

Development of Fortified Paneer with Dietary Fiber

M.S.Shivasamy^a, J.Lawrence^b, A.Koushikha^c, S.Mahalakshmi^d

^aAssistant Professor, ^{bcd}Department of Food Technology, Kongu Engineering College, Perundurai, Tamilnadu, India

ABSTRACT: Increasing demand of low calorie and high fibre containing products give impetus to dairy industry for development of a well palatable low calorie dairy products like paneer. The objective of the present study was to develop fibre-supplemented paneer. The ingredients were chosen for fibre-supplemented paneer to reduce the cost and calorie content besides providing the functional benefits. The present work deals with the development of low-fat fibre-supplemented paneer by optimizing ingredients and parameters using response surface methodology (RSM). Optimization of ingredients was carried out in terms of dependent variables viz milk fat (3-4.5%) orange peel powder (0.5-1.5%) and pomegranate peel (0.5-1.5%). Full second order polynomial was developed to predict each response. All the sensory responses were statistically analyzed.

Keywords: Fibre .Low calorie .Paneer. Peel .Sensory properties .RSM

I. INTRODUCTION

Fruits and vegetable processing in India generates substantial quantities of waste. It had been previously reported that these wastes and by-products of fruits are an abundant source of antioxidant polyphenols. These peels and pomace are a source of sugars, minerals and organic acids, dietary fibres and phenolic which have a wide range of actions which includes antioxidants, antimutagenic, cardio preventive, antibacterial and antiviral activities. Use of waste as a source of polyphenols and antioxidants may have considerable economic benefit to food processors. Therefore a cheap, efficient and environmentally sound utilization of these wastes is needed.

Paneer is a popular heat and acid-coagulated Indian milk product analogous to the western cottage cheese. It is prepared by coagulating milk with citric acid and pressing the resulting curd into blocks or cubes. The product has a shelf life of 6 days at 10°C (Jagannath *et al* 2001). Paneer consists usually of the protein and nearly all the, insoluble salts and colloidal materials, together with part of the moisture of serum of the original milk in which are contained lactose, whey proteins, soluble fats, vitamins and other milk components. It contains approximately 53-55% moisture, 23-26% fat, 17-18 % protein, 2-2.5 % carbohydrate and 1.5-2.0 % minerals (Kanawjia and Singh 2000). Traditionally, buffalo milk is boiled in a suitable vessel. The coagulant (usually sour whey) from previous batch is added to the hot milk and stirred with a ladle till coagulation is complete as evident from separation of clear greenish yellow whey. The contents of the vessel are emptied over a piece of coarse cloth (to collect coagulum) held over another bigger vessel (to collect whey). The curd, collected by draining the whey, is pressed further to remove more whey and to provide textural properties is finally washed with cold tap water (Anantakrishnan and Srinivasan 1964). However, at pilot plant the paneer was manufactured from buffalo milk with 6 % fat which was heated at 82°C for 5 min in a jacketed vat

(Bhattacharya *et al* 1971). One per cent hot citric acid solution was added at 70 °C. The mixture was stirred continuously till coagulation is complete. The paneer thus formed was separated and pressed (Rao *et al*. 1992). The conventional paneer is quite rich in fat content, which not only pushes up the price of paneer but also makes it unsuitable to those consumers who are conscious of high fat as milk fat increases the risk of coronary heart disease. Recent research has shown that quite good quality paneer could be manufactured from milk with fat content as low as 3.0 % (Kanawjia and Singh 2000). It is estimated that 1% of the country's total milk production is converted into paneer.

1.1 DIETARY FIBRE

Dietary fibre is the edible part of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fibre includes polysaccharides, oligosaccharides, lignin and associated plant substances (American Association for Clinical Chemistry (AACC) 1999). Since the mid 1980s, dietary fibre has been added to some functional as well as medical foods to improve functional properties of the products and to improve gastrointestinal functions by regulating transit time and facilitating absorption of fluid and electrolytes from the gut lumen (Schmidl and Labuza 1994). It is believed that a fibre intake of 30 g per day is desirable, half derived from cereal bran and half from fruits and vegetables. Most of the dietary fibres have good water holding capacity and few of them are readily soluble in water. Upon hydration, majority of them undergo swelling. Dietary fibres have been shown to bind nutritionally important minerals and therefore, they may influence electrolyte and mineral absorption, heavy metal toxicity, etc. Many organic molecules including bile acids, cholesterol, steroid hormones and toxic compounds also get adsorbed by dietary fibres so dietary fibres are beneficial for human health (Study *et al* 1982).

1.1.1 ORANGE PEEL

Oranges are one of the most consumed fruits among the citrus family across the world. That contains active phyto chemicals that can protect the human health. It also provides a good supply of folic acid, potassium, vitamin C and pectin. About 34% of citrus fruit is used for juice production. Therefore, a larger quantity of peel is left every year. It has been recognized by the presence of Polyphenol, vitamins, minerals, dietary fibres, essential oils and carotenoids content which makes citrus a health-benefit promoting fruit. And the essential oil present in the peel has anti-inflammatory properties that boost your immunity power.

1.1.2 POMEGRANATE PEEL

Pomegranate peels help to moisturize the skin. It contains ellagic acid which is an antioxidant. It helps to repair the skin cells naturally and reduces wrinkles. This peel on the skin helps to break the enzymes which affect the collagen of the skin. Per 100 g the skin powder is made up of energy 252.5 kcal, protein 15.56 g, fat 1.228 g, Carbohydrate 44.98 g, Fiber 5.24 g and vitamin C 50.842 mg. FAO/WHO (1973) provided the composition of Amino acids contents as per 100 g of Arginine 8.58 g, Histidine 8.20 g, Lysine 7.08 g, Aspartic 11.19 g, Glutamic 19.4 g and Glycine 15.20 g and USDA (2010) provided the composition of mineral contents containing calcium 10mg, magnesium 12mg, phosphorus 36mg, zinc 0.35mg, sodium 3mg and potassium 236 mg (Sayeeda Fathima *et al*, 2013).

II. MATERIALS AND METHODS

This chapter deals with the materials and methods used for preparation of fruit peel powder and various processes involved in manufacturing of the paneer.

2.1 RAW MATERIALS

Milk was bought from milk society and fruit peels were got from local fruit stall.

2.2 PREPARATION OF FRUIT PEEL POWDER

Fruit peels such as Orange, Pomegranate were manually segregated and cleaned without any dirt, and dried at 60°C until 3% moisture content is obtained. The dried peels are then grinded into fine powder using ball mill grinder and sieved in 212 µm sieve mesh.

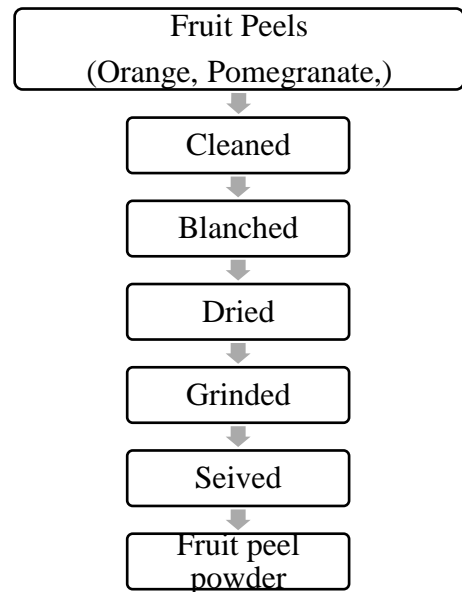


Fig 1: Process flow chart for peel powder preparation

2.3 PREPARATION OF PANEER

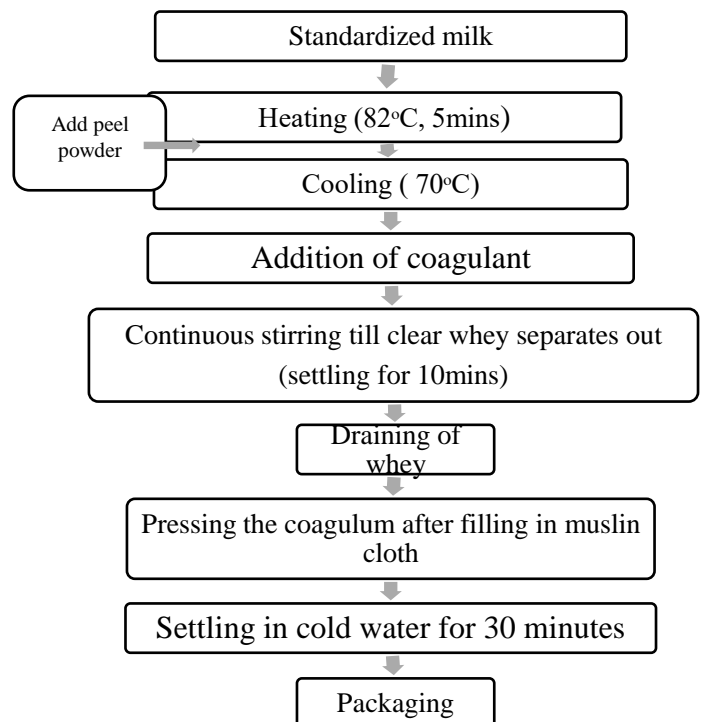


Figure 2 : Process flowchart for paneer making

Initially, the peel powder was added in the standardized milk and milk was heated to 82°C kept for 5 minutes and then it was cooled to 70°C and then coagulant (citric acid 1%) was added. Then it will be stirred continuously for the separation of whey and it was filtered using muslin cloth. And then it was pressed and kept in cold water for the development of paneer texture and it was packed.

2.4 DESIGN OF EXPERIMENT

Design for our project is done using “DESIGN- EXPERT® VERSION 7.0” which is statistical software package State Ease Inc. that is especially dedicated to performing design of experiment. It provides test matrices for screening up to 50 factors and statistical

Significance of these factors is established with analysis of variance (ANOVA).

Table 1: Independent Variables with their Limit

Component Name	Units	Low Actual	High Actual
Fat	%	3	4.5
Orange Peel	%	0.5	1.5
Pomegranate peel	%	0.5	1.5

The experimental design is shown in Table 3.1. The optimization of product is done using responses such as moisture content, ash content, protein content and fibre content

III. RESULTS AND DISCUSSIONS

In this chapter, the results and discussions of the study is presented. It deals with the results on the 17 trails of experiments carried out and effects of process parameters like milk fat, orange and pomegranate peel composition on the response variables that were selected. The experimental values obtained are statistically analysed and presented in graphs as a 3Dimensional representation. The final results were validated by repeated verification of the standard procedure and the analysis of variance was also carried out.

3.1 EXPERIMENTAL RESULTS

By using a Box Behnken design, the RSM was carried out to optimize the moisture content, ash content, protein content, fibre content

Std.	Run	INDEPENDENT VARIABLES			DEPENDENT VARIABLES			
		Fat %	Orange peel %	Pomegranate Peel %	Moisture Content %	Ash Content %	Protein Content %	Fiber %
6	1	3	1	1.5	60.9	2.096	16.8	2.22
3	2	3.75	1.5	0.5	61.2	2.16	17.3	1.86
4	3	3.75	1	1	61.1	2.154	17.2	1.68
2	4	4.5	1	0.5	61.1	2.193	18.4	1.2
7	5	3.75	0.5	0.5	61.4	2.111	17.6	0.84
9	6	3	1.5	1	61.8	2.074	16.6	1.98
5	7	3	1	0.5	61.3	2.152	16.8	1.2
16	8	3.75	1	1	61.1	2.158	17.9	1.68
11	9	4.5	1.5	1	61.4	2.074	18.7	1.98
8	10	3.75	0.5	1.5	60.4	2.081	17.4	1.86
13	11	4.5	1	1.5	60.3	2.163	18.7	2.22
15	12	3.75	1	1	61.2	2.154	17.7	1.62
14	13	3.75	1	1	61.1	2.161	17.5	1.62
10	14	3.75	1.5	1.5	60.8	2.135	17.8	2.52
17	15	3.75	1	1	61.2	2.158	17.4	1.56
12	16	3.75	0.5	1	61.3	2.07	17.6	1.38

1	17	4.5	0.5	1	61.2	2.084	18.5	1.32
---	----	-----	-----	---	------	-------	------	------

Table 2: Experimental runs generated by Box Behnken Design and observed values of response variables

3.2 STATISTICAL ANALYSIS OF PROCESSING CONDITION

In order to study the combined effect of dependent variables such as moisture content, ash content, protein content and fibre content on the effect of end product, experiments were performed for

different combination of the ingredients such as milk fat, orange peel and pomegranate peel composition using statistical designed experiments. The data obtained are statistically analysed and proper model fitting analysis was done.

3.

2.1 EFFECT OF MILK FAT, ORANGE PEEL, POMEGRANATE PEEL ON MOISTURE CONTENT

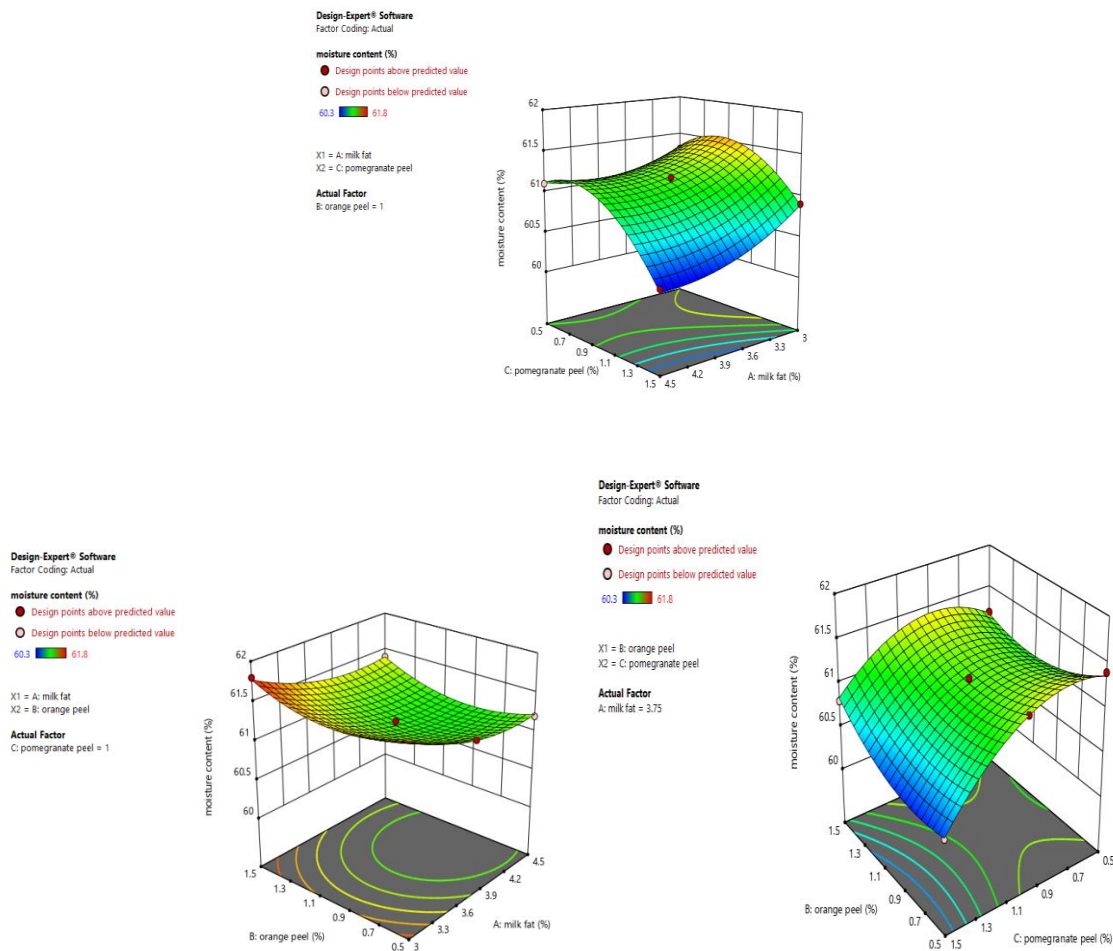


Figure 3: Effect of milk fat, orange peel, and pomegranate peel on moisture content

From the figure 3.1 we have inferred that milk with high fat content shows the high moisture content. Changing the milk fat can affect the fat content vigorously. Milk fat with 4.5% and orange peel with 1.5% has high moisture content. Milk fat with 3.75% and orange peel of 1.5% and pomegranate peel of 0.5% shows low moisture content in the paneer

3.2.2 EFFECT OF MILK FAT, ORANGE PEEL, POMEGRANATE PEEL ON ASH CONTENT

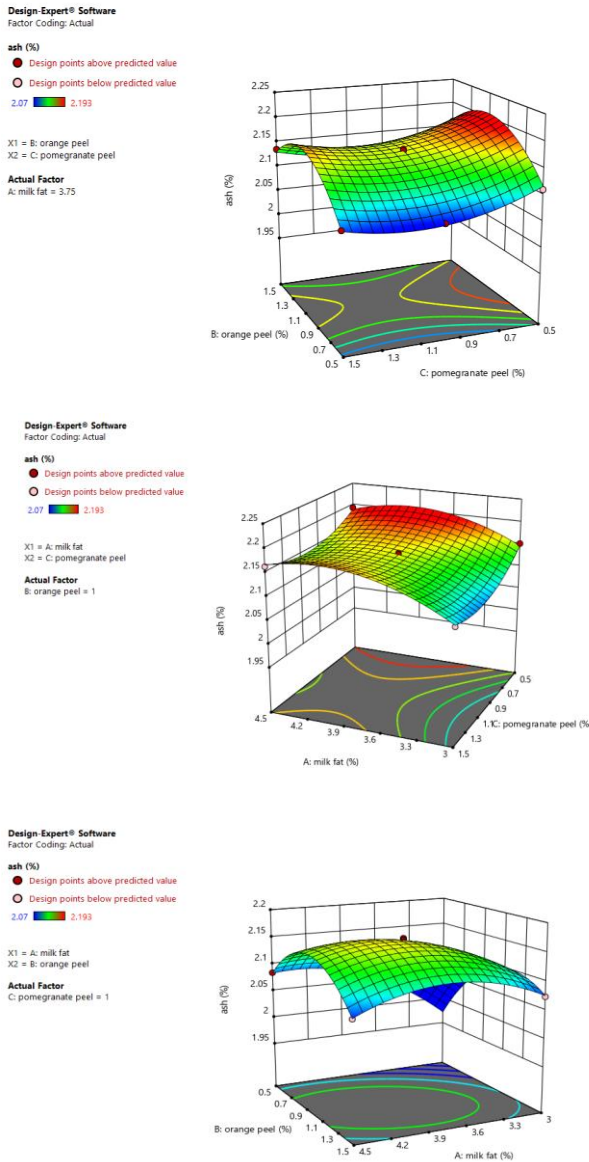
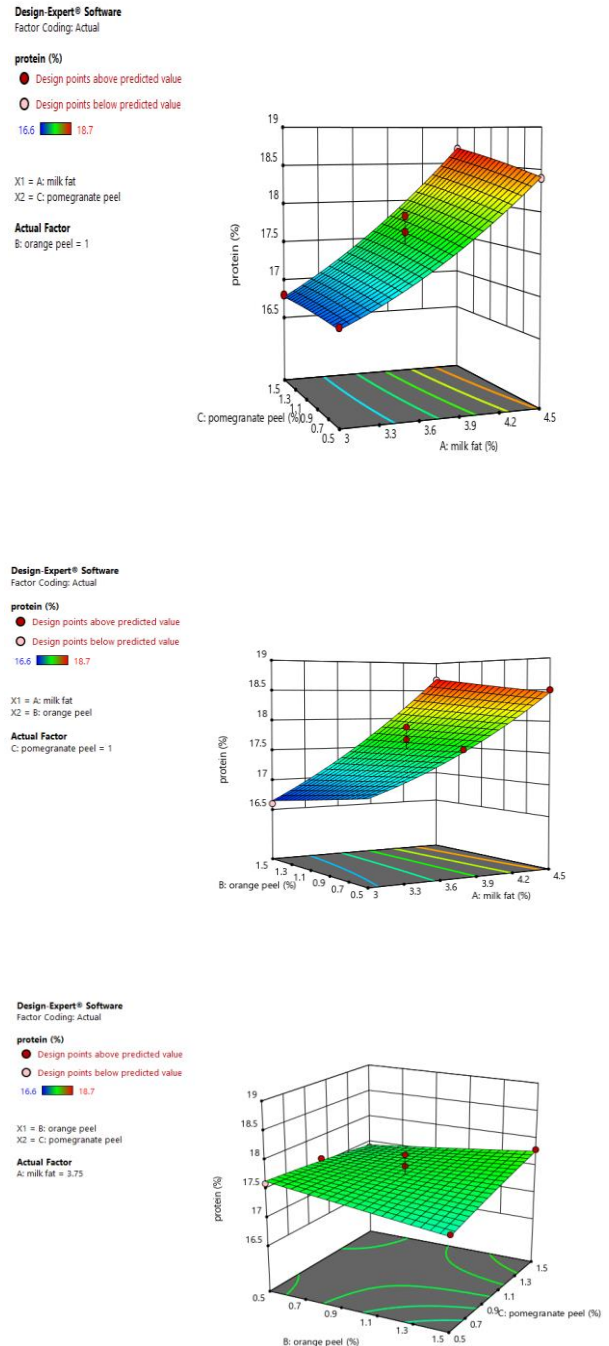


Figure 4: Effect of milk fat, orange peel, and pomegranate peel on ash content

From that Figure 3.2 we have inferred that panner with orange and pomegranate peel composition shows the high ash content. If it is high ash content it shows that the paneer has high mineral and fibre content. Adding orange peel with 1 – 1.5% and pomegranate peel with 1- 1.5% shows the high ash content in the paneer. It shows the less ash content when

low milk fat and lesser composition of orange and pomegranate peel. Adding orange peel with 0.5 – 1% and pomegranate peel with 0.5 – 1% shows the low ash content in the paneer

3.2.3 EFFECT OF MILK FAT, ORANGE PEEL, POMEGRANATE PEEL ON PROTEIN CONTENT



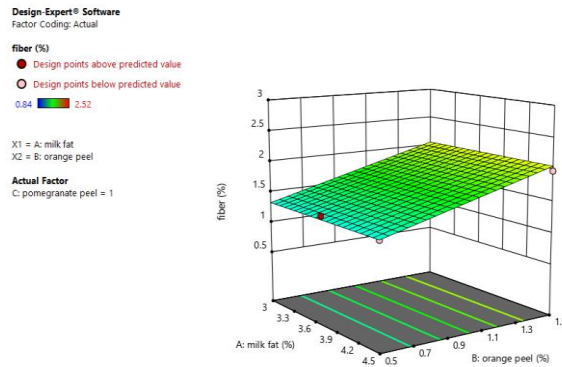


Figure 5: Effect of milk fat, orange peel, and pomegranate peel on protein content

From the figure 4.3 We have inferred that the protein content of the paneer. In this paneer with high amount of orange and pomegranate peel shows the high protein content on the paneer. And less amount of protein content in paneer with low amount of orange peel and pomegranate peel

3.2.4 EFFECT OF MILK FAT, ORANGE PEEL, POMEGRANATE PEEL ON FIBRE CONTENT

Figure 6: Effect of milk fat, orange peel, and pomegranate peel on fibre content

From the Figure 4.4 we have inferred that paneer with high amount of fibre in adding of orange peel and pomegranate peel, adding orange peel of 1- 1.5 % shows the increase in fibre content in the paneer. Orange peel and pomegranate peel positively affect the fibre content in the paneer. Paneer with orange peel of 0.5% and pomegranate peel of 0.5% shows the low amount of fibre content in the paneer.

3.3 ANALYSIS FOR THE OPTIMIZED PRODUCT

Physicochemical and nutritional analysis for protein, fibre, moisture content, ash content were done on the optimized product. The analysed value for the optimized product is moisture content-60.97%, ash content-2.1%, protein content-17.62%, fibre content-2.02

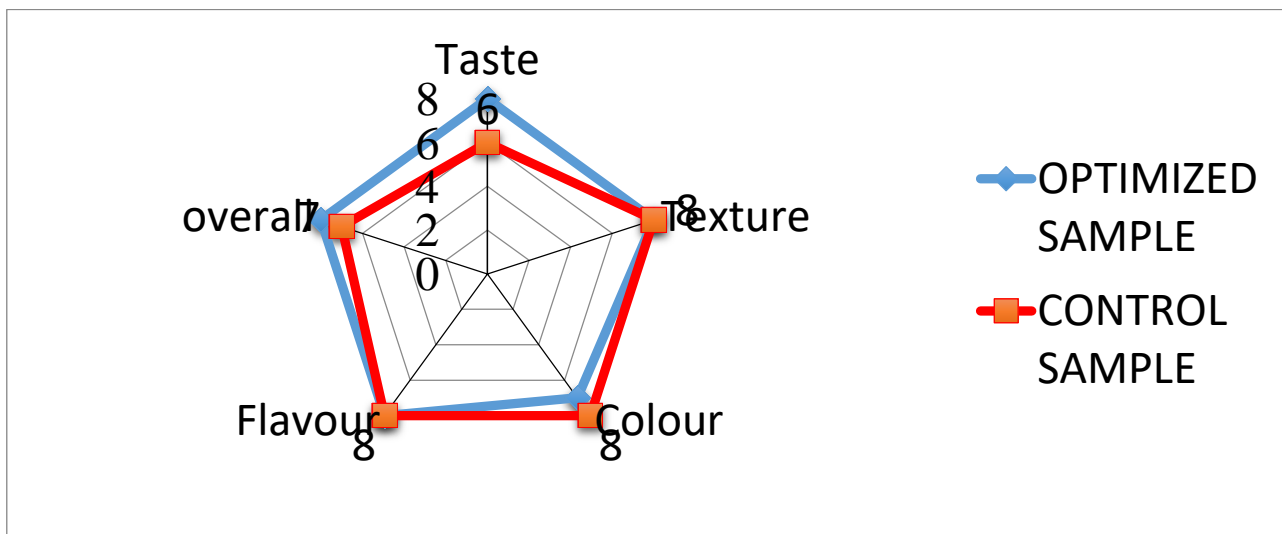
3.4 SENSORY EVALUATION

The sensory evaluation results were carried out using nine-point hedonic scale. The evaluation was done by providing the samples to different age group peoples and noted. The sensory analysis of optimized paneer was performed and was compared to control paneer. The appearance of paneer has higher acceptance than control as it was light yellow due to the presence of carotenes in orange peel. The taste was also accepted to greater range. The texture were lesser than control sample. Addition of orange peel gives good flavour to the paneer. The overall acceptability of the product was higher than the control sample

Table 3: Sensory analysis for optimized sample and control sample

ATTRIBUTES	OPTIMIZED SAMPLE	CONTROL SAMPLE
Taste	8	6
Texture	8	8
Color	7	8
Flavor	8	8
overall acceptability	8	7

Figure 7: Sensory analysis chart for optimized sample and control sample



3.5 COMPARATIVE STUDY BETWEEN OPTIMIZED SAMPLE AND CONTROL SAMPLE

The control and optimized sample were compared based on their biochemical, performed

Table 4 : Analysis for optimized sample and control sample

S.NO	ANALYSIS	Units	OPTIMIZED SAMPLE	CONTROL
1	Moisture content	%	60.97	62.274
2	Ash content	%	2.1	1.9
3	Protein content	%	17.62	15.25
4	Fibre content	%	2.02	0.1
5	Sensory analysis	-	8	7

IV. CONCLUSION

The paneer was developed by adding the orange peel and pomegranate peel as the source for dietary fibre. The paneer were effectively prepared by optimizing the ingredients level using RSM with a minimum number of trials. In this study it was observed that the protein and fibre content of optimized paneer was found to be increased than the control paneer. From the results and interpretations, we could infer that the sample was fortified with dietary fiber was ideal for consumption. Our primary objective of the project is to fortify the paneer with dietary fiber obtained from fruit peel powder which is achieved in this sample. Sensory profile was also found to be high for the optimised sample than the control.

REFERENCES

- [1].Adriana Dabija, Georgiana Gabriela Codina, Anca-Mihaela Gatlan & Lacramioara Rusu.(2018) 'Quality assessment of yogurt enriched with different types of fibers, CYTA' - Journal Of Food Vol.16 No.1 pp. 859-865.
- [2].Al-Rawahi, A. S., Rahman, M. S., Guizani, N., & Essa, M. M. (2013)'Chemical composition, water sorption isotherm, and phenolic contents in fresh and dried pomegranate peels'- *Drying technology* Vol.31 No.3 pp.257-263.
- [3].Anantakrishnan CP, Srinivasan MR (1964) *Milk products of India*. I.C.A.R, New Delhi
- [4].Bhattacharya D.C., Mathur.O.N. Srinivasan.M.R. Samlik.O.L (1971)'Studies on the method of production and shelf-life of paneer (cooking type of acid coagulated cottage cheese) '- *J Food Sci Technology*, Vol. 8 No.5 pp.117-120
- [5].Christos Soukoulis, Dimitra Lebesi, Constantina Tzi, (2009) 'Enrichment of ice cream with dietary fibre: Effects on rheological properties, ice crystallisation and glass transition phenomena'-*Food Chemistry*, Vol .115 pp.665-671
- [6].Deepak Mudgil, Shewata barak (2016)'Development of functional buttermilk by soluble fiber fortification'-*Agro food industry HI Tech*, Vol. 27 No.2 pp.44-47
- [7].Devinder Dhingra, Mona Michael, Hradesh Rajput, and R.T.Patil , (2012)'Dietary fibre in foods' -*J Food Sci Technology*, Vol. 49 No.3 pp.255-266

- [8].Fardat A, (2015)'Complex foods versus functional foods, nutraceuticals and dietary supplements: differential health impact'-Agro Food Ind. Hi Tech, Vol.26 No.2 pp.20-24
- [9].Jagannath A, Ramesh M.N, Varadaraj M.C. (2001) 'Response surface model for predicting the behaviour of yersinia enterocolitica in paneer - a heat and acid coagulated milk product of India'. Acta hortica, Vol. 56 No.6 pp.487 - 491
- [10].Kanawjia. S.K, Singh .S (2000)'Technological advances in paneer making'- Indian Dairyman Vol. 52 No.10 pp.45-50
- [11].Kushwaha. S.C, Bera. M.B and Pradyuman Kumar, (2013)'Nutritional Composition of Detanninated and Fresh Pomegranate Peel Powder, IOSR Journal of Environmental Science'- Toxicology and Food Technology (IOSR-JESTFT), Vol. 7 No.1 pp.38-42
- [12].Luis Eduardo Garcia-Amezquita, Viridiana Tejada-Ortigoza, Osvaldo H. Campanella, and Jorge Welti-Chanes. (2018)'Influence of Drying Method on the Composition, Physicochemical Properties, and Prebiotic Potential of Dietary Fiber Concentrates from Fruit Peels'- Hindawi Journal of Food Quality, Vol. 36 pp.1-11.
- [13].Narender Raju. P & Dharam Pal, (2014)'Effect of dietary fibers on physio-chemical, sensory and textural properties of Misti dahi'-J Food Sci Technology, Vol. 51 No.11 pp.3124-3133
- [14].Rao KVSS, Zanjad PN, Mathur BN, (1992) 'Paneer technology: a review'-Indian J Dairy Sc Vol. 45 No. 6: pp.281-291
- [15].Romelle, F. D., Rani, P. A., & Manohar, R. S. (2016) 'Chemical composition of some selected fruit peels'- European Journal of Food Science and Technology, Vol. 4 No.4 pp.12-21.
- [16].Sankalpa, K. B., Ramachandra, C. T., Dinesha, B. L., Nidoni, U. K., Sharanagouda, H., & Beladhadi, R. V. (2017)'Effect of different drying and grinding methods on biochemical properties of sweet orange peel powder'- Asian J Dairy Food Sci, Vol. 36 No.3 pp.260-263.
- [17].Sathya.P, Lejaniya, C. Srinivasan, V. Madhupriya and S. Sasikumar. (2016)'Fortification of milk and milk products'-International Journal of Science, Environment and Technology, Vol. 5 No.6 pp.4125 - 4129.
- [18].Sayeeda Fathima, Yamuna Devi Puraikalan. (2013)'Development of Food Products Using Pomegranate Skin'-International Journal of Science and Research, Vol.6 pp.1756-1758
- [19].Shahnawaz Umer Khan, Mohammad Ashraf Pal, Sarfaraz Ahmad Wani, and Mir Salahuddin(2018)'Effect of Different Coagulants on the Quality of Paneer Made from Cow Milk'-International Journal of Scientific and Research Publications, Vol. 8 No.4 pp.2250-3153
- [20].Sharoba, A.M. ; Farrag, M.A. , Abd El-Salam, A.M(2013)'Utilization of some fruits and vegetables waste as a source of dietary fibre and its effect on the cake making and its quality attributes'-Journal Of Food And Dairy Science, Vol. 4 No.9 pp.433-453
- [21].Singh.G, A. Kumar, B. K. Kumbhar, and B. N. Dar. (2015) 'Optimization of processing parameters and ingredients for development of low-fat fibre-supplemented paneer'- Journal of Food Science Technology, Vol. 52 No.2 pp.709-719.