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Optimization of Persea Americana pulp incorporated cookies using sensory analysis: a response surface methodology

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ABSTRACT

The sensory properties are vital in catching shopper eye and subsequently impacting their inclinations and purchasing choices for nourishment items. Taste, colour, texture, mouthfeel, aroma, flavour, and overall acceptability are sensory properties which are regularly used to portray the nature of the treats, just as to foresee customer response. In this examination were embraced to discover the impact of various degrees of Persea Americana fruit pulp (A), honey (B) and wheat flour (C) consolidated treats and their ideal levels. Information got from Response surface methodology of Persea Americana incorporated cookies treats were exposed to the investigation of change (ANOVA) and examined utilizing a second-request polynomial condition. Response surface methodology was demonstrated to be a satisfactory methodology for displaying the organoleptic parameters and the level of preferring of good Persea Americana cookies. After the effects of this investigation discovered that a most extreme attractive score that can be accomplished with the ideal estimation of taste was 7.8, texture 6.68, flavour 7.11 and by and overall acceptances 8.44 scores. This example was viewed as the best advancing hotspot for tangible traits.

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INTRODUCTION

Expanding wellbeing cognizance among purchasers and their interest for sound sustenance with high nutritive qualities has driven specialists to enhance and grow new nourishments choices that will, in general, keep up customer's wellbeing and fulfilment. Delights have turned out to be one of the most alluring snacks for both youth and older individuals because of their low assembling misfortune, more accommodation, the long period of usability and capacity to fill in as a vehicle for significant supplements (Hooda and Jood, 2005; Akubor, 2003). As per Position of the American Dietetic Association (2005), Fat substitution in nourishment frameworks represents a mind-boggling issue since fat adds to tactile and physiological qualities, for example, season, mouthfeel, taste, smell and surface. Impacts of item alteration on tactile properties, just as dietary advantages, must be considered in the improvement of high caliber, worthy items (Setser and Racette, 1992).

Avocado (Persea History of the U.S) is a tropical organic product started in Mexico. It is saturated with supplements and phytochemicals, which are mindful for cardiovascular medical advan-

tages (Weschenfelder *et al.*, 2015). The restorative impacts in weight and hypercholesterolemia were given by the natural product proposed to be known as useful nourishment (Pahua-Ramos *et al.*, 2014). Avocado is likewise a rich wellspring of lipids, with the most elevated level of monounsaturated unsaturated fats (MUFA; about 66.67%), trailed by 14.29% of soaked unsaturated fats (SFA), and 12.24% polyunsaturated unsaturated fats (PUFA) (Gillingham *et al.*, 2011). Yahia and Woolf (2011) announced that avocado is generally expended crude or utilized as a serving of mixed greens natural product or sandwich spread, just as guacamole. Be that as it may, the rich surface of avocado tissue proposes the possibility to be utilized as fat replacer as to change the use of the organic product (Pieterse *et al.*, 2003).

In pastry shop items, for example, bread, biscuits, and cakes treat fat is the most significant fixing that assembles the scrap and raises the prepared products by entangling air rises into player and batter (Kumar *et al.*, 2010). (Tarancón *et al.*, 2013) in their investigations, detailed that both Trans and soaked fats ought to have stayed away from for a more advantageous way of life. In this manner, in light of both fat quality and fat significance in pastry shop items, specialists have been exploring different avenues regarding various fixings in discovering appropriate fat replacers to satisfy the high shopper for sound items. Past examinations displayed various common fixings that can be utilized as fat replacers, for example, mung bean glue, pawpaw natural product puree, fruit purée, and okra gum (Adair *et al.*, 2001; Ibrahim, 2013; Hu and Lai, 2017; Wiese and Duffrin, 2003).

Analyzing the interior structure of pastry shop items is basic as smooth structure impacts the nature of definite items, for example, physicochemical, tangible, appearance, and transport properties (Turabi *et al.*, 2010). In spite of the challenges in surveying the quality because of the unpredictability of the fixings included, analysts have been finding numerous solid techniques accordingly surface methodology (RSM). These incorporate the Statically examination of good items dependent on the probability,3 D picture investigation, and focal composite plan additionally picture examination is utilized in evaluating the nature of pastry kitchen items (Granato *et al.*, 2010).

The objective of this investigation was to consolidate avocado puree as a fat replacer to create low-caloric treats without trading off the nature of the treats. The way that avocado is practical nourishment is likewise an additional incentive to the Avocado-fused treats. In substitution of spread or margarine, which are usually utilized in bread shop items, avocado aides in decreasing the danger of coronary illness and hypercholesterolemia. Thinking about the wholesome substance and medical advantages given by the avocado, the puree is viewed as a monetarily elective fat, when contrasted with the plain spread and margarine. The spread like puree surface makes it promptly utilized without requesting expensive readiness. The admission of wheat is expanding all-inclusive, Wheat-based sustenance's give a scope of fundamental and gainful segments to the human eating regimen, including protein, B complex vitamins, dietary fiber, and phytochemicals.

Dietary fiber is especially significant as utilization is related to decreased danger of CVD, type 2 diabetes, and certain types of malignancy. Nectar is a characteristic item that has been broadly utilized for its helpful and preparing impacts. It contains a high measure of cancer prevention agents and phenolic mixes. It forestalls numerous infection conditions are gastrointestinal, cardiovascular, provocative (Duester, 2000). Response Surface Methodology (RSM) is an accumulation of factual systems for planning tests, building models, assessing the impacts of the variables and looking for ideal states of elements for attractive responses (Langenhoven *et al.*, 1991). In this investigation, RSM was utilized to decide the ideal detailing for a useful treat with avocado frit pulp incorporated cookies.

MATERIALS AND METHODS

Exploratory methodology for the preparation of cookies

Persea Americana History of the U.S (Avocado) organic products were obtained from Agriculture Research Station (HRS), in Kodaikanal, Tamil Nadu, during June - August 2018. All other ingredients acquisition from the neighbourhood advertise in Salem locale, Tamil Nadu, India. Every one of the ingredients was chosen by thinking about its accessibility, nutritious and medical advantages.

Extraction of mash

The avocado fruits were completely screened to evacuate the terrible ones. The fruit was washed completely with faucet water and in distilled water and after that dried in the room temperature. The identified fruit was stripped and de-stoned. The mash was kept in the cooler. Sifter the refined wheat flour and blend other dry fixings to get a uniform mix. Different amount of Persea Americana pulp was incorporated to produce the following treatment (Table 1).

Table 1: Coded and un-coded independent variables used in RSM design

Independent variables	Coded value		
	-1	0	+1
Persea americana pulp (A)	50	250	150
Honey (B)	5	20	12.5
Wheat flour (C)	50	150	100

Table 2: Central composite face-centered design with experimental values of response variables

Run	Independent variable (Ingredients)			Dependent variable (Sensory attributes)			
	Persea americana pulp (A)	Honey (B)	Wheat flour (C)	Taste	Texture	Flavour	overall acceptability
1	250	20	50	8.44	7.68	7.91	7.68
2	150	20	100	7.55	7.59	7.38	7.56
3	50	12.5	100	3.91	4.55	4.47	3.66
4	150	12.5	100	7.54	9.87	8.66	7.45
5	250	5	50	6.67	7.25	5.93	5.75
6	250	5	150	6.65	6.08	5.77	5.91
7	150	12.5	50	9.81	9.85	9.44	8.56
8	50	20	50	5.65	4.67	4.25	5.23
9	50	20	150	6.67	6.55	5.74	5.89
10	150	5	100	6.54	7.47	7.44	6.85
11	50	5	150	4.77	5.67	4.45	3.05
12	150	12.5	100	9.25	9.87	9.22	8.54
13	250	12.5	100	4.71	4.81	4.31	3.59
14	50	5	50	4.55	9.69	3.93	5.44
15	250	20	150	5.67	4.55	9.74	9.06
16	150	12.5	150	9.55	9.77	9.12	8.74
17	150	12.5	100	9.62	9.97	8.55	8.45

Table 3: Results of Regression Analysis of Responses

Factors	Taste				Texture			
	SS2	DF	F	p	SS2	DF	F	p
Model	52.09	9	6.06	0.0134	55.82	9	2.74	0.0989
A	4.34	1	4.55	0.0705	0.0578	1	0.0255	0.8776
B	2.30	1	2.41	0.1644	2.62	1	1.16	0.3176
C	0.3276	1	0.3429	0.5765	4.25	1	1.88	0.2130
AB	0.6105	1	0.6390	0.4503	1.16	1	0.5101	0.4982
AC	2.03	1	2.12	0.1883	0.5832	1	0.2575	0.6274
BC	0.4753	1	0.4975	0.5034	1.94	1	0.8569	0.3854
A2	31.46	1	32.92	0.0007	33.31	1	14.71	0.0064
B2	1.28	1	1.34	0.2849	1.22	1	0.5405	0.4861
C2	10.12	1	10.59	0.0140	6.89	1	3.04	0.1245
Residual	6.69	7			15.85	7		
Lack of fit	4.23	5	0.6863	0.6827	15.85	5	950.71	0.0011

SS^2=Sum of squares DF = degree of freedom F= f values
P= probability values A= Avocado fruit pulp B= honey C= wheat flour

Table 4: Results of Regression Analysis of Responses

Factors	Flavour				Overall acceptability			
	SS2	DF	F	p	SS2	DF	F	p
Model	62.13	9	6.02	0.0136	53.23	9	6.37	0.0116
A	11.71	1	10.22	0.0151	7.60	1	8.19	0.0243
B	5.63	1	4.91	0.0623	7.09	1	7.64	0.0280
C	1.13	1	0.9852	0.3540	1.000	1	0.0000	0.9975
AB	2.35	1	2.05	0.1948	0.7503	1	0.8082	0.3985
AC	0.0144	1	0.0126	0.9137	1.34	1	1.44	0.2692
BC	1.10	1	0.9558	0.3608	2.28	1	2.45	0.1611
A2	31.56	1	27.54	0.0012	31.19	1	33.59	0.0007
B2	0.4550	1	0.3971	0.5486	0.0759	1	0.0818	0.7832
C2	5.69	1	4.97	0.0610	6.97	1	7.51	0.0289
Residual	8.02	7			6.50	7		
Lack of fit	7.76	5	12.03	0.0785	5.77	5	3.15	0.2583

SS^2=Sum of squares DF = degree of freedom F= f values
P= probability values A= Avocado fruit pulp B= honey C= wheat flour

Table 5: Predicted optimization of process parameters by desirability approach

Process Parameters	Target	Experimental Design		Optimum values	Importance
Avocado fruit pulp	Maximize	50	250	150	3
Honey	Range	5	20	12.5	3
Water	Range	50	150	100	3
		Responses			
Taste	Range	3.91	9.81	7.8	3
Texture	Range	4.55	9.71	6.68	3
flavor	Range	3.93	9.74	7.11	3
Overall acceptability	Range	3.05	9.05	8.44	3

Preparation Procedure

Persea Americana mash, honey was blended to set up the dough. The mixture was set up by manual massaging of all the dry and fluid fixings to accomplish consistency with alluring viscoelastic attributes. At the point when the dough was prepared, it was kept for 10-15 minutes all things considered and afterwards utilized for sheeting. Sheets were made by moving wads of batter on a wooden stage. These sheets were cut by the hand-worked metal colour, masterminded on an avocado oil-covered plate and were kept for heating. Heating happens in three progressive stages in the electric broiler. In the third stage, the shade of treats changes to the run of the mill light green shade of completed treats. Each part requires 15-20 minutes at 160 c for preparing.

Experimental design and optimization of formulation

Test Design for Optimization of Formulation In this investigation, the exploratory plan utilized was Face Centered Central Composite Design (CCF). This plan is one of the three sorts of Box-Wilson Central Composite structures. A focal composite plan contains an embedded factorial or fragmentary factorial structure with focus focuses that is enlarged with a gathering of 'star focuses" that permit estimation of the arch. The focal composite structure is the most famous of the numerous classes of reaction surface approach (RSM) plans (Khuri, 1987). On the off chance that the good ways from the focal point of the plan space to a factorial focuses is ± 1 unit for each factor, the good ways from the focal point of configuration space to a star focuses is $\pm \alpha$ with $|\alpha|$ >1. In CCF, the star focuses are at the focal point of each face of the factorial space, so $\alpha = \pm 1$. This plan requires three levels for each factor, subsequently making the absolute number of examinations equivalent to 20 rather than full factorial structure.

The coded and un-coded free factors utilized in the RSM plan. The three fixings (free factors) of the treats utilized in the investigation were Persea

Americana fruit pulp, wheat flour, honey. The level scope of the fixings utilized in the examination was resolved to utilize starter preliminaries. The degrees of fixings in coded and un-coded structure for the readiness of treats are introduced in Table 1. Each structure point comprises of the repeats. For the measurable examination, the numerical levels are institutionalized to - 2, - 1, 0 and +1, +2. The tests were done in a randomized request (Gacula and Singh, 1984). The connection between institutionalized variable's qualities is given as pursues.

Response surface methodology

Response surface methodology (RSM) was connected to upgrade the degrees of three factors avocado fruit pulp (X1), nectar (X2) and wheat flour (X3). Focal Composite Rotatable Design (CCRD) was utilized in choosing the degrees of the factors. The primary and association impacts of autonomous factors on tangible properties were evaluated utilizing investigation of change (ANOVA). The second-request polynomial condition was fitted to the trial information of every one of the tactile properties as given beneath

$$Y_k = \beta k0 + \sum_{i=1}^{n} \beta kixi + \sum_{i=1}^{n} \beta kiix^2 i + \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} kijxixj$$

Where, Y_k = reaction variable; Y1 = Taste, Y2 = Texture, Y3 =flavor Y4=over all agreeableness. Xi speaks to the coded free factors [x1 = Persea Americana fruit pulp (Gm), x2 = nectar (Gm), x3 = wheat flour (Gm)]; βko is the estimation of the fitted reaction at the middle purpose of the structure, βki, βkii and βkij were the direct, quadratic and cross-item relapse coefficients, separately. The sign and extent of the coefficients related to the autonomous factors portrayed the course and level of relationship of different fixings with tactile properties. The reaction surfaces were created for the connection of any two ward factors while holding the estimation of the third factor as consistent (at the focal worth). Such three-dimensional surfaces could give precise geometrical portrayal and give helpful data about the conduct of the framework inside the exploratory plan. The decency of fit was dictated by the absence of fit insights and coefficient of assurance. The model was viewed as sufficient when the coefficient of assurance (R2) was more than 0.70 and huge. The non-huge absence of fit worth and qualities for balanced and anticipated R2 near one affirm the legitimacy of the model. The numerical enhancement of the procedure was utilized to locate the ideal level of wheat flour, Persea Americana fruit pulp, and nectar which was kept in range while the textural qualities were either expanded, limited or with objective worth fixed relying upon the trait. The free preliminaries were directed to approve the decided ideal levels. Understudy's t-test was utilized to test the centrality of the distinction among watched and anticipated estimations of the different tangible credits and mistake rate to evaluate approve the ideal levels. Structuring of trial focuses, randomization, investigation of fluctuation, and fitting of quadratic models were done by Design-Expert 9.

Statistical analysis

Information was broken down by the least-squares technique, and response surfaces were created utilizing the Design Expert ® 9.0.0 programming (Stat Ease Inc., Minneapolis, MN). Investigation of change (ANOVA) was utilized to test the hugeness of every factor ($p \leq 0.05$) and to confirm the ampleness of the model. Association impacts were resolved utilizing LS implies ($p \leq 0.05$). All trials were completed in triplicate.

RESULTS AND DISCUSSION

Relapse coefficients, P esteems, and model fit insights of the fitted quadratic models for tangible qualities of Persea American incorporated cookies are displayed in Table 3 to check the ampleness of the built model for the sensory attribute. The R2 (coefficient assurance) of models for checking the wellness of model, was near one showing that variety accordingly could satisfactorily be clarified by detailing ingredients(Table 2). The quadratic models were adequate to clarify the legitimacy in the sensory traits and for predicting and exploring reason inside structure space. The response surface and contour plots to contemplate the impact of progress in the degree of chose ingredients on the response parameters are represented too in the figures. Luckow and Delahunty (2004) expressed that buyers judge the worthiness of an item dependent on taste instead of different characteristics, for example, therapeutic advantages. The taste is of pivotal significance for soy-containing nourishments because of the astringent flavour they generally have. The impact trials are led by the planning grid, and relating results are recorded in Table 3. The quadratic condition for foreseeing the ideal point was acquired by the CCRD structure and information factors, and after that, the observational connection between the reaction and the free factors in the coded units was displayed dependent on the trial results as pursues. The fixing arrangements of avocado organic product mash consolidated treats, was enhanced from 20 distinct details dependent on tactile scores. avocado natural product mash, nectar, and wheat flour, were free factors and the general tangible scores of the items were chosen as

the reaction. with in house trails, a treat was made with a moderate worthiness rating and after that the extent of fixings levels was considered by utilizing focal composite structure for improvement. The test scores of the degrees of the real fixings (autonomous factors) utilized in RSM with genuine and coded factors for avocado natural product mash joined treats are given in Table 1. Genrally, the coding is accomplished for the consistency inside the structure and to stay away from the predisposition .the coding is from - 1 to +1 through 0 for least, greatest, most extreme and the middle point, separately .the real levels extended from 50 to 250 gm ,5 to 20 gm and 50 to 150 gm for avocado fruit pulp, nectar and wheat flour, Separately.

The trial plan with real degrees of various autonomous factors having 20 mixes and the watched reactions for treats are given in Table 2. The tactile score reactions went between 3.5 to 9.0. The after-effects of second-request reaction surface model fitting as ANOVA for shading, season, mouthfeel, taste, smell, consistency and generally acknowledgments are given in Table 2. The ANOVA of the quadratic relapse model shows that the model isn't huge. The taste of cookies depends on mouthfeel and sensory sensations of the different age group people. The taste difference mainly based on ingredients variations, avocado fruit pulp characterization is bitter taste some variations are identified bitter taste addition of honey help to reduce the bitterness of cookies. The colour of cookies should be appealing with light green to dark green colour. The colour changes depend on the ingredients variations. The consumers are more attracts based on the colour. The colour is one of the best sensory parts of new food products. The taste score ranged from 3.91 to 9.7 (Table 5).the regression analysis showed that sensory attributes of avocado incorporated cookies had significant ($p< 0.05$) positive linear effects of taste in the cookies (Table 3). It was observed from the response plots (Figure 1-design-A) that with an increase of plot based on the taste and variations of ingredients, The coefficient of assurance (R2) was 0.88. The "Pred R-Squared" of 0.11 is insensible concurrence with the "Adj R-Squared" of 0.73. "Adeq Precision" was 8.37 shows an insufficient sign, and it should utilize this model to explore the structure space for the advancement item.

Taste $=+8.19+0.6590A+0.4800B-0.1810C-0.2763AB-0.5038AC-0.2438BC-3.43A^2-0.6914B^2+1.94C^2$ (Eq-1)

Where Y is the taste attributes, A1 avocado fruit pulp and B2 is honey and C3 is Wheat flour, respectively.

The texture of cookies should be appealing with light soft to little hard. The 3D plot also identified the little harden of cookies; the texture changes depends on the avocado fruit pulp variations. The texture of the food is very important to chewing. The texture score ranged from 4.55 to 9.55 (). The regression analysis showed that sensory attributes of avocado incorporated cookies ensured important ($p< 0.05$) positive linear effects on texture of cookies (Table 3).it was observed from the response plots (Figure 1-design-B) that with increase of plot based on the response variables changes and ingredients variations also, The constant of determination (R2)were 0.77. A "Pred R-Squared" of 2.10 is in practical contract with the "Adj R-Squared" of 0.49. "Adeq Precision" were 5.38 indicates.

Texture$=+8.93-0.0760A-0.5120B-0.6520C+0.3800AB-0.2700AC+0.4925BC-3.53A^2-0.6759B^2+1.60C^2$ (Eq-2)

Texture based on the consistency of cookies. The term texture is related to the consumer's perception of eating ability. The taste and texture sensations are the main factors influencing a preference to choose particular foods, and this is then related to this consumption, not only in childhood and youth but also in the adult. The flavour of cookies should depend on the ingredients variations. The flavour one of the major factor for sensory attributes. The flavour score ranged from 3.93 to 9.45 (Table 5).the regression analysis showed that sensory attributes of avocado incorporated cookies had significant ($p< 0.05$) positive linear effects on the flavour of cookies (Table 3). It was observed from the response plots (Figure 1-design-C) of the surface effect of levels of ingredients combined cookies. The coefficient of determination (R2) was 0.88. The "Pred R-Squared" of 0.19 is in reasonable agreement with the "Adj R-Squared" of 0.73. "Adeq Precision" was 7.68 indicates the model should negative design space.

Flavor$=+8.25+1.08A+0.7500B+0.3360C+0.5425AB-0.0425AC+0.3700BC-3.43A^2-0.4121B^2+1.46C^2$ (Eq-3)

The minimum and maximum range of overall acceptances score varied from 3.55 to 9.66. The quadratic model for general adequacy was observed to be noteworthy ($p<0.05$). The coefficient of estimation is exhibited in Table 4. The coefficient of assurance (R2) was 0.89. The "Pred R-Squared" of 0.27 is insensible concurrence with the "Adj R-Squared" of 0.75. "Adeq Precision" was 7.98. The reaction plots (Figure 1- design-D) showed the general response of the item is high.

Overall acceptability$=+7.51+0.8720A+0.8420B-0.0010C+0.3062AB+0.4087AC+0.5338BC$

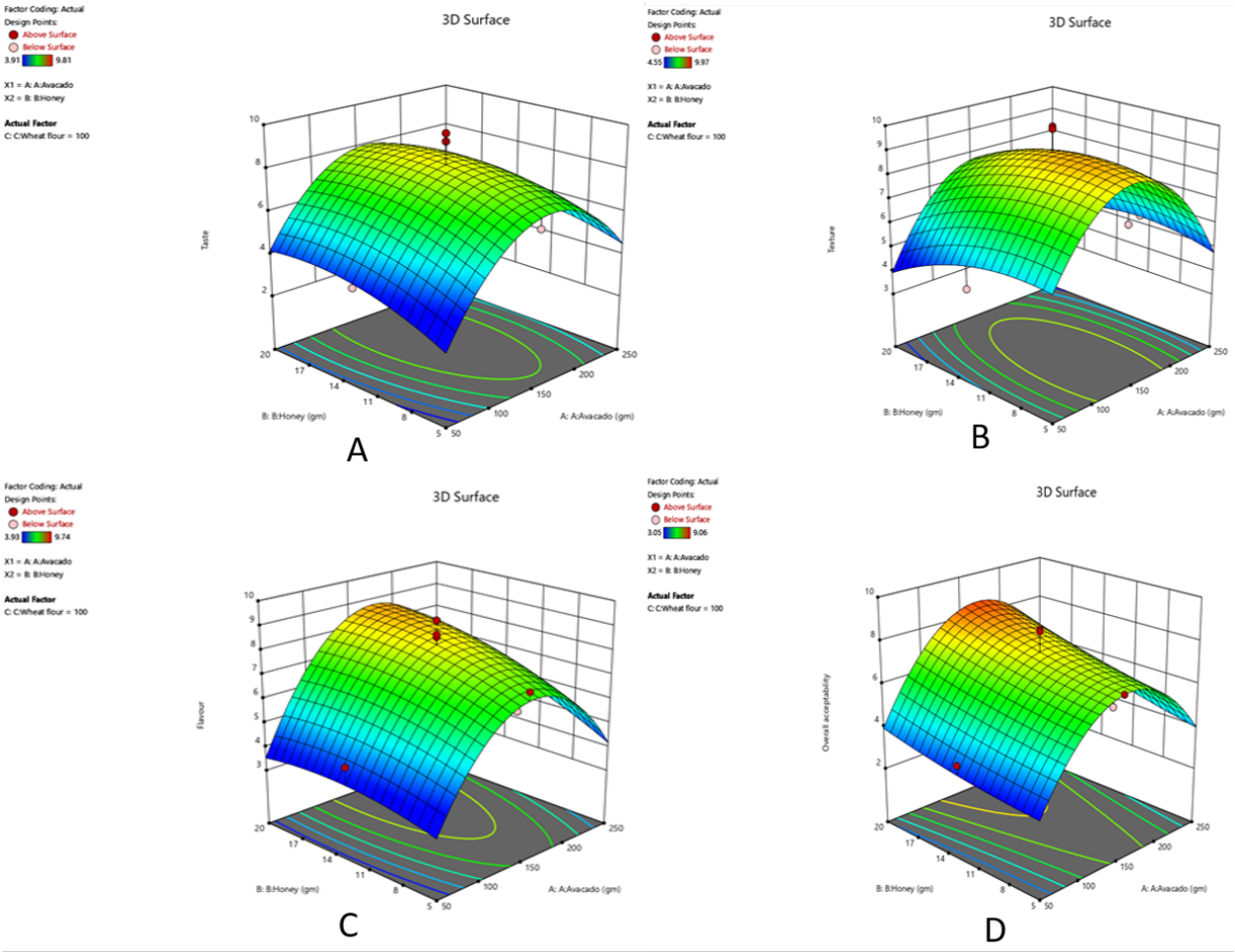

Figure 1: (A): Response surface plot on the taste attributes of Persea Americana fruit pulp cookies. (B): Response surface plot on the texture attributesof Persea Americana fruit pulp cookies. (c): Response surface plot on the flavour attributes of Persea Americana fruit pulp cookies. (D): Response surface plot on the overall acceptability attributes of Persea Americana fruit pulp cookies.

$-3.41A^2+0.1683B^2+1.61C^2$ (Eq-4)

Optimization

Predicated streamlining was performed for sensory characteristics parameters like taste, texture, flavour and overall acceptability by forcing allure limitations. Table 5 demonstrates the requirements forced for treats with better tangible qualities with the ideal incentive for both free and ward factors. The most extreme alluring score that can be accomplished with the ideal estimation of taste was 7.8, texture 6.68, flavour 7.11 and by and overall acceptability 8.44. In light of these figuring's Persea Americana based treats were ready. The watched and predicted qualities were not altogether extraordinary (P>0.05), which affirmed the improvement results and demonstrated the predicted model to be right.

CONCLUSION

After-effects of the investigation exposed that all the tangible properties considered (viz. taste, texture, flavour, and overall acceptability) can be all around predicted by sensory strategies for the created products. It recognizes the imperative to decide by, and large response all three fixings (viz. avocado fruit pulp, nectar, and wheat flour) were found to impact all the tangible characteristics considered. The face-focused focal composite structure was observed to be reasonable in displaying of instrumental tangible traits of treats. The important quadratic relapse models had a high coefficient of assurance esteems which uncovered that every one of the parameters could be precisely anticipated by the chosen fixing levels. An ideal degree of all fixings given by the model for the planning of treats was 150 percent avocado fruit mash, 12.5 percent nectar, and 100 g

wheat flour. Tactile investigation of ideal degrees of fixings was completed, which indicated high generally worthiness of the readied treats.

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