Development and Optimization of Unripe PapayaFlakes with Protein Enrichment

S.kandasamy[a], P.Santhiya Devi[b], G.S.Srinidhi[c], K.Sabari[d]

[a]Professor, [bcd]Department of Food Technology, Kongu Engineering College, Perundurai, Tamilnadu, India

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ABSTRACT *Demand of low fat and protein rich products increasing the development of well palatable cereal flakes. The purpose of this project is to develop and optimize unripe papaya flakes with protein enrichment from de-oiled peanut cake. The ingredient were chosen for the protein enriched papaya flakes to reduce the cost. The flakes consisting of different proportion of pre-gelatinized rice flour, corn flour and pectin are evaluated for physio-chemical and sensory characteristics. Present work deals with the development of low-fat protein rich cereal flakes by optimizing ingredients and parameters using response surface methodology (RSM). The optimized product is chosen on the basis of amount of protein, carbohydrate, crude fiber, ash, moisture content and sensory evaluation. The second order polynomial is developed to predict each response. All the organoleptic responses are statistically analyzed.*

Keywords: Protein, Unripe papaya flakes, pre-gelatinized rice flour, de-oiled peanut cake powder, RSM, organoleptic properties.

1. INTRODUCTION

Breakfast cereal, is one of the traditional breakfast food made from processed cereal grains and other ingredients. It is traditionally eaten as part ofa balanced breakfast, or a snack food. Granula (not the same as granola) is the first cold breakfast food, was invented in the United States in 1863 by James Caleb Jackson, operator of Our Home on the Hillside which was later replaced by the Jackson Sanatorium in Dansville, New York. According to research from the International Journal of Obesity, skipping the morning meal is associated with decreased vitality and impaired social as well as with obesity, emotional and mental health functioning. Breakfast cereal is one of the healthiest and cheapest breakfast choicesyou can make. As it is a crispy product, it gives good mouthfeel and taste [1]. Ready-to- eat fruit flakes has lesser amount of calories than almost any other common breakfast option [2]. Papaya Flakes making without drum dryer (Sureka et al. 2014) reduces the cost of production.

1.1 UNRIPE PAPAYA

Green papaya, is also known as Mexican papaya, where it originated. It is pear shaped fruit has a bright green exterior, yellow-green flesh, and a central pocket filled with black coloured seeds. The consistency and texture of this papaya is closer to a mango, and it lacks the sweetness than others that makes regular papaya so popular. The flesh and seeds of the fruit are consumed. The seeds have a slight peppery flavour. This seeds can be used as a spice if the seeds are dried and ground up. This fruit grows on a tree that reaches a height of about 12 feet and bears the scientific name *Carica papaya*. Green papaya and Hawaiian papaya, the former is commonly used more as a vegetable than a fruit because of flavour between them. Green papaya has an excellent profile of nutrient, including high levels of vitamin C, E, A, and folate, iron, potassium, magnesium and other antioxidants [3]. The levels of fat and cholesterol are negligible in these fruits, and there are less than 40 calories in a 100-gram serving. They also contains the significant amount of carotenoids and polyphenols, as well as a required amount of lycopene and various amino acids the body needs [4]. The most important health benefits of green papaya include aiding in skin care as well as soothing menstrual pain, boosting the immune system, protecting against heart diseases, and regulating digestion, among others fruits. This unusual fruit is great for anti- aging, as it can help prevent wrinkles, blemishes, and age spots as we age, as well as treat inflammation and irritation with high concentration of vitamin E and C, amino acids. The fibre content in green papayas is impressive, present in least amount, which can help optimize digestion, increase feelings of fullness, improve nutrient uptake, and balance the pH balance of the stomach. Potassium levels in green papaya are high, which means that this fruit can help control blood pressure. Potassium is a vasodilator, lowering the risk of heart attacks, coronary heart diseases, strokes and relieving pressure onthe cardiovascular system. A single serving of this fruit has more than 70% of your daily requirement for vitamin C, which helps to stimulates the production of white blood cells. This white blood cells are the body's first line of defense against infections and foreign pathogens. Green papaya's active ingredients and dense nutrient profile canhelp to relieve inflammation and affect hormone levels to minimize menstrual pain, shown in the anecdotal evidence and research studies. There is a significant amount of folate, a vitamin B in the green papaya is essential for preventing neural tube defects in babies.

1.2 PRE-GELATINIZED RICE FLOUR

Gelatinization is a process, the starch granules are heated in the presence of liquid, resulting in the swelling of granules and produces viscous fluids to impart the desired quality to food products. An understanding of gelatinization process is a must to obtain the desired quality of food products. Pregelatinized rice flours can be used in food preparations to emulsify, stabilize, bind and thicken. The prepared pre-gelatinized starches are 100% natural ingredients for a true clean label. Pregelatinized rice flours maintain their natural structure via a delicate process based on the natural elements such as water, air, and heat are transformed into ingredients with great properties [5]. Knowing the right amount of energy and water to be added, the best dehydration process, and right milling capacity to get the desired performance is the first basic step to identify the perfect rice variety. Nature of pregelatinized rice flours are white, odourless, and can disperse easily. They work as functional agents, thickeners, emulsifiers, taste-maskers, viscosity enhancers, and also act as a coating material for preparation of dishes [6]. They can substitute and even modified starches. Low molecular weight chains form highly resistant films when used in a batter mix and fried, gives a good structure. This coating capacity has been proved to have a good resistance to freeze-thaw process (frozen, fried food) the entire part of the finished product, creating a good barrier for moisture loss. This is how other flours deliver functionality. It helps to produce gluten-free products [7]. Pre-gelatinized starch favoured the formation of elastic gel like network structure on starch granules. The addition of pre-gelatinized rice flour, especially at high amount, significantly influenced the granular, crystalline and molecular structure of glutinous dumplings, probably due to the structural amorphization of pre-gelatinized starch [8]. Accordingly, the dumplings complexation with suitable pre-gelatinized starch exhibited a better storage, an increased content of slowly digestible starch (SDS), and integrated quality attributes including transmittance, textural properties and cracking rate via weakening the water mobility.

1.3 DE-OILED PEANUT CAKE POWDER

In many countries, Groundnut seeds serve as an important dietary ingredient but owing to its richness in high quality dietary protein and oil it helped to reduce malnutrition in many developing countries. The relation between food, nutrition and health give rise to promotes healthy population and promotes development of the people through satisfaction of needs. This de-oiled peanut cake is the potential source of food-grade protein for the fortification of food products [9]. Such protein could be concentrated through industrially applicable techniques from residual cakes and flour (Deep et al. 2012). De-oiled cake is a rich source of protein for vegetarians, the utilization of this defatted meal into food products could be an excellent vehicle for enhancing the nutritive value to the malnourished people who are taken the groundnut protein in the diets [10]. De-oiled groundnut flour produced from cake blends easily and enhances or enriches the nutritivevalue of wheat and other flour or other food products. This flour is composite flour, used in bakery products, breakfast cereal flakes, snack foods, multipurpose supplement, infant and weaning foods, extruded foods or fabricated food etc [11].

1.4 PECTIN

Pectin is a vegetable fibre in fruits that, generally it forms gel, when combined with water. It act as a thickener when combined with sugar or the acids in sugar. World Health Organization recommends the regular intake of both soluble and insoluble fibre. It's shown that, the regular consumption of substance improves the composition of microbiota. Moreover, it improves the protective factor against symptoms of certain intestinal disorder and against various types of cancers related to the gastrointestinal tract. Pectin is derived from the protopectin, which is found in the middle lamellae of plant cells. Protopectin is insoluble in nature, but is converted to soluble pectin as fruit ripens or is heated in an acid medium. In an acid fruit substrate, Pectin is a negatively charged colloid. As sugar is added to this colloid, the pectin and water equilibrium breaks down, and a fibrous network capable of supporting liquids is established. The gel is formed because of this fibre network necessary for jams, jellies, and preserves.

2. MATERIALS AND METHODS

Unripe papaya and De-oiled peanut cake were procured from local market of Perundurai. Corn flour, Rice flour, Sucrose, Citric acid, Pectin, Liquid glucose, Calcium Carbonate were purchased from local market of Erode District.

2.1 UNRIPE PAPAYA PULP PREPARATION:

Fresh unripe papaya were selected.It is peeled, cut into small pieces and finely ground in mixer. Obtained pulp was covered and stored at refrigeration temperature for further usage (Fig.1).

Selection of unripe papaya

Wash the fruit using clean water

↓

Peeling and cutting

↓

Grinding

↓

Unripe papaya

Fig. 1: Unripe papaya pulp extraction

2.2 PREPARATION OF PRE-GELATINIZEDRICE FLOUR

Pre-gelatinized rice flour was made by adding the water to the flour on the basis of 5/1 (w/w). The mixture then heated with stirring by using spatula until the temperature reaches 70 Degree Celsius. Cover the treated flour with plastic wrap to prevent a film forming on the surface. The pre-gelatinized flour were then cooled 1 hour at room temperature and kept for 24 hour at 4 Degree Celsius (Fig. 2).

Corn flour and water(Ratio 1/5 (w/w))

↓

Whisking together

↓

Heating

(With stirring until the temperature reaches70 Degree Celsius)

↓

Covering

(With plastic wrap to prevent a film formingon the surface)

↓

Cooling

(1 hour at room temperature)

↓

Refrigeration (24 hour at 4 Degree Celsius)

Fig. 2: Preparation of pre-gelatinized riceflour

2.3 PREPARATION OF DE-OILED PEANUT CAKE POWDER

De-oiled peanut cake were purchased. Grind the cake to fine particlesize. After grinding the powder was dried in hot air oven at 60 Degree Celsius for 2 hours to remove the moisture content (Fig. 3).

De-oiled peanut cake were purchased

↓

Grinding

↓

Drying

(In hot air oven at 60 Degree Celsius foe 2hours)

↓

De-oiled peanut cake powder

Fig. 3: Preparation of de-oiled peanutcake powder

2.4 PREPARATION OF PAPAYA FLAKES

Prepare the pulp of unripe papaya. Adding the dry ingredients such as sucrose, pectin, rice flour, corn flour, calcium carbonate and prepared peanut cake powder. Mix well, then adding the Pre- gelatinized rice flour, water and liquid glucose. Adjust the pH to 4 by addition of citric acid. Mix the all ingredients using beater. Dehydrating the paste in hot air ovenat 60 Degree Celsius for 1.5 hour. Drying in electrical oven at 60 Degree Celsius for one hour and 70 Degree Celsius for one hour. Packing the prepared flakes in air tight packaging material. Corn flour, Pre- gelatinized rice flour, pectin at varying composition was added depending upon trials (Fig. 4).

Pulp preparation from unripepapaya

↓

Addition of dry ingredients

(Sucrose, Pectin, Rice flour, Corn flour, Calcium carbonate, Peanut cake powder)

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Addition wet ingredients

(Pre-gelatinized rice flour, Liquid glucose,Water)

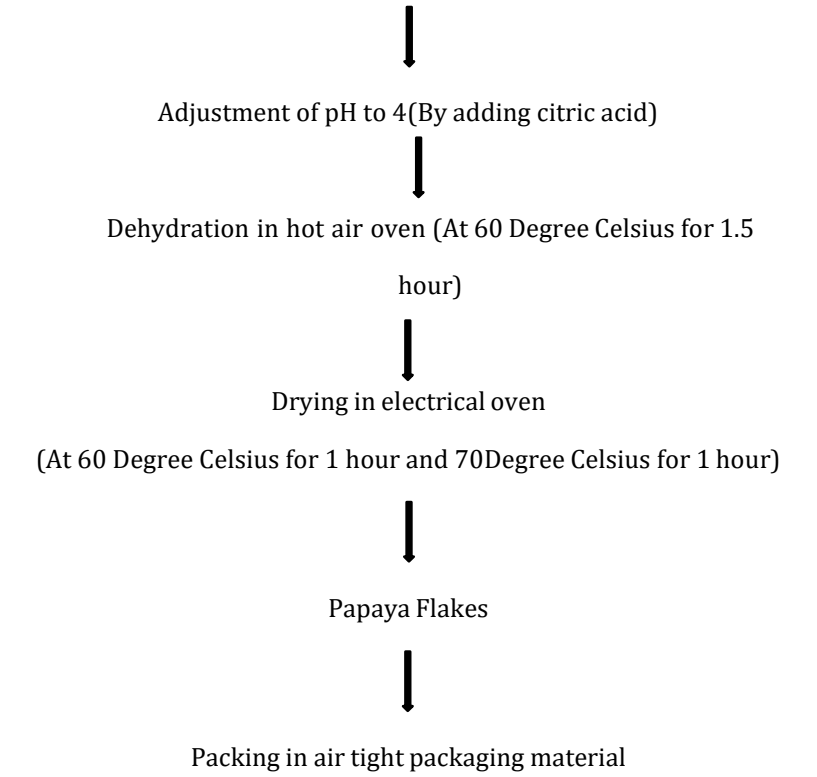


Fig. 4: Preparation of unripe papayaflakes

2.5 EXPERIMENTAL DESIGN

Experimental methods are widely used in research as well as in industrial settings. Design of experiments techniques provides an efficient means to optimize the process. The mixture simplex lattice design was used to find optimum combination of constituents. Design for our project is done using "DESIGN – EXPERT VERSION 7.0" which is statistical dedicated to performing design of experiment. It provides test matrices for screening up to 56 factors and statistical significance of these factors is established with analysis of variance (ANOVA).

3. RESULT AND DISCUSSION

In the present research, we made the breakfast flakes using unripe papaya. Corn flour, pectin, pre-gelatinized rice flour are mixed with various composition in order to know the acceptability of papaya flakes. Physio-chemical analysis were done. The prepared unripe papaya flakes was tested for moisture, ash, protein, carbohydrate, crude fibre and sensory analysis.

Table -1: Data obtained for rawmaterials from analysis

Parameters	Unripe papaya
Moisture (%)	25.98
Ash (%)	3.24
Protein (%)	12.38
Fat (%)	1.15
Carbohydrate (%)	54.86
Crude fibre (%)	1.63
Vitamin C	59.76

Table -2: RSM Data obtained

	Factor 1	Factor 2	Factor 3	Response 1	Response 2	Response 3	Response 4	Response 5
Run	Pre-Gelatinized rice flour, g	Corn flour, g	Pecting	Protein %	Ash content %	Crude fibre %	CHO %	Moisture content %
1	1	10	0.15	17.21	1.53	0.326	47.48	9.55
2	1	5.5	0.2	17.85	1.67	0.319	23.81	9.87
3	3	1	0.2	14.25	1.81	0.326	12.50	9.99
4	3	5.5	0.15	16.29	1.57	0.337	27.44	9.90
5	1	1	0.15	15.40	1.61	0.344	17.95	10.10
6	3	5.5	0.15	16.32	1.45	0.338	27.22	10.10
7	3	5.5	0.15	15.15	1.50	0.336	30.24	10.24
8	3	5.5	0.15	16.35	1.49	0.342	27.18	10.15
9	3	10	0.2	21.58	1.24	0.354	57.51	9.65
10	3	5.5	0.15	16.34	1.45	0.338	33.46	10.16
11	5	1	0.15	14.79	1.51	0.317	30.87	7.76
12	5	5.5	0.1	13.70	1.50	0.315	44.95	7.47
13	3	10	0.1	13.80	1.45	0.338	35.88	9.27
14	3	1	0.1	16.17	0.94	0.327	27.43	10.13
15	5	10	0.15	18.79	1.85	0.369	65.37	7.35
16	5	5.5	0.2	19.55	2.25	0.361	45.42	7.12
17	1	5.5	0.1	17.06	1.83	0.335	23.25	9.21

3.1 EFFECT OF COMPOSITION ONPROTEIN

From that figure 5, Protein content ofthe unripe papaya flakes show less increase with increase in flour content. Rice flour, corn flour contains low percentage of protein. So the variation in composition of rice flour and corn flour influences the protein content on the final product. Final product will be selected based on the high protein content obtained among all the trials. Compared to other sample protein percentage of trial 9 shows high (21.58%). Protein percentage of trial 12 shows low (13.70%).

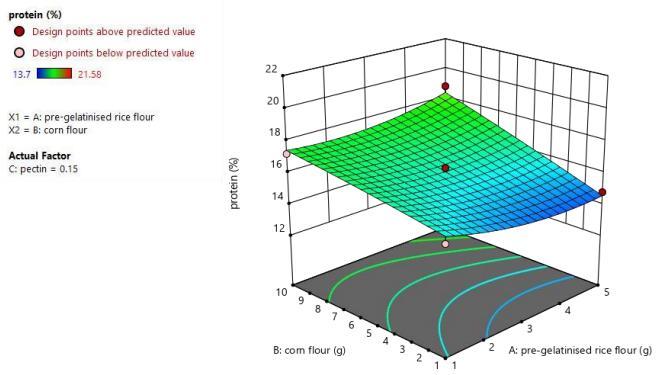


Fig. 5: Effect of composition on protein inunripe papaya flakes

3.2 EFFECT OF COMPOSITION ON ASHCONTENT

From that figure 6, Ash content of the unripe papaya flakes show less increase with increase in flour content. Rice flour, corn flour contains low ash percentage. So thevariation in composition of rice flour and corn flour influences the ash content on the final product. Among all trials, Trial 16 gives high value (2.25%). Likewise, Trial 14 gives low value (0.94%). Final product will be selected based on the high ash content obtained among all the trials

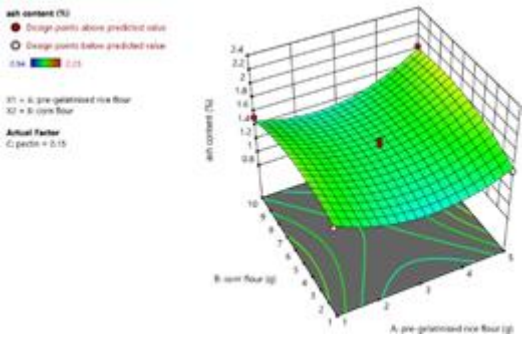


Fig. 6: Effect of composition of flours onash content in unripe papaya flakes

3.3 EFFECT OF COMPOSITION ON CRUDEFIBRE

From that figure 7, Crude fibre of the unripe papaya flakes not increase much with increase in flour content. Rice flour, corn flour contains less amount of crude fibre content. So the variation in composition of rice flour and corn flour not influences much in the

crude fibre content on the final product. Among all the trials, ash content of Trial 15 gives high percentage (0.369%). Likewise trial 12 (0.315%) gives low value. Final product will be selected based on the moderate amount of crude fibre content obtained among all the trials.

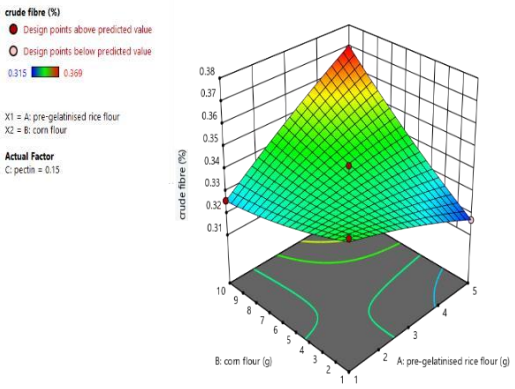


Fig. 7: Effect of composition on crudefibre in unripe papaya flakes

3.4 EFFECT OF COMPOSITION ON CARBOHYDRATE CONTENT

From that figure 8, Carbohydrate content of the unripe papaya flakes increase with increase in flour content. Rice flour, corn flour, pectin contains large amount of carbohydrate content. So the variation in composition of rice flour and corn flour shows much influences in the carbohydrate content on the final product. Amomg all the trial, Trial 15 gives high value (65.37%). Trial 3 gives low value (12.50). Final product will be selected based on the moderate level of carbohydrate content obtained among all the trials.

Fig. 8: Effect of composition on carbohydrate content in unripe papayaflakes

3.5 EFFECT OF COMPOSITION ON MOISTURE CONTENT

From that figure 9, Moisture content of the unripe papaya flakes increase with decrease in flour content. Rice flour, corn flour, pectin increases, the water content will be decreases. So the variation in composition of rice flour corn flour and pectin influences the moisture content on the final product. Above all the trials, Trial 7 shows high value (10.24%). Trial 16 shows low value (7.12%).Final product will be selected based on the low amount of moisture content obtainedamong all the trials.

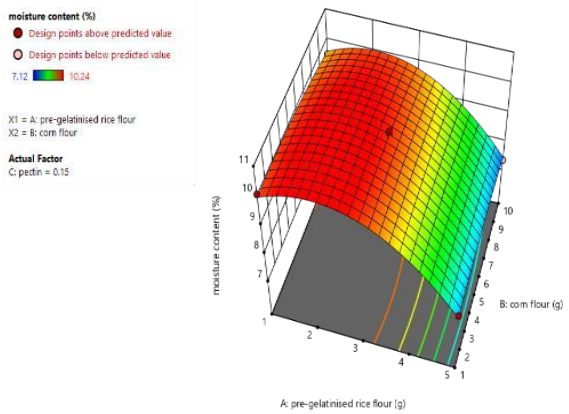


Fig. 9: Effect of composition on moisturecontent in unripe papaya flakes

3.6 ORGANOLEPTIC QUALITY

The sensory evaluation was done by 10 semi trained panel members using 9 point hedonic scale method for colour, texture, mouth feel, taste and overall acceptability.

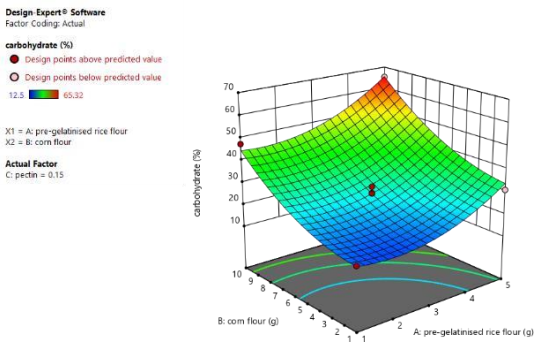


Table -3: Organoleptic Quality

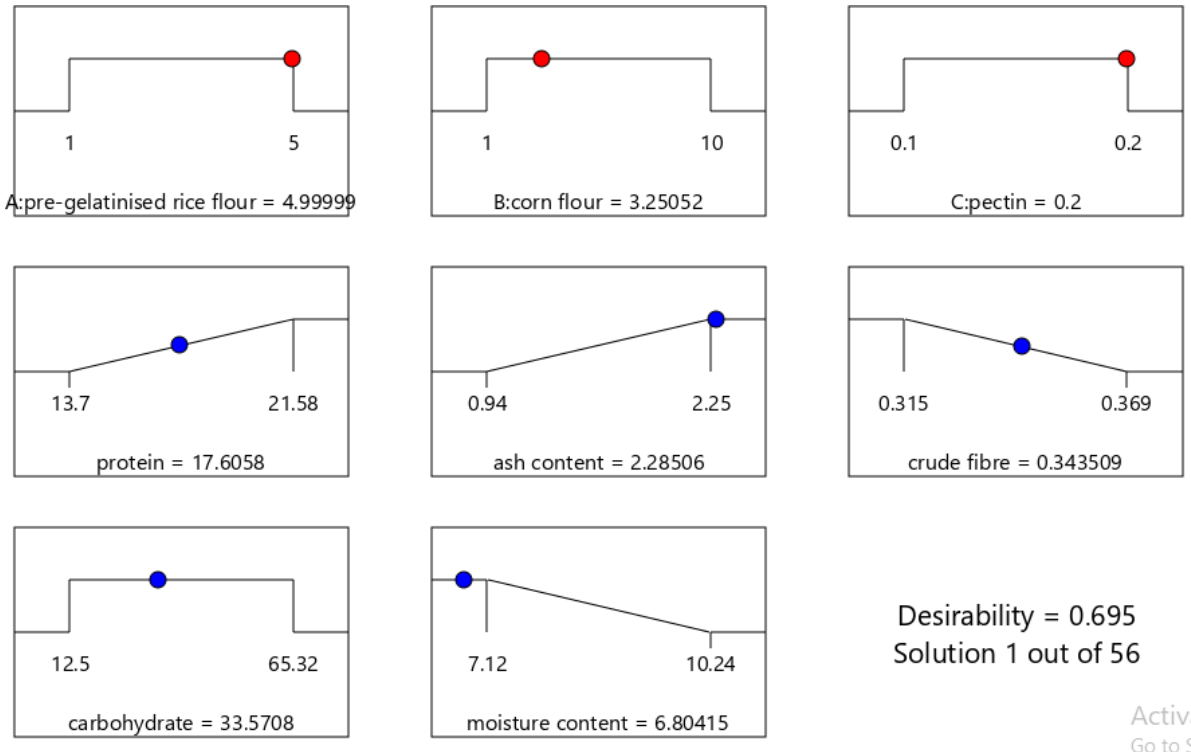
Trials	Score	Rating
Trial 1	8	Like very much
Trial 2	7	Like moderately

Trial 3	7	Like moderately
Trial 4	8	Like very much
Trial 5	6	Like slightly
Trial 6	6.5	Like slightly
Trial 7	7	Like moderately
Trial 8	8	Like very much
Trial 9	8	Like very much
Trial 10	6	Like slightly
Trial 11	7.5	Like moderately
Trial 12	7.5	Like moderately
Trial 13	8	Like very much
Trial 14	7	Like moderately
Trial 15	8	Like very much
Trial 16	8	Like very much
Trial 17	6	Like slightly

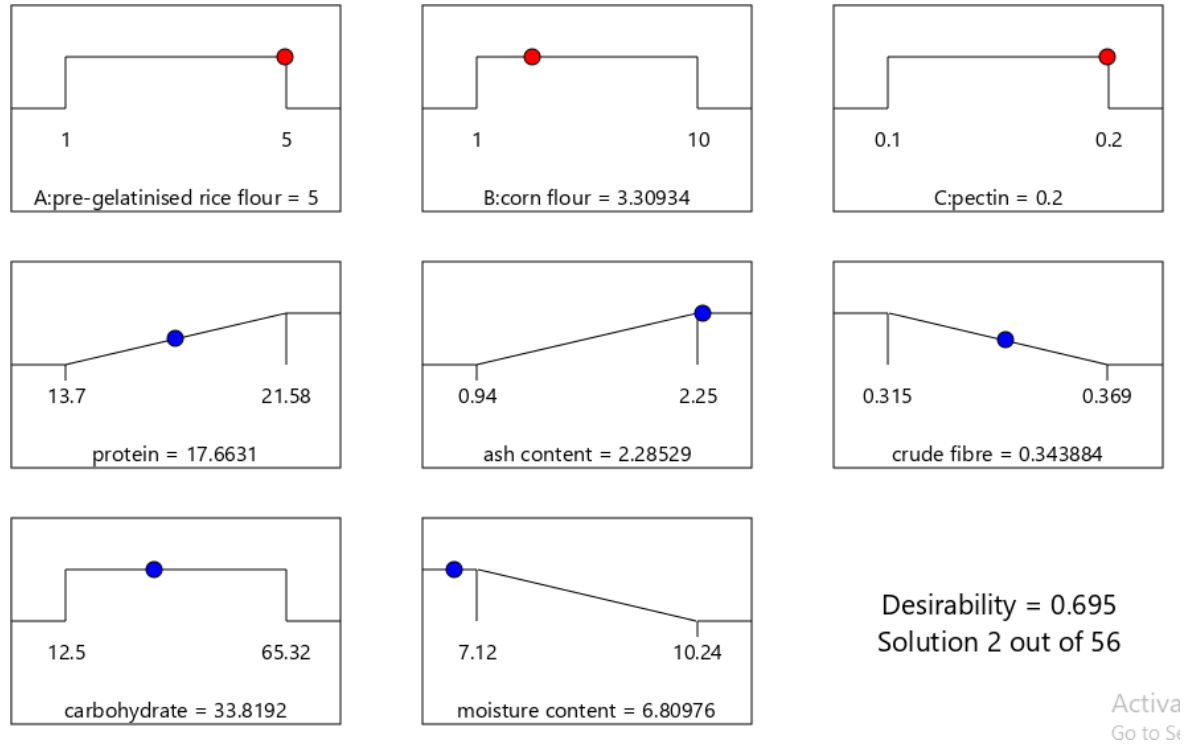
3.7 OPTIMISATION OF UNRIPE PAPAYAFLAKES

The Response surface method (RSM) has suggested 56 solutions as optimized final product. Some of the solutions with highdesirability are:

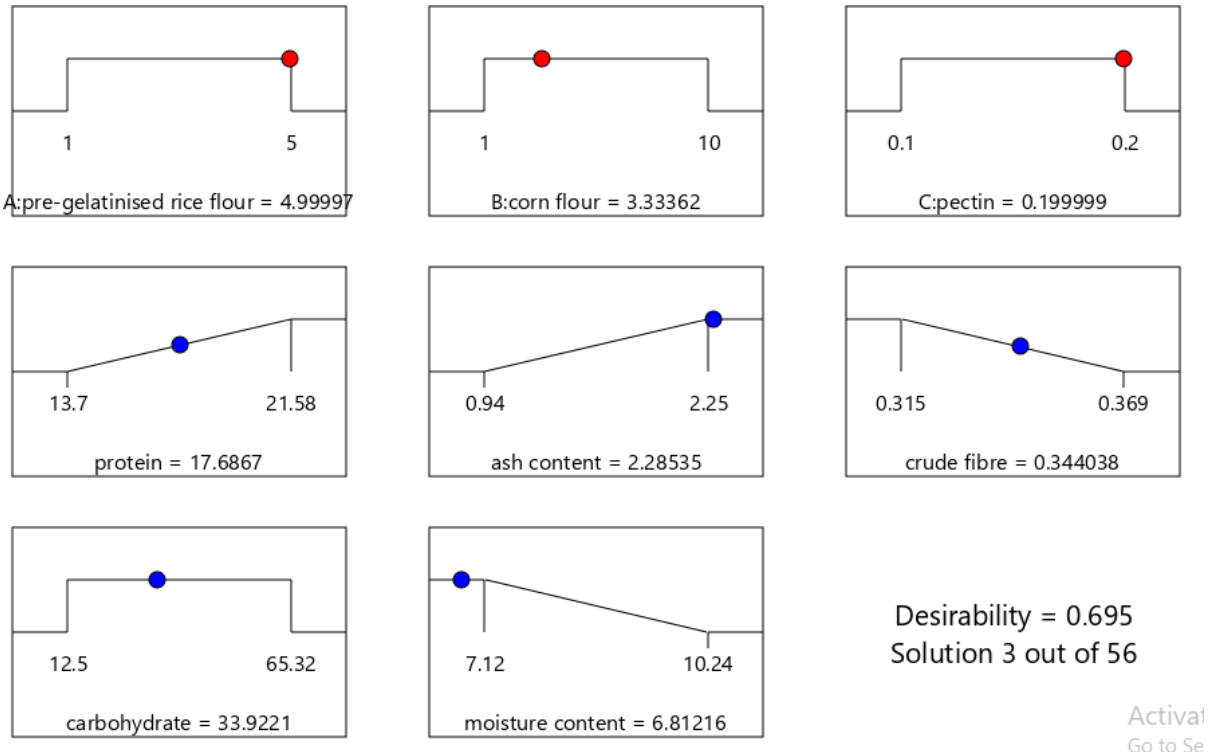
Solution 1



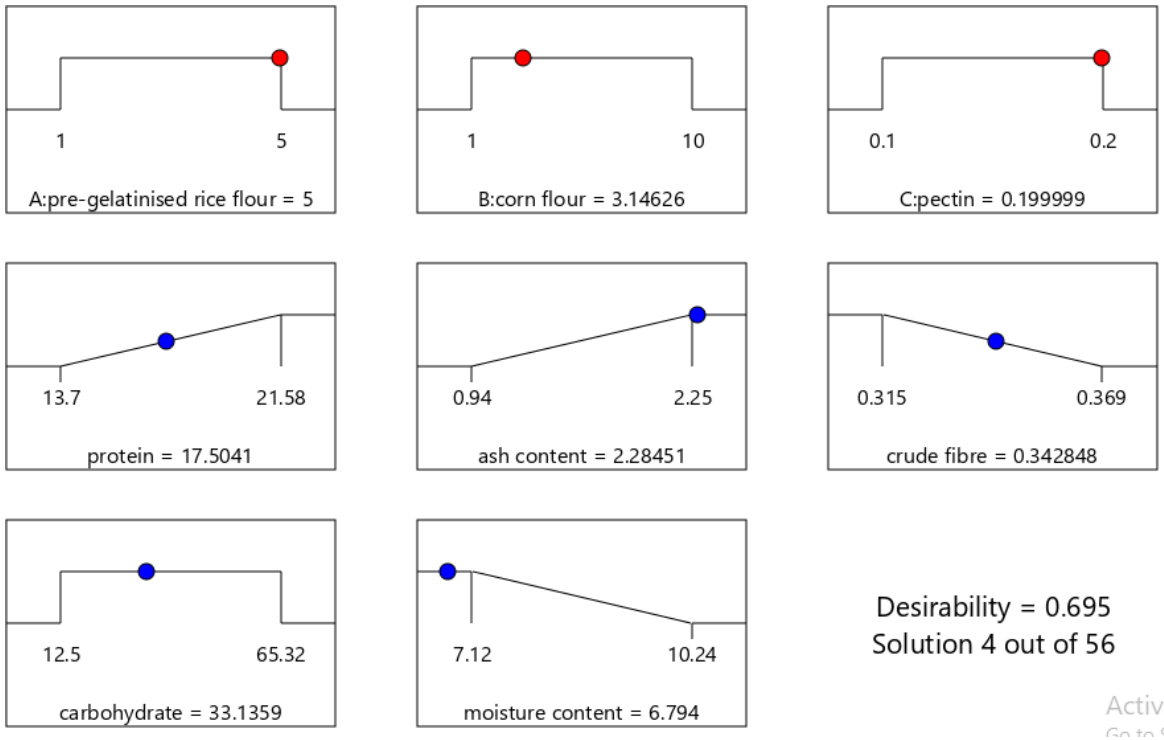
Solution 2



Solution 3



Solution 4



As the quantity of flour increases, it leads to the flour taste in the final product. Whereas when quantity of flour decreases, it produces some cracks on surfaces during drying. Based on the physio-chemical properties and sensory evaluation the pre- gelatinized rice flour, corn flour, pectin in the amount of 5g, 5.5g, 0.2g respectively were acceptable for preparation of unripe papaya flakes. The graph for comparison of sensory evaluation points obtained for the optimisedsample and the overall points obtained isgiven below (Fig. 10):

Fig. 11: Drying of Flakes

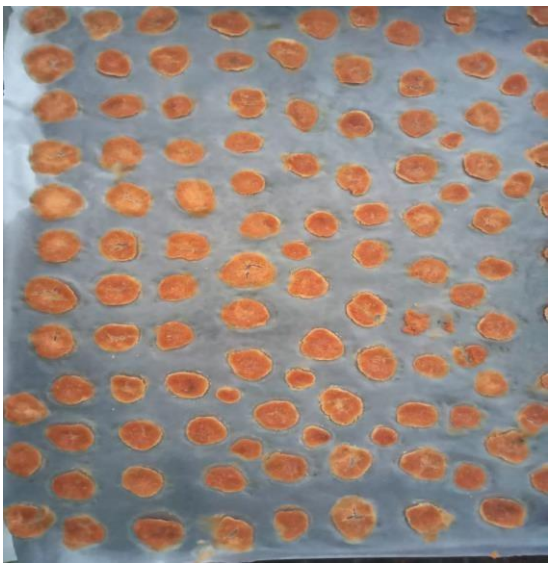


Fig. 12: Final Product

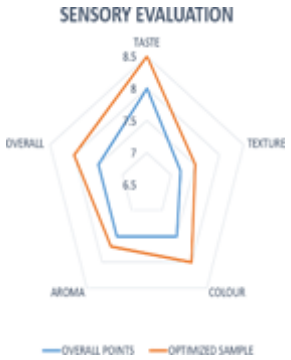


Fig. 10: Organoleptic analysis

CONCLUSION

Present work of unripe papaya flakeswas carried out in different proportions using RSM. The prepared flakes was stored in air tight packaging material for further analysis like protein, carbohydrate, ash content, moisture content, crude fibre. Consumer acceptability of the papaya flakes was known by conducting sensory analysis. Various physio-chemical analysis were examined for the prepared papaya flakes.Result obtained in this study shows that the increase in flour content gives the flour taste during consumption. From that, protein content and ash content should present high amount, carbohydrate and crude fibre content should present moderate amount, moisture content should present low amount in the final product. So, we conclude that trial 16 (Pre-gelatinized rice flour: 5g, Corn flour: 5.5g, Pectin: 0.2g) is the best among all the trials in the form of nutritive value as well as sensory property. Our primary objective of the project to be made protein rich papaya flakes which is achieved.Sensory profile was also found to be high forthe optimised sample.

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