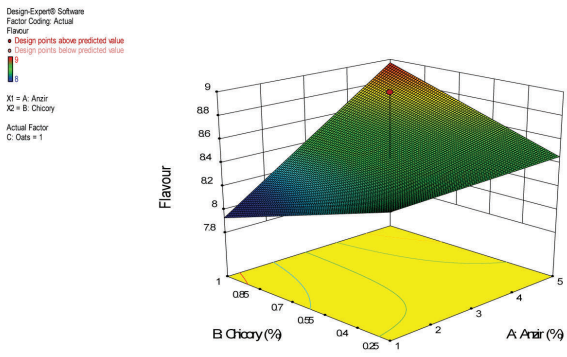

Fig. 4: Effect of anjeer, chicory root and oat on flavor

Overall acceptability

In the present study effect of Anjeer(A), Chicory(B) and Oat(C) on OAA could be described by the following quadratic equation

OAA = + 8.31 + 0.17 * A+ 0.20 * B + 0.050 * C + 0.38 * AB +0.13 * AC – 0.12 * BC + 0.018 * A^2 -0.16 * B^2 +0.20 * C^2

Here A, B, and C are coded terms for three variable viz. Anjeer, Chicory and Oat respectively. The coefficient estimates of OAA showed linear model. ANOVA F-value was determined to examine the goodness of fit for the developed model (Table3). The F-value for the model for Body and texture was significant (P<0.8313). The Model F-value of 0.52implies the model is significant. R^2 was found to be0.3182, indicating that Std. Dev. (0.85) of the variability in the response could be explained by the model. The 'Pred -R-squared' of –2.2463 is in reasonable agreement with the 'Adj R-squared' of -0.2955. OAA of product was 8.5. It could be observed from Fig.5 that higher chicory concentration decreased OAA of the product.

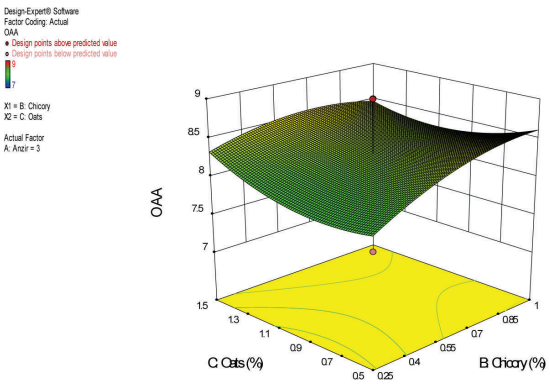

Fig. 5: Effect of anjeer, chicory root and oat on overall acceptability

Chemical Analysis

The chemical composition viz.fat, protein, carbohydrate, minerals and calorific of the optimized *Burfi* prepared using 5% anjeer, 0.25% chicory root and 1.5% oat was determined and the results are presented in Table 5. Experiments were performed in triplicate.

Table 5: Chemical composition and calorific value of burfi

S.No.	Composition	Contents (in %)
1	Fat	16.6
2	Protein	11.55
3	Ash	3.069
4	Carbohydrate	29.70
5	Moisture	10.92
6	Energy (kcal/100g)	317.370

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