Effect of partial replacement of refined wheat flour with varying levels Cycas flour (*Cycas circinalis. L*) On Physico-chemical and Sensory attributes of cookies

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Abstract— A composite flour cookies were prepared by partially replacing (0-30%) refined wheat flour with Cycas flour (*cycas circinalis*. L). Response Surface Methodology (RSM) was used to optimize the flour composition as well as the baking conditions (temperature and time). The incorporation of cycas flour has significantly affected the physical, chemical and sensorial properties of the cookies. The cookies prepared with composite flour had significantly higher (P≤0.05) amount of protein, fat, fiber and ash. The physical analysis revealed that thickness and spread ratio decreased with increase in addition of cycas flour. The hardness values of cookies made from Cycas flour and control found to be 1.01 N and 4.77 N respectively. The Total Plate Count (TPC) of the cookies was ranged from 2.1×10^2 to 2.6×10^5 cfu/g were within the prescribed limit during the storage period of 6 months. The parameters like texture and color (hue) values of cookies with control and cycas were varied from 4.77 N to 3.82 N & 1.01 N to 0.90 N, 1.10 to 1.15 & 1.19 to 1.22 respectively. The analysis of various Physico-chemical and sensorial attributes showed that the cookies were well accepted and the parameters were within the acceptable limit.

Index Terms— *Cycas circinalis*. L flour, Composite cookies, Response Surface Methodology, Physico-chemical analysis

1 INTRODUCTION

Cycad belongs to the family of CYCADACEAE of the gymnosperms. The Cycads have been reported to present in different parts of world from Mesozoic era, hence they are called living fossils [1]. Queen sago (*Cycas circinalis*. L) plant is having medicinal, economic and nutritional importance in the areas where they are indigenous. Cycad stems and seeds are known to be used for high blood pressure, headaches, congestion, and rheumatism and bone pain. Cycads are known to provide both as a stable and emergency food due to the presence of high amount of starch. Increased the consumption of cycas circinalis L seed, there has been a little development of novel processed foods in which cycas seeds is a major component. In the food processing industry, the Baking industry is considered as one of the major segment in India.

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A wide variety of bakery products are available in the supermarket, and it becomes an important part of a diet in day to day life. This includes unsweetened goods like bread, buns, muffins and bagels, sweet goods such as pancakes, doughnuts, and cookies, and filled goods include fruit and meat pies, pastries, sandwiches, cream cakes and pizza [2].

Baking product are gaining popularity because of their availability, nature of ready to eat, good nutritional quality and availability of the product in affordable cost. Among the bakery products, cookies are most significantly accepted by all the levels of society [3]. Cookies are most familiar among all the groups especially in children's because of their variety in taste, crispiness and digestibility. Cookies have long shelf life and free from microbial spoilage due to its low moisture content. Basically cookies are prepared from the refined wheat flour. Researcher reported that industrial production of sorghum flour incorporated cookies would require the understanding of the function of raw ingredients to manipulate the quality of the final product [4]. With this as a background cycas flour had incorporated into the cookies to enhance the quality.

Nowadays, Response Surface Methodology (RSM) are widely used for the optimization of the product in food industry. RSM is considered as an experimental design for the compilation of statistical and mathematical techniques. The usage of RSM

helps in the development of product and to optimize the ingredients better for the required response [5]. The use of RSM in the optimization of composite flour as well as the baking conditions like temperature and time can generate a lot of samples for consumer's evaluation in a short period of time, and thus the laboratory level tests are more efficient. According to this as a background the study was framed to develop a product with partial replacement of refined wheat flour with varying levels cycas flour (*Cycas circinalis*. L) on Physico-chemical and sensory attributes of cookies.

2 Procedure for Paper Submission

2. Materials and Methods

Queen sago *(Cycas circinalis.* L*)* is an under-exploited legume. It is mainly shown in tropics and subtropical areas, mostly grown in under dry-land agriculture. It is an important source of carbohydrate. Cycas circinalis are seasonal seeds, this were obtained from Nilambur area, Kerala, during the months of July and August. The collected seeds were subjected to remove the seed pod and then soaked in 1:4 v/w boiled water for 72 hours and consisting within 24 hours change the water for the removal of the toxic content present in the seed. The samples were dried in a tray drier at 60±65°C during 12 hours until the final moisture attained 8.50%. Following that the seed were subjected for milling into fine flour with a sieve size of 100μm. The obtained flour were finally stored in the refrigerator at 4ºC in separate air-tight containers for further quality analysis and formulation of cookies.

2.1 Preparation of cookies

The cookies were prepared based on method reported by Hussain et al. (2006)[3] with slight modifications. Cookies were prepared by partial replacing of 0-30% refined wheat flour with Cycas flour. All the ingredients like refined wheat flour, cycas flour, sugar, baking powder, egg were used in different proportion. Initially all the mixtures blended and kneaded with hand by the addition of butter for change the texture of cookies. The prepared dough was molded and shaped into cookies and baked. Baking was carried out with electric oven at the baking condition of time (10 min) and temperature (150°C). Once the baking is finished the baked cookies were allowed to cool for 30 min and stored in a high density polythene (HDPE) and stored at ambient temperature.

2.2 Experimental design

The RSM is an effective tool to optimizing several experiments. It is used to developing, improving and optimizing the product. Optimization of composite flour as well as baking conditions (temperature and time) was carried out. Design expert, Trial version 8.0, State Ease Inc., Minneapolis, IN statistical software were used for the generation of response surface plot and optimization of process variables. A five –level-two-factor experimental design was adopted. The experiments were conducted according to Central Composite Rotatable Design (CCRD) within a chosen range. The design includes 20 experiments with replication at the centre point**.** This study to decided the effects of two independent variables [temperature (X1; 170-190°C), time (X2; 15-25 min), cycas flour (X3; 0-30 %)] at four levels on the dependent variables [texture (Y1), color (Y2), taste (Y3), overall acceptability (Y4)]. 20% substitution of cycas flour were selected and further analysis were carried out.

2.3 Sensory evaluation of cookies

The sensory evaluation of the composite cookies was conducted with 45 semi-panel members [6]. To assess the organoleptic properties of the formulated composite cookies were carried out using a 9 pointer hedonic scale. The mean of sensory score for attributes *viz*. color and appearance, flavor, texture and grain, crispiness, taste and overall acceptability were recorded.

2.4 Physico-chemical Analysis of cookies

The cookies were analyzed for ash, moisture, fat, carbohydrate, fiber and protein using the standard [7] method. Physical properties like Diameter (D), Thickness (T) and spread ratio (D/T) of the cookies were calculated as per the [8] method. Color value (L*, a* and b*) and from the a* and b* the hue value of the cookies were determined using the hunter lab calorimeter. The instrument was calibrated using q standard black and white plate. Breaking strength (hardness value) of the composite cookies were measured using HDP/BS blade of texture analyzer (TA) TA-HD Plus, Stable Micro systems, Survey, UK.

$$\text{Hue} = \tan^{-1}(b/a) \quad \text{(1)}$$

2.5 Shelf life study

The prepared cookies were packed in HDPE and stored at ambient temperature for the period of six months and consecutive 30 days the Total Plate Count (TPA), color (hue) value and Texture was analyzed.

2.6 Statistical analysis

All the analysis was done using triplicate samples. The data obtained was analyzed statistically to determine the statistical significance of treatments. Statistical analysis was

performed using RSM software, design – expert 8 (stat Ease Inc, USA). The data on experimental results were subjected to Analysis of Variance (ANOVA). The data on physico-chemical analysis were subjected to Analysis of Variance (ANOVA) with the help of statistical package SPSS (20 version) to compare the means and to determine the most acceptable treatment ($p \leq 0.05$). The experimental data were evaluated by multiple regressions using response surface methodology at significant levels ($p < 0.01$, $p < 0.05$ and $p < 0.1$)

3. Result and discussion

3.1 Model description

In this study, RSM was used to optimize the flour, as well as the baking conditions like time and temperature of the baked product. Multiple regression analysis were adopted to modeled the data. $p < 0.01$, $p < 0.05$ and $p < 0.1$are the significant levels used to interpret the data's. The experimental data were evaluated using response were selected for the model construction. The goodness-outfit of the models was evaluated using the adjusted r2, approximate r2 for prediction values based on PRESS statistic and analysis of the residual plots.

3.2 Color

Result showed that the ratio of color value is 26.750 indicates an adequate signal. This model can be used to navigate the design space. The regression equation for the response function in the Actual level of these variables is:

$$Y1=1311.87+0.0001X1+0.0001X2+0.0007X3$$

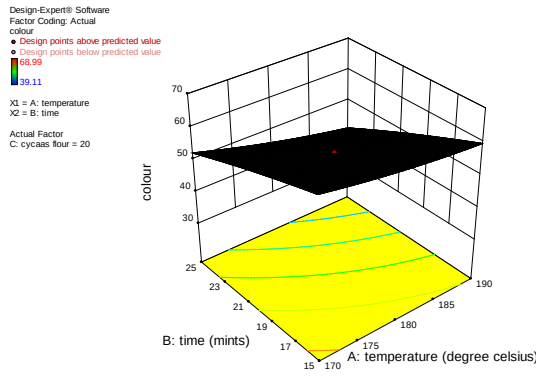

Figure a: Color of composite cookies

3.3 *Texture*

Ratio of this study had 4.580 indicates an adequate signal. This model can be used to navigate the design space. The regression equation for the response function in the Actual level of these variables is:

$$Y1=6.423 +0.8922X1+0.1711X2+0.6994X$$

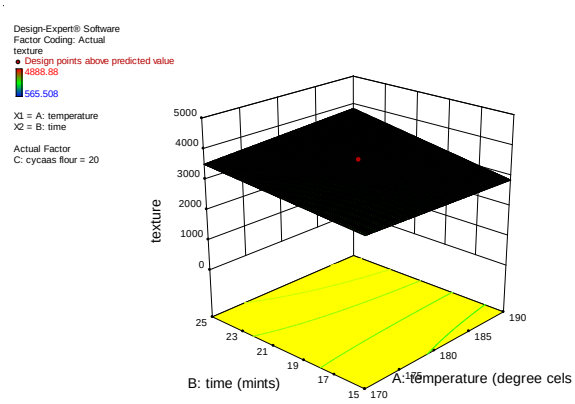

Figure b: Texture of composite cookies

3.4 Taste

All empirical models should be tested by doing confirmation runs. "Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Denoted Ratio of 11.605 indicates an adequate signal. This model can be used to navigate the design space. The regression equation for the response function in the Actual level of these variables is:

$$Y1=15.35+0.9251X1+0.0024X2+0.1295X3$$

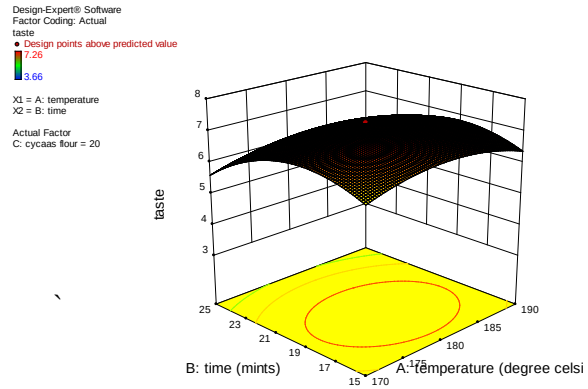

Figure c: Taste of composite cookies

3.5 Overall acceptability

The ratio of 4.929 indicates an adequate signal. This model can be used to navigate the design space. The regression equation for the response function in the Actual level of these variables is:

$$Y1=3.65 +0.2529X1+0.8055X2+0.0.1016X3$$

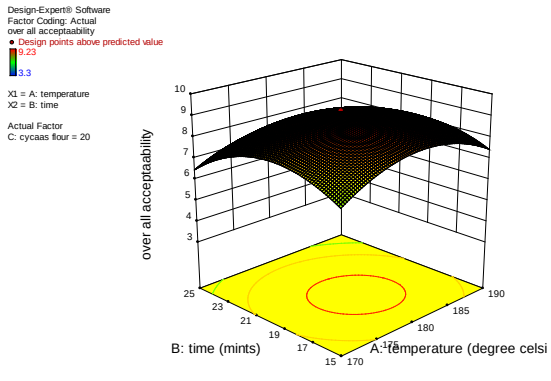

Figure d: Overall acceptability of composite cookies

The result was analyzed using ANOVA showed. The linear term temperature (A), inter active term time (AB) as well as the quadratic term is (B^2) were showed to be significant model terms ($P<0.05$).It is evident from the table that model and lack of fit was significant Figure a, b, c and d represents the Response surface for the effect of time and temperature percentage on color, texture, taste and over all acceptability of the composite cookies respectively.

3.6 Physico-chemical Analysis of cookies

The Physico-chemical properties of the control cookies and the cookies prepared from the composite flour with the help of RSM were denoted in table 1. The moisture, carbohydrate, protein, ash, fiber and fat content of the cookies were 3.83%, 70.18, 10.54%, 0.63%, 0.86% and 23.06% and 3.50%, 65.42%, 14.78%, 0.83%, 1.23% and 24.86% respectively. The moisture content of the control and composite cookies ranged from 3.83% to 3.50%. This value is acceptable according to researcher [9], they reveals that in the baked cookies the acceptable range for moisture is usually below 5%. It reveals that the cookies had slow down the growth of microorganisms and enhance the shelf life. It was observed that the amount of ash, fat, fiber and protein was significantly higher in composite cookies while compared to the control cookies. The incorporation of cycas flour with the refined wheat flour will enhance the nutritive composition of the product. These observation are comparable and in agreement with regard to the supplementation of cookies with mungbean flour [10].

The physical parameters of composite cookies prepared by replacement of refined wheat flour with 0-30% of cycas flour are discussed below.

Table 1: Physico chemical properties of the control and composite cookies

Physico chemical properties	Control	Composite cookies
Moisture (%)	3.83±0.28	3.50±0.34
Carbohydrates (%)	70.18±0.20	65.42±0.52
Protein (%)	10.54±0.40	14.78±0.18
Ash (%)	0.63±0.57	0.80±0.03
Crude fiber (%)	0.86±0.11	1.23±0.23
Fat (%)	23.06±0.24	24.86±0.46
Thickness (mm)	9.83±0.26	10.67±0.34
Diameter (mm)	56.17±0.80	56.43±0.35
Spread ratio (D/T)	5.71±0.21	5.28±0.29
Color (L*)	67.13±2.66	64.58±2.36
(a*)	15.90±0.29	13.26±0.69
(b*)	31.94±1.44	33.19±1.09
Hue	1.16±0.29	1.19±0.44
Hardness (N)	4.77±0.18	1.01±0.54

VALUES ARE MEAN ± STANDARD DEVIATION; EACH OBSERVATIONS IS THE MEAN OF THREE DETERMINATIONS

The spread ratio of the cookies was varied from control to composite cookies. The spread value was greater 5.71 for the control cookies than the composite cookies (5.28). The spread ratio was decreased significantly and the thickness was significantly increased with the marginal increase of cycas flour. Lower spread ratio of composite cookies implies better rising ability of the product [11]. The diameter of the control cookies and composite cookies were 56.17 and 56.43mm respectively. These desirable changes of physical parameters may be due to the higher fiber content in the flour [12].

Color value of control and composite cookies were also showed in table 1. The L* value is represented for the lightness of the cookies extended from 0 (black) to 100 (white). The L* value of the cookies were decreased significantly from 67.13 to 64.58 in the case of control and composite flour respectively. The a* and b* value represents redness (+a) to greenness (-a) and yellowness (+b) to blueness (-b) respectively. In the case of control and composite cookies, the b* value were decreased and a* value were increased significantly. This is attributed due to the enhancement in redness and yellowness of the cookies during the baking process [13]. The hue values were increased with increase in addition of cycas flour. The changes in the color value of cookies might be due to the caremalization of sugar, which cause the browning effect.

As texture greatly has an effect on consumer acceptance of the product, it is an important factor of comparing the

cookies [14]. The cutting force of the control cookies (4.77 N) indicating more hardness than the composite cookies (1.01 N), which would have been the cause attributed by the increased protein content of enrichment with cycas flour [15].It was also found that the cutting force of cookies was negatively correlated with the spread ratio of cookies.

3.7 Sensory evaluation

Acceptability of the developed product is mainly depends on the Organoleptic properties, which are usually measured in terms of appearance, texture and taste [4]. Table 2 indicates the sensory attributes of control cookies and composite cookies prepared from 20% of cycas flour. It was noticed that composite cookies had highest for sensory attributes like appearance, texture, taste, mouth feel, aroma and overall acceptability. Scores of sensory attributes showed that there was a significantly higher ($p<0.05$) in cookies prepared from the composite flour. Cookies prepared with the incorporation of cycas flour (20%) substitution levels produced acceptable cookies as evaluated by semi-panel of 45 members.

Table 2: Sensory evaluation of the control and composite cookies

Sensory attributes	Control cookies	Composite cookies
Appearance	8.20±0.26	8.50±0.40
Color	8.83±0.15	8.13±0.15
Sweetness	8.63±0.40	8.60±0.26
Texture	7.96±0.15	8.03±0.11
Flavor	8.33±0.32	8.20±0.20
Taste	8.00±0.43	8.10±0.11
Mouth feel	8.20±0.20	8.86±0.15
Aroma	7.60±0.40	7.86±0.75
Overall acceptability	8.21±0.11	8.29±0.26

Values are mean ± standard deviation (n=45)

3.8 Shelf life study

After completing the Physico-chemical and sensory evaluation, the control and composite cookies with maximum sensory score were packed in HDPE pouch and stored at ambient temperature for six months. HDPE was the better packaging material than low density polyethylene (LDPE) and polypropylene (PP) [16].Consecutive 30 days (one month), the parameters like moisture, color, texture and Total Plate Count (TPC) were analyzed. Table 3 shows the values for moisture, color (L*, a*, b* and hue), texture and TPC. The moisture content and texture were remained somewhat same until 90 days (3 months). After 90 days, the values were gradually decreased during the storage period. However no undesirable changes in color value. The TPC of the cookies were ranged from 2.1×10^2 10 2.6×10^5 cfu/g. it shows that the TPC were within the prescribed limit during the storage period of 180 days (6 months). This result showed that the composite cookies were acceptable till six months.

Table 3: Shelf life content of the cookies

Storage period	Cookies	Parameters						
		Moisture	L*	a*	b*	Hue	Texture (N)	TPC (cfu/g)
30 days	Control	3.94±0.24	67.07±1.28	15.90±0.19	31.82±1.42	1.10	4.57±0.16	2.1×10^2
	Composite	3.73±0.11	63.82±1.54	13.22±0.23	33.06±1.07	1.19	1.19±0.37	2.1×10^2
60 days	Control	3.98±0.17	66.72±1.07	15.65±0.73	31.97±1.08	1.11	4.52±0.21	2.3×10^2
	Composite	3.85±0.36	63.63±1.87	12.82±0.17	32.65±0.82	1.20	1.07±0.23	2.2×10^2
90 days	Control	4.09±0.12	66.45±1.13	14.78±1.08	30.48±0.97	1.12	4.49±0.19	2.2×10^2
	Composite	3.87±0.28	63.10±1.18	12.80±0.56	32.58±1.04	1.20	0.99±0.32	2.4×10^2
120 days	Control	4.15±0.20	65.76±1.23	13.92±0.87	30.35±1.11	1.14	4.42±0.28	2.4×10^3
	Composite	3.98±0.56	61.43±0.92	12.45±0.83	32.13±0.87	1.20	0.97±0.25	2.4×10^2
150 days	Control	4.60±0.05	63.65±0.34	13.65±0.25	30.18±1.03	1.15	3.99±0.11	2.5×10^4
	Composite	4.03±0.45	61.38±0.50	11.86±0.02	31.82±1.03	1.21	0.95±0.15	2.5×10^3
180 days	Control	4.89±0.83	63.34±0.48	13.50±0.24	29.98±1.15	1.15	3.82±0.34	2.6×10^5
	Composite	4.67±0.78	59.25±0.45	11.43±0.78	31.79±1.13	1.22	0.90±0.20	2.5×10^4

Values are mean ± standard deviation; standard deviation; each observation is the mean of three determinations

4. Conclusion

This study was conducted for finding out the best composite cookies which was prepared with the partial replacement (0-30%) of cycas flour and refined wheat flour with the help of RSM. According to the experimental design 20% of cycas flour was selected as final composite cookies. The Physico-chemical analysis and organoleptic properties were done and the result was compared with control cookies. The substitution of 20% of Cycas flour would enhance the nutritional as well as physical and sensory attributes of the composite cookies. The storage study was also carried out for six months. Results denote the range of storage study was prescribed limit during the storage period. Partial replacement of cycas flour resulted in higher quality of composite cookies, as indicated by overall acceptability in the sensory evaluation.

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REFERENCES

1. E. Rivadeneyra-Domínguez, J.F. Rodríguez-Landa., 2014, Cycads and their association with certain neurodegenerative diseases. *Neurología*, 29(9), 517—522.
2. Smith, W. H., 1972, *Biscuits, Crackers & Cookies*.(2), 136 *in: Formulas*. (Magazines for Industry: New York).
3. Shahzad Hussain, Faqir Muhammad Anjum, Masood Sadiq Butt, Muhammad Issa Khan, Ali Asghar., 2000, Physical and Sensoric Attributes of Flaxseed Flour Supplemented Cookies. *Turkish Journal of Biology*, 30, 87-92.
4. B. Dayakar Rao, Mohamed Anis, K. Kalpana, K.V. Sunooj, J.V. Patil, T. Ganesh., 2016, Influence of milling methods and particle size on hydration properties of sorghum flour and quality of sorghum biscuits. *LWT - Food Science and Technology*, 67, 8-13.
5. Myers, R. H. & Montgomery, D. C., 2002, *Response surface methodology: Process and product optimization using designed experiments* (2nd ed.). (New York: Wiley).
6. Amerine MA, Pangborn RM, Roessler EB., 1965, *Laboratory studies. Quality–quantity evaluation in principles of sensory evaluation of foods*. (Academic, New York). 349–397.
7. AOAC. 2000, Official methods of analysis (17th ed.). (Washington, DC: Association of Official Analytical Chemists).
8. AACC. 1976, Approved methods of the American Association of cereal chemists. (St. Paul Minnesota, U.S.A).
9. Cauvain, S. P. & Young, L.S., 2009, *Bakery food manufacture and quality: water control and effects* (2nd ed.). (Oxford, UK: Blackwell Publishing).
10. Noor Aziah, A. A., Mohamad Noor, A. Y., & Ho, L. H., 2012, Physico chemical and organoleptic properties of cookies incorporated with legume flour. *International Food Research Journal*, 19, 1539–1543.
11. Olapade, A. A. &Adeyemo, A. M., 2014, Evaluation of cookies produced from blends of wheat, cassava and cowpea flours. *International Journal of Food Studies*, 3, 175–185.
12. Sukhcharn Singh, C. S. Riar and D. C. Saxena., 2008, Effect of incorporating sweet potato flour to wheat flour on the quality characteristics of cookies. *African Journal of Food Science*. (2), 065-072.
13. Yueh Fang Cheng, Rajeev Bhat., 2016, Functional, physicochemical and sensory properties of novel cookies produced by utilizing underutilized jering (*Pithecellobium jiringa* Jack.) legume flour. *Food Bioscience*, 14, 54-61.
14. Eisa, H. A., 2006, The effect of using gluten free flours on the palatability, texture and water activity of white chocolate chip Macadamia Nut Cookies. Individual project written report, *Food and nutrition*, 453.
15. R Sai Manohar and P Haridas Rao., 1999 Effect of emulsifiers, fat level and type on the rheological characteristics of biscuit dough and quality of biscuits. *Journal of the Science of Food and Agriculture*, 79, 1223-1231.
16. Amit Arjun Kulthe, Vithal Deorao Pawar, Pramod Mohanlal Kotecha, Uttam Dhyanu Chavan & Venkatraman Vishwanath Bansode., 2014, Development of high protein and low calorie cookies. *Journal of Food Science Technology*, 51(1), 153–157.