STUDIES ON UTILIZATION OF PAPAYA PEEL AND SEED POWDER FOR DEVELOPMENT OF FIBER ENRICHED FUNCTIONAL COOKIES

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ABSTRACT

The focus of this research project was to develop papaya peel and seed powder from matured papaya and utilizing the papaya peel and seed powder for the development of functional cookies. In this regard, functional foods play an outstanding role. Fresh papaya was blanched, peeled, cut into small pieces, further washed and treated with sanitizer, tray dried and finally grinded to powder form. The Response Surface Methodology (RSM) was used in the optimization of functional cookies to pinpoint the best combination of the most important factors, in order to obtain an enhanced product with quality characteristics similar to the typical one. Sensory evaluations of all fortified functional cookies were also carried out and it was found that 3.82% papaya peel powder and 1.24% papaya seed powder blend for cookies formulation was acceptable. Therefore 3.82% papaya peel and 1.24% seed powder based formulated cookies enhanced nutritional properties, physicochemical characteristics and organoleptic attributes.

Keywords— Functional Cookies, Papaya peel powder, Papaya seed powder, RSM

1. Introduction

In this year of industrialization and technological advancement, the life style of the people has changed. With the changing lifestyle, demand for ready to eat and convenient foods has increased considerably.

Functional foods are similar in appearance to conventional foods, the former being consumed as part of the normal diet. Functional foods are foods that have a potentially positive effect on health beyond basic nutrition. In contrast to conventional foods, functional foods, however, have demonstrated physiological benefits and can reduce the risk of chronic disease beyond basic nutritional functions. Functional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates, *etc*., needed for its healthy survival (Cencic and Chingwaru, 2010).

Carica papaya belongs to the family of *Caricaceae*, and several species of *Caricaceae* have been used as medication against a variety of diseases. It was originally derived from the southern part of Mexico, *C. papaya* is a constant plant and it is presently distributed over the whole tropical area. All parts of the papaya plant can be used as medicine, the fruit flesh, flowers, seeds and the flowers. Many scientific investigations have been conducted to evaluate the biological activities of various part of *C. papaya* including their fruits, shoots, leaves, rinds, seeds, roots or latex (Maisarah *et al*., 2013).

Response Surface Methodology (RSM)

Response Surface Methodology (RSM) is a collection of statistical techniques for designing experiments, building models, evaluating the effects of the factors and searching for optimal conditions of factors for desirable responses (Myers 1976).Generally, optimization was done by means of varying one parameter while keeping the others at a constant level or varying both parameters. The main disadvantage of this method was that it does not include interactive effects among the other variables, and also does not represent the effects of various parameters on their responses. RSM, which uses CCRD to fit a first- or second-order polynomial by a least significance technique, is used to optimize the variables for the development of biscuits with high protein and dietary fiber. The RSM technique gives the effect of an individual parameter as well as interactive effect of the parameters (Kumar *et al*., 2015). It is a collection of mathematical and statistical techniques useful for analyzing and optimizing the response of multivariate systems (Nahemiah *et al*., 2015).

The aim of present research was to use the RSM technique as a statistical and methodological approach to enhance and maintaining the quality characteristics of the original one in the new product. The development of the mathematical models represents useful tools that are able to predict the effect due to the different settings of factors on the most important characteristics of this kind of cookie (texture, color and moisture content).

2. Methodology

Raw materials

Raw material preparation- waste form the papaya i.e papaya peel and papaya seed powder was prepared on the basis of required quality parameters and necessary pre-treatments such as washing, grading, sorting etc., was carried out. Refined wheat flour and other ingredients were purchased on the basic of quality parameters from local market.

All raw materials purchased on the basis of required quality parameter from the local market of Kolhapur, Maharashtra**.**

Methods

Preparation of papaya peel powder
↓
Washing in normal water
↓
Peeling manually by using peeler
↓
Peels cutting and washing
↓
Keep in a tray and drying at 60°C for 24 hrs. in tray drier
↓
Grinding and sieving (30mesh size)
↓
Packing in polythene and Keep in sealed container

Figure 1. Flowchart of preparation of papaya peel powder (Bokaria and Ray, 2016)

Preparation of papaya seed powder

Selection of papaya
↓
Washing (remove dirt, dust)
↓
Cutting
↓
Removing seeds
↓
Washing (removal of residue of pulp)
↓

Drying at 60°C

↓

Grinding and Sieving (30 mesh size)

↓

Storage

Figure 2. Flow chart of production of papaya seed powder (Shrivastava, 2002)

Physical and Functional Properties

Physical analysis

The physical parameter i.e thickness, diameter, weight, color, spread ratio of cookies was calculated by AOAC, 1967.

Functional properties

Water and oil absorption capacity (Udachan *et al*., 2012), swelling power (Suriya *et al*., 2016), foaming capacity (Narasinga Rao, 1982), bulk density (Udachan and Sahoo, 2017) was calculated.

Chemical analysis

Moisture, ash Content, protein, fat, crude fiber, carbohydrate and mineral was estimated by AOAC, 2000.

Textural analysis of cookies

Hardness of baked cookies was measured in terms of breaking strength using Texture Analyzer (TA-HD plus, stable Micro systems). Breaking strength of cookies was placed on the platform such that they are supported at two points and the blade was attached to the crosshead of the instrument. Texture analysis instrument, capable of measuring virtually any physical product characteristic such as hardness, factorability, adhesiveness, extensibility of foods (Suriya et al. 2016).

Sensory evaluation of cookies

Sensory evaluation was carried out by a panel of ten semi trained panel members. Hedonic rating test was employed using 9-point hedonic scale. Sensory parameters such as color, taste, texture and overall acceptability were evaluated (Ranganna, 1986).

Development of cookies

Weighing all the ingredients

↓

Creaming

↓

Sieve all dry ingredients mix well

↓

Addition of papaya peel and seed powder

↓

Preparation of dough (addition of water)

↓

Sheeting

↓

Cutting

↓

Baking
(120°c for 30min)

↓

Cooling

↓

Weighing and Packing

Flowchart 3.Functional Cookies production flow chart (Vaijapurkar K. et al., 2015)

Optimization of functional cookies

With the help of response surface methodology (RSM), functional cookies were optimized on the basis of sensory and textural properties.

Statistical Analysis

Optimization 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 was employed in the study (Khuri and Cornell, 1987). To optimize the various parameters for the product response surface methodology (RSM) was used. The experimental data obtained from the design were analyzed by the package Design-Expert® version 9.0.2 software, Stat-Ease. The full quadratic equation of the response variables was derived by using RSM as following Eq.

$$Y = \beta 0 + \beta 1A1 + \beta 2B2 + \beta 3C3 + \beta 11A1\ 2 + \beta 22B2\ 2 + \beta 33C3\ 2 + \beta 12A1B2 + \beta 13A1C3 + \beta 23B2C3 \ldots (1)$$

Where, Y= responses; $\beta 0$ = constant; $\beta 1, \beta 2, \beta 3$ = linear regression;

$\beta 11, \beta 22, \beta 33$ = interaction regression; A1, B2, C3 = variables.

3. Results and discussion

In the present investigation, efforts have been made to develop functional cookies using papaya peel and seed powder to increase the nutritional quality of the cookies. Different trials were done for the development of functional cookies.

Optimization of Fortified functional cookies

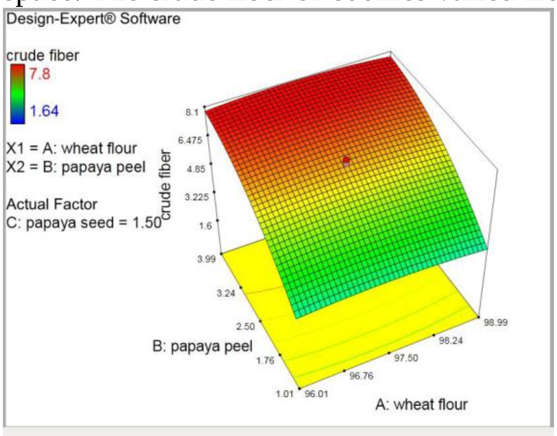
Optimization of Parameters Using a Central Composite Rotatable Design (CCRD), levels of variables viz., wheat flour, papaya peel powder and papaya seed powder were selected through 20 experiments. In order to quantify the curvature effects, the data from the experimental results were fitted to higher degree polynomial equations i.e. quadratic. In these polynomial equations A, B and C are coded terms for the three variables i.e. wheat flour, papaya peel powder and papaya seed powder respectively.

Effect of Crude Fiber

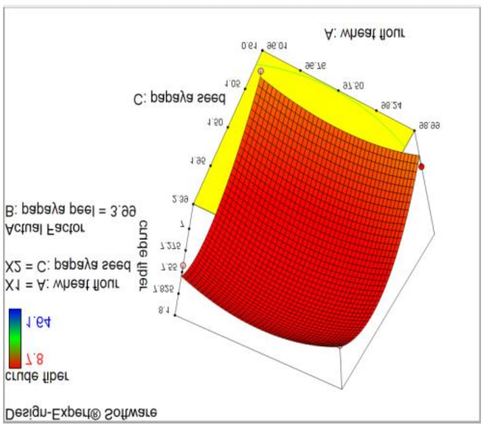
Effect of wheat flour (A), papaya peel powder (B) and papaya seed powder (C) on the crude fiber content of cookies could be described by the following equation:

Crude fiber =+6.86-0.042 * A+2.03 * B+0.82 * C+0.020 * A * B+0.013 * A * C-0.54 * B * C-0.21 * A2-0.84 * B2-0.49 * C2

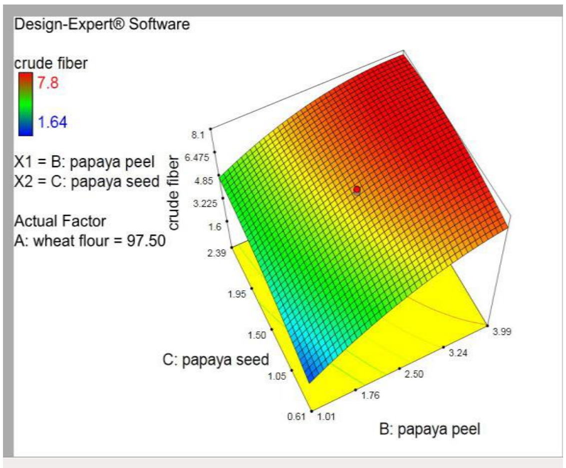
The F-value (74.27) for the model of crude fiber was significant ($p<0.0001$). The coefficient of determination (R2) was 0.98 indicating that 98% of the variability in the response could be explained by the model. The "Pred R-Squared" of 0.8908 is in reasonable agreement with the "Adj R-Squared" of 0.9720. A lack of fit value of 33.38 is found to be significant. Hence, this model could be used to navigate the design space. The crude fiber of cookies varied from 1.64 to 7.8.



A



B



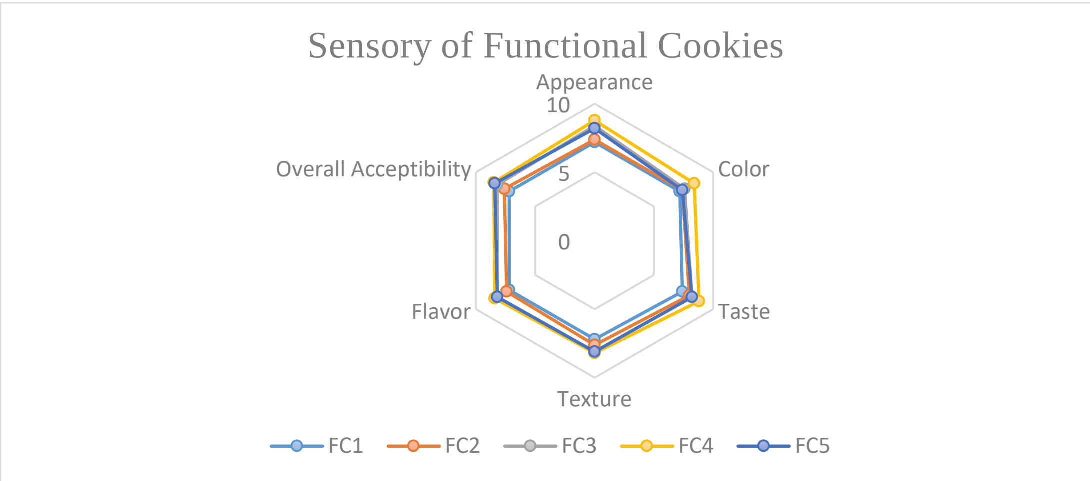
C

Figure no 1. Response surface plots showing interaction effect of variables on crude fiber of functional cookies a) wheat flour and papaya peel powder b) wheat flour and papaya seed powder c) papaya peel powder and papaya seed powder

The highest crude fiber was recorded 7.8 % at 97.50, 5 and 1.50 g of wheat flour and papaya peel powder and papaya seed powder respectively. The response surface plots for crude fiber are presented in fig. 3.2 (a, b & c). The crude fiber increased ($p<0.05$) with increasing the level wheat flour (95 to 100 g) of papaya peel powder (0 to 5g) and papaya seed powder (0 to 3).

Papaya peel powder and seed powder had significant (($p<0.05$) positive effect quadratic level. Interactive effect of papaya peel and seed powder with wheat flour with was positive.

Sensory evalution of optimized functional cookies by RSM



*Each value represents the average of five evaluators

Fig. 7 Sensory attributes of functional cookies

FC1: WF: PP: PS, 98.92: 3.96: 1.15

FC2: WF: PP: PS, 97.84: 3.81: 1.38

FC3: WF: PP: PS, 97.49: 3.7: 1.53

FC4: WF: PP: PS, 96.63: 3.82: 1.24

FC5: WF: PP: PS, 96.35: 3.70: 1.63

FC4 was selected by above sensory evaluation. **FC4** contains Wheat Flour(WF), papaya peel powder(PP), papaya seed powder(PS) i.e 96.63, 3.82, 1.24gm respectively.

3.6 Physico-Chemical Properties of papaya peel and Seed Powder Fortified Functional Cookies and Control cookies

The physico-chemical properties of control cookies (CC) and papaya peel and seed powder fortified functional cookies were analyzed. The weight of the papaya seed powder fortified functional cookies samples was higher than that of control cookies. The width of the control cookies was lower than those of the papaya peel and seed powder fortified functional cookies. Functional cookies gave the highest thickness. The spread ratio is concerned as one of the most important quality parameters of cookies since it correlates well with texture, grain fineness, bite and overall mouth feel of the cookies.

Table 1. Physical analysis of cookies results

Parameter	Control cookies	Developed functional cookies
Weight	12.43 ± 0.12	13.02± 0.2
Diameter	52.17 ± 0.60	54.46 ± 0.29
Thickness	8.28 ± 0.26	8.32 ± 0.26
Spread ratio	6.67 ± 0.27	6.34 ± 0.27
Hardness	1996±59.43	2442±42.53

Data are means of three replicate trials ± Standard Deviation

Table 2. Color analysis of cookies

Sample	L*	b*	b*
Control cookies	41.65±0.15	4.91±0.39	12.31±0.78
Functional cookies	41.09±0.39	2.15±0.42	10.37±0.17

The product parameters like weight, thickness and width and spread factor in case of cookies have direct relation to product uniformity, quality, and consumer acceptance (Chauhan et al. 2015). The weight, thickness, and width of control and functional cookies were not significantly different. In general cookies with higher spread ratios are considered as supremely desirable. The spreadability potential of the flour along with the action of leavening agent and influence of heat would be responsible for the changes in cookie dimensions when baked. Table 1 shows the improvement in diameter of cookies along with raise in thickness due to baking. The width of baked functional cookies was smaller than that of the control cookies. The quality of cookies is widely determined by spread factor which is a relatively complex phenomenon influenced by a wide variety of factors (Pareyt *et al.* 2009). Earlier, Olapade and Adeyemo (2014) reported that the lowest spread ratio implies better rising ability of cookies. As shown in Table 6, the highest spread ratio was observed for control cookies (6.67) and lowest spread ratio for functional cookies (6.34). Similar results were reported in cookies made from wheat-water chestnut flour (Shafi *et al*. 2016).

Table 3. Proximate analysis of cookies results

Parameter (%)	Control cookies	Functional cookies
Moisture	3.35±0.50	2.86±1.67
Ash	0.79±0.12	3.32±0.25
Fat	18.76±0.23	16.54±0.74
Protein	9.90±0.42	24.36±2.26
Fiber	0.83±0.23	7.94±0.7
Carbohydrate	65.96	44.48

Conclusion

In order to utilize and explore the properties of papaya peel and seed powder which is a waste product obtained from papaya processing industry and possess good nutritional value, functional properties, dietary fiber and it can be used for value addition. Optimization of functional cookies was performed using Central Composite Rotatable Design (CCRD) of Response Surface Methodology (RSM).The prepared functional cookies contained higher amount of protein content than control cookies. It was also high in the crude fiber than the control wheat cookies. On the basis of quality evaluation and sensory of the products, it was concluded that the acceptable and protein and dietary fiber rich functional cookies can be prepared with the addition of 3.82% papaya peel powder, 1.24papaya seed powder with 96.63 gm wheat flour.

Authors' contributions

All authors of the paper contributed equally to the writing of the paper and were involved in the overall planning and supervision of the work.

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