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Sensory Evaluation of Low Calorie Eggless Functional Cake

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ABSTRACT

The purpose of this work is to prepare and evaluate a formulated functional eggless cake using key ingredients to incorporate nutritional value. The functional ingredients that were added to develop the batter were selected as prebiotic, probiotic, and stevia leaf powder. The aim of the study was to substitute the sugar content with a natural sweetener and to reduce the browning effect upon baking, followed by achieving a properly baked finished product with desirable sensory qualities. The shelf life study of the finished products was evaluated with respect to quality parameters, such as taste, color, flavor, texture, and visual microbial growth in different packaging materials. Various trials were made with less oil content, varying prebiotic and probiotic concentrations, and using percentage variations of stevia. The reduced oil percentage was done with the objective of developing a low-calorie cake that would provide health benefits for baked products. The food safety aspects in relation to chemical safety were also considered when using low oil percentage. All proximate analysis and antioxidant analysis were performed for functional baked products. The low-calorie developed product was evaluated with respect to some instrumental as well as sensory characteristics along with microbial analysis. Statistical analysis with respect to sensory qualities among different age groups was also evaluated using the Tuckey test (honestly significant difference test), which works in conjunction with ANOVA. A normality test was also performed to understand the p-value correlating the hypothesis to confirm.

INTRODUCTION

In recent decades, the supply and consumption of bakery products with reduced energy content has been increasing in response to the demand for products with lower calorie content (Sandrou & Arvanitoyannis, 2000). Fat plays an important role in making various food items in bakeries and confectioneries. Not only is it an important ingredient in cake-making operations because it affects food taste and texture, but it also influences human health depending on its intake. Moreover, it adds moistness, enhancing the quality with added flavor (Gisslen, 1994).

Cakes are soft bakery products produced mainly from wheat flour, sugar, oil, baking powder, and other ingredients. Consumption of cake prepared from wheat flour has become popular in most developing countries of the tropics, especially among children and adults (Adewoym *et al*, 2017).

The world is trending towards habituating to bakery items with excess calories, lack of essential nutrients, imbalanced nutrition, and deterioration in meal quality. Unhealthy dietary trends have led to metabolic syndrome, which causes health problems (Shin *et al*., 2013).

Bakery products are consumed all over the world, either in the form of a staple diet or snack food items. Fat is an important ingredient in bakery products, providing an oil-water microemulsion. Some trends have emerged in diets around the world, including bakery items of intermediate moisture foods like cake and bread, evolved with functional components, having good sensory qualities. Antioxidant-rich products with the inclusion of some phyto-components are currently involved in various research works. Lower consumption of herbal aromatic plants in recent decades is insufficient in the food processing sectors (Nanditha & Prabhasankar, 2009).

The present study focuses on including some phytonutrients along with adding probiotic and prebiotic components with a varied composition of ingredients.

Sometimes bakery products are used as vehicles for the incorporation of different nutritionally rich ingredients (Sudha, M. *et al*, 2007). The excess intake of macro and micronutrients in the bakery sector shows an increased amount of calories and lack of bioactive or vital nutrients, leading to imbalanced nutrition and metabolic syndrome (Shin *et al*., 2013 & Cheng *et al*, 2009).

The rise of cardiovascular disease and disorder in sugar metabolism and the associated syndrome has become very common in health-related problems, mostly associated with our high fat and carbohydrate intake through the diet. Considering all the current problems consumers are facing related to illnesses has led to research to find solutions by creating a low-fat, lower carbohydrate, and moderate protein di*et al*ong with some bioactive components. The effect of the lower consumption of herbal plants in processed products is insufficient (Nanditha & Prabhasankar, 2009).

Attempts have, therefore, been made to develop a low-calorie eggless cake with a reduced amount of added oil and sugar ratio. Various trials are done, including curd, probiotic and prebiotic, and stevia to develop a functional food product for the bakery sector.

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Yogurt is used to confer color and flavor to baked products. Reducing fat in the developed product may address public health issues. A concern of most consumers is to lead a healthy daily life. While in the bakery sector, reducing fat content in the products is attempted to make them acceptable to the consumers, other sectors use fat alternatives. The flavor, color, texture, taste, and overall quality of baked products (cake) are the prime focus for consumer acceptability. Among the various intrinsic properties of bakery products, texture is the most important one. Nowadays, antioxidant compounds also play a key role in perception as well as nutrition, in the context of acceptance and health benefits (Dewettinck *et al*., 2008).

Functional foods research is gaining importance because of the interest in nutrition as a positive force for health. Any fresh or processed foods that are claimed to have health-promoting and disease-preventing properties beyond nutrition of supplying nutrients are called Functional Foods (Arias-Aranda *et al*., 2010). Functional foods represent one of the most interesting areas of research and innovation in the food industry (Annunziata *et al*., 2011). A list of potential health substances like probiotics, prebiotics, natural sugar substitutes, fortified oils, oil analogs, etc. is continuously growing and has been included in a wide variety of substances that are recognized to have a positive role in the pathogenesis of many diseases, such as aging, cancer, cardiovascular disorders, and diabetes (Sun, Y. & Hayakawa, S., 2007).

The main focus of this study was given to develop eggless cake production with the inclusion of some dietary functional nutrients and probiotics. Stevia leaf powder was also included to reduce the sugar content in the development of functional cake products. The investigation was aimed at various formulation trials reducing the oil content and getting instrumental analysis along with some sensory analysis among various age groups to infer the process viability and product acceptance. The statistical correlation has been drawn with respect to sensory analysis to confirm the hypothesis. Various sensory attributes are judged with a normality test in ANOVA among different age groups."

MATERIAL AND METHODS

Wheat flour variety of 90 % extract was purchased as a principal ingredient for cake preparation from local market of Kolkata, Ganesh variety. Powdered sugar, baking powder, baking soda were admixed along with milk, cardamom, and curd. Low amount of shortening was purchased with the brand name, Doctors Choice, fortified with vitamin A, D, E. All the said ingredients were purchased from the local market of Kolkata, India.

Functional ingredients are also procured to develop different valued products as to make different trials with some functional benefits. Probiotic and prebiotic immune symbiotic sachets were purchased from the local medicinal shop (Intel health solutions private Limited) and used in making trials.

Stevia Powder was used for another trial instead of sugar to develop low-calorie product. Stevia powder was procured from Kushan International, Kolkata.

Cake Preparation

Cakes were prepared according to sugar batter method using wheat flour, baking powder, baking soda and sugar in a dry mix sieved by 60 mesh size and then taken in a vortex mixer and mixed properly with the addition of milk / curd along with oil.

In the trial runs probiotics and prebiotics are mixed with varied percentages and also with stevia. Natural flavouring component was also added. After that moulding operation was done in pans and the baking time temperature were set at 160°C for 30 minutes in a deck oven, manufactured by Suan scientific instrument and equipment. After the cakes were baked, they were completely cooled for 1 hour and unplanned and sealed in packaging materials of different categories with paddle sealer.

Cake Batter Density and pH

The specific gravity of flowable batter was determined as the ratio of the weight of a standard container filled with batter to that of the same container filled with water keeping them at 30°C the pH of the batter was determined with the pH paper (Merck Life Science Private Limited)

Measurement of Bulk Density of Cake

Bulk density was measured by the rapeseed displacement method. The initial weight of the cake was measured which was utilized to calculate the final bulk density in terms of gm/cc (Abe, 2022).

Instrumental Analysis

A compression test was carried out to evaluate the texture of different samples of finished product with respect to springiness and cohesiveness. It was measured by Texture Profile Analyser (TA-XT plus Texture Analyzers tab micro systemsms 36 mm Cylinder radius)part Code P/36R, Test mode-Compression, pretest speed-1.00mm/sec, Test Speed- 1.00mm/sec, post -Test speed – 10.00mm/sec, Distance- 5.000mm, Trigger Type- Auto (Force), Trigger Force-5.0g, Hold time- 60.00 sec. Texture profile analysis is a double compression test for determining the textural properties of foods (Bourne, 2002).

Sensory Evaluation

Sensory trials were made with a set of panelists of 5 people for different age groups, young age group (20 - 40years), medium (40 - 60 years), old age (above 60 years, based on the evaluation of cakes through 9-points Hedonic scale (where 9 = extremely like and 1 = dislike extremely). The samples were scored for colour, flavour, taste, texture and overall acceptability Chude (2023).

Tuckey (HSD) Test

Tuckey HSD test, also known as ("honestly significant difference test") is a statistical tool which works in

conjunction with ANOVA. It identifies whether interaction among three or more variables is mutually statistically significant. Tuckey test is a single-step multiple comparison that compares all possible pairs of means. The fundamental requirement for this test is to be applied, in the population from which the sample has been drawn which follow normal distribution (Granato *et al.*, 2014). Tuckey HSD test analyses all pairwise comparisons among means. Tuckey HSD is calculated using the following formula.

$$T_{HSD} = \frac{m_i - m_j}{\sqrt{\frac{ms_w}{n}}},$$

where $m_i - m_j$ is the difference between the pair of means ($m_i > m_j$), ms_w is the within mean square and n is the number of treatments. considering one-way ANOVA test, Tuckey test is considered the post-hoc ANOVA test.

Normality Test

Since the Tuckey test is based on the normality of the given data, to check whether the data conforms to normality or not, the Shapiro-Wilk (SW) test can be applied (Granato *et al.*, 2014). In the SW test, if the p-value is less than 0.05 (by p-value we mean the p-value of the test statistic), then the null hypothesis that the data conforms to normality must be rejected. On the other hand, if the p-value is greater than 0.05, then the hypothesis of normality is not rejected. It has been observed that the data, according to the SW-test, does not conform to normality. One of the reasons for this is that the test is not well-suited to handle small data sets with repeated values (the sample size is 30, which may be considered large, but it is still small enough for the SW test to be unreliable). For such a case, the D'Agostino-Pearson test (Pearson *et al.*, 1977)] can be applied to check normality (Granato *et al.* 2014 & Nanda *et al.*, 2021). The D'Agostino-Pearson test correlates the shape of the distribution with the shape of the normal distribution. It is a combination of the skewness and kurtosis tests. The D'Agostino-Pearson test can be used for any distribution, and it is most often applied when data has repeated values.

Chemical Evaluation

Analytical methods were followed from AOAC, 2010 to find out the proximate composition of all trials in the Quality control and Food Chemistry laboratory of TMSL, Kolkata.

Composition of Trial Formulation

Table 1: Composition of Trial Formulation

Trial 1(control)	Trial 2 (Pre-probiotic 0.5)	Trial 3 (Pre-probiotic 0.25)	Trial 4 (stevia)
Wheat flour-100gm	Wheat flour-100gm	Wheat flour-100gm	Wheat flour-100gm
Sugar -70gm	Sugar -70gm	Sugar -70gm	Sugar -50gm
Oil-12ml	Oil-14ml	Oil-14ml	Oil-14ml
Milk-40ml	Milk-50ml	Milk-50ml	Milk-40ml
			Curd-30gm
Baking powder-0.1gm	Baking powder-0.1gm	Baking powder-0.1gm	Baking powder-0.3gm
Baking soda-0.1gm	Baking soda-0.1gm	Baking soda-0.1gm	Baking soda-0.3gm
Cardamom-0.2gm	Cardamom-0.2gm	Cardamom-0.2gm	Cardamom-0.5gm
Curd-50gm	Prebiotic-probiotic powder-0.5gm	Prebiotic-probiotic powder-0.25gm	Stevia-2 gm

Proximate Composition of Low-Calorie Cakes Prepared (chemical analysis of the various trials)

Proximate analysis was carried out following (A.O.A.C., 2010). Instruments utilized in Chemistry Of Food laboratory, TMSL named hot air oven (Instrumention India), muffle furnace (Instrumention India), shoxtech, kjeltech (Kel plus- Distylem). Carbohydrate was calculated by subtraction method . Calorific value was calculated for each trial knowing the corresponding proximate composition.

Analysis of Antioxidant

5 gm sample was taken for each trial in a 250 ml conical flask with the inclusion of 100 ml of methanol: water (1:1) in each flask was kept in rotary shaker with the speed of 250 rpm for an hour. It was filtered and collected the filtrate followed by addition of 1 ml folin-chiocalteu, 3 ml Na_2CO_3 with respect to 1 ml of filtrate volume. It was kept for 30 minutes and the absorbance was recorded at 760 nm in spectrophotometer(make).Antioxidant analysis was calculated in terms of total polyphenolic in gallic acid equivalent.

Microbial Analysis and Shelf Life Study

Microbial analysis was done by pour plate method with MRS Agar for probiotic count. The plates were kept in the incubator keeping at 42°C for 48 hours maintaining the time temperature ratios for colonization. Colonies were counted by colony counter.

Shelf life study of various product were studied selecting three categories of packaging materials, low density polyethylene, cellulose paper and laminate keeping them in biosafety cabinet. The packaged products were then arranged on a tray and kept for 30 days in the laboratory

at 30^{0}C maintaining relative humidity near about 70 – 75%. Shelf-life determined by recording the number of days each product remained at safe microbial level (visual microbial growth, and quality was judged with respect to colour, flavour and texture). After every 7 days interval observational studies were carried out for each product category from the zero day of production.

RESULTS AND DISCUSSIONS

Composition of Trial Formulations

Table 2: Composition of Trial Formulation

Trial 1(control)	Trial 2 (Pre-probiotic 0.5)	Trial 3 (Pre-probiotic 0.25)	Trial 4 (stevia)
Wheat flour-100gm	Wheat flour-100gm	Wheat flour-100gm	Wheat flour-100gm
Sugar -70gm	Sugar -70gm	Sugar -70gm	Sugar -50gm
Oil-12ml	Oil-14ml	Oil-14ml	Oil-14ml
Milk-40ml	Milk-50ml	Milk-50ml	Milk-40ml
			Curd-30gm
Baking powder-0.1gm	Baking powder-0.1gm	Baking powder-0.1gm	Baking powder-0.3gm
Baking soda-0.1gm	Baking soda-0.1gm	Baking soda-0.1gm	Baking soda-0.3gm
Cardamom-0.2gm	Cardamom-0.2gm	Cardamom-0.2gm	Cardamom-0.5gm
Curd-50gm	Prebiotic-probiotic powder-0.5gm	Prebiotic-probiotic powder-0.25gm	Stevia-2 gm

Figure 1: Trial 1

Figure 2: Trial 2

Figure 3: Trial 3

Figure 4: Trial 4

The four trials are made with the varied composition of used ingredients which are shown in the table no 2 as formulation trials. Functional components like curd, prebiotic-probiotics and stevia were used to achieve the comparable quality of the products with respect to market cake. Specific gravity/batter density and batter pH with the level of inclusion of some functional components and with the minimum addition of fat, the cake batters were judged. Low specific gravity is associated with good aeration of the batter. The addition of low amount of oil and milk along with the proper air incorporation process leaded to make of desirable batter for accepted finish product quality. Similar results were obtained by (Khalil, 1998) reported that specific gravity of cake batter prepare by fat replacement was higher than the control. The investigation was also done by (Pong et.al.,1991), reporting batter prepare without shortening had higher specific gravity than those prepared with shortening.

Cake Batter Density and pH

pH value of cake batter was slightly affected by functional ingredients. More or less pH value of cake batters were within the optimum level of 5.8 to 6.2 .The recorded pH value of cake batter are shown within a level of 6.5-7.7 as reported by (Ash & Colmey, 1973).The Present study was focused on the ingredient inclusion and corresponding batter density as to correlate the product quality with the formulation trials. The cake batter density and pH is mentioned in Table no 3. Measurement of bulk density & baking loss is mentioned din Table no 4.

Table 3: Cake batter density and pH

Formulation Trial	Batter Density (gm/cc)	Batter pH
Trial 1Control	0.991	6.2
Trial 2 Pre-probiotic 0.5	0.981	6.1
Trial 3 Pre-probiotic 0.25	0.984	6.1
Trial 4 Stevia	0.989	5.8

Measurement of Bulk Density & Baking Loss of Cake

Table 4: Measurement of Bulk Density & Baking loss of cake

Formulation Trial	Bulk Density (gm/cc)	Oven loss%
Trial 1Control	0.4	38.18
Trial 2 Pre-probiotic 0.5	0.667	43.32
Trial 3 Pre-probiotic 0.25	0.3875	26.57
Trial 4 Stevia	0.526	54.27

Instrumental Analysis

The texture profile of the various trials was recorded to springiness and cohesiveness, which indicate the elasticity and inner matrix cohesion. The maximum Force (g) required to compress the eggless cake is found to be highest in Trial 2 which is represented in fig 6. This indicates much more spongy character of the developed matrix which may be attributed with proper gelatinization of starch during baking and the gelling property might be good enough to reflect a proper sponginess and chewiness in crumb texture. The Crumb firmness is attributed by the starch content with respect to amylose and amylopectin fraction which is reflected in crumb texture (Schiraldi & Fessas, 54). The inclusion of stevia shows the lesser force peak value in compression in comparison to probiotic-prebiotic where the amount of sugar was added less and might be an indication of under baking. Springiness measure elasticity in determining the recovery in the first and second compression factor with the gram force applied. Cohesiveness quantify internal resistance of food structure and the ability of the materials to be stuck together. The overall compression value of different categories of products are in co-relation with TPA results shown by (Salehi, *et al*., 2016) in developing cake.

In the texture meter when plunger is brought down to reach to the end of the compression stroke, and then it gets stops and then accelerated upward. This procedure is a deformation motion that closely in action relating to human jaw. It also causes the visco elasticity reaction of the sample to vary in the analysis (voisey and man,1976). Force time curve is produced with respect to a variable speed of the load arm, which prevent conversion to force-distance. The constant speed in the texture analyzer list to both Force-Time and Force-Distance curves. In the present study we observed the force-time curves for different Trials by which the springiness and cohesiveness values are evaluated. Cohesiveness is a ratio of the positive force area of the second compression to that of the first. Springiness is the height recovered between the end of the first bite and the start of the second. It is measured along the baseline from the start of the second peak to the spot directly under the top of the peak. Measurement is converted from second to unit of the length. Sample of all Trials Springiness and Cohesivenesss calculated is given in Table no 5. X axis the all figure stand for time & Y axis represents force in gram-force.

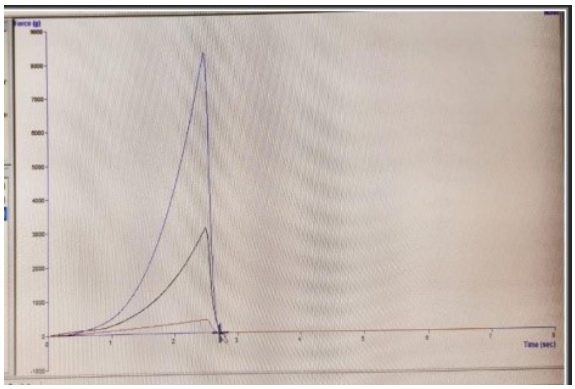


Figure 5: Trial 1

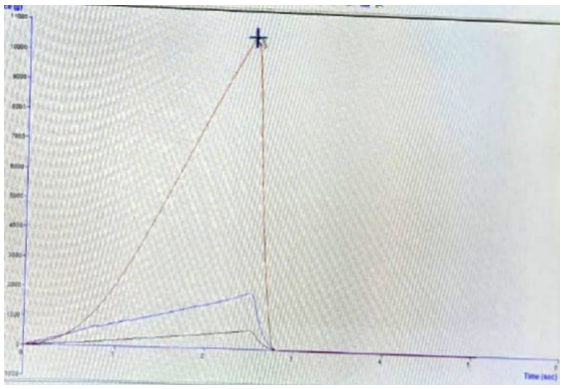


Figure 6: Trial 2

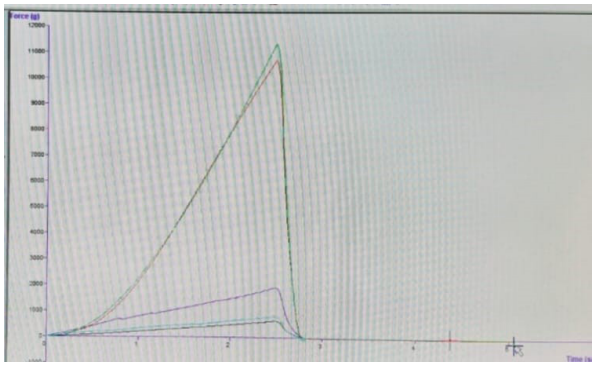


Figure 7: Trial 3

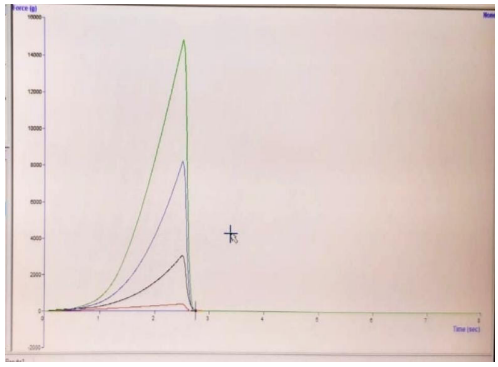


Figure 8: Trial 4

Texture Profile Analysis

The overall texture with respect to springiness and cohesiveness show the best value for trial 4 but trial 2 springiness is quite high. As the springiness illustrate the elastic behaviour, the trial 2 can be considered as the characteristic of sponginess behavior.

Table 5: Texture Profile Analysis

Sample of all Trials	Springiness	Cohesiveness
Trial 1	55sec/cm	0.37
Trial 2	93.3 sec/cm	0.17
Trial 3	25.3 sec/cm	0.94
Trial 4	33.6 sec/cm	0.55

Sensory Evaluation

Sensory Evaluation Among Various Age Group with Specified Panelists for Each Trial

Sensory analysis was done in a panel and it was customized with the age group of between 20-40 / 40-60 / 60-70.

Sensory characteristics of low-calorie cakes were highly accepted among young age group people. The quality attributes were judged with respect to taste, texture, appearance, colour, odour, flavor, gumminess, chewiness and mouthfeel. Mouthfeel, texture and taste showed the highest evaluated score among other quality attributes for young age groups on hedonic scale for Trial no 1. Measuring product liking and preference in the scale of hedonic view is done worldwide with a uniqueness, providing reliable and valid results, (Stone *et. al.*, 2012). Sensory evaluated score sheet is given in Table no 6.

Table 6: Trial 1

Sample of control	Taste	Texture	Appearance	Colour	Odour	Flavour	Gumminess	Chewiness	Mouthfeel	Overall acceptability
Young age group	7	8	7	7	7	8	7	7	8	8
	7	7	6.5	7.5	6.5	7	6	6.5	8.5	7
	7.5	7	7.5	6.5	7.5	6.5	7.5	7.5	7	7.5
Medium age group	6	8	7	8	8	8	7	8	7	8
	7.5	7	8	7	7.5	7	8	7.5	6.5	7
	7	7.5	8.5	7.5	7	7.5	7.5	7	7	7.5
Older age group	7	7	7	8	6	7.5	7	7	8	7
	7	7.5	7.5	7.5	6.5	6.5	6.5	6.5	7.5	7.5
	6.5	6.5	8	7	7	7	7.5	7.5	7	6.5

Sensory rating score of low-calorie cakes are highly accepted among medium age group for Trial 2 category and reported in Table no 7. The mean value of the product, Trial 2 showed the higher value for texture, colour, flavour. A little bit gumminessis also shown for the higher value upon evaluation by hedonic scale, which by indicating entrapment of water in bound phase maintaining a good mouthfeel effect.

Sensory evaluation for the Trial 3 was carried out with respect to sensory parameters which is illustrated in Table no 8 highest score in mean value was shown for appearance, colour and flavour. With shows a good acceptance and mouthfeel value among medium age group.

Trial 4 was based on the inclusion of stevia as a functional

Table 7: Trial 2

Sample of Probiotic-prebiotic Powder (0.5)	Taste	Texture	Appearance	Colour	Odour	Flavour	Gumminess	Chewiness	Mouthfeel	Overall acceptability
Young age group	7	8	8	8	7	6.5	7	7	7	7
	7	8	7.5	7	7	6.5	6.5	6.5	6.5	7.5
	7.5	8.5	7	7.5	7.5	7.5	7.5	7	7.5	7
Medium age group	7	8	8	8	6	8	8	7	7	8
	6.5	7.5	7.5	7	7.5	7	7.5	6.5	6.5	7.5
	8	6.5	6	7.5	8	7.5	7	8	8	7
Older age group	8	8	7	8	7	8	8	6	7	7
	7.5	7	8	8.5	7.5	8	8	7.5	7.5	7.5
	8	7	7.5	7	6.5	7	7.5	7	6.5	6.5

component and the sensory evaluation of the product is given in Table no 9 which was accepted highly among young age group. The recorded mean value for colour, was evaluated with the very high acceptance among young age group. Texture and flavour were observed with a very good mean value.

The four varieties of cake were prepared with the reduction of fat and sugar percentage with an objective to developed low calorie cake with the good health value. Since various functional components like curd, prebiotic-probiotic, stevia was used to developed functional bakery product, the sensory score for flavour, softness and overall texture were given the priority for quality product development. (Khalil, 1998)

Table 8: Trial 3

Sample of Probiotic – prebiotic Powder (0.25)	Taste	Texture	Appearance	Colour	Odour	Flavour	Gumminess	Chewiness	Mouthfeel	Overall acceptability
Young age group	7	7	7	7	7	7	7	7	7	6.5
	7.5	6.5	7.5	6.5	7	7.5	8	6.5	7.5	7.5
	7	7	6	7.5	7.5	6.5	7.5	7.5	6.5	7
Medium age group	6	6	7	8	7	8	6	7	8	7
	7	7.5	7.5	6.5	7.5	7.5	7.5	7.5	7	6.5
	7.5	6.5	7	7	6	6.5	6.5	6.5	6	7.5
Older age group	7	7	7	8.5	8	8	6	7	7	7
	7	7.5	6	8	7	7	7	6.5	7	7.5
	7.5	6.5	6.5	7	7.5	7.5	7.5	6	6.5	6.5

Table 9: Trial 4

Sample of stevia leaf powder	Taste	Texture	Appearance	Colour	Odour	Flavour	Gumminess	Chewiness	Mouthfeel	Overall acceptability
Young age group	7	8	7	8	7	6	7	7	7	7
	6.5	7.5	6.5	7	6.5	7.5	7.5	8	6	6.5
	8	7	7.5	7.5	7.5	7	6	6.5	6.5	7.5
Medium age group	6	7.5	6	7	8	7	7	8	7	7
	7	7.5	7.5	8	7	6	7.5	7.5	6	6.5
	6.5	7	6.5	7.5	7.5	6.5	7	7	6.5	7.5
Older age group	7	7	7	7	6	6.5	7	7	7	7
	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5
	6.5	7.5	6.5	7	6	7	7.5	7.5	7	6.5

Hypothesis Testing of the Above Data

Now as we have seen above that all our samples are byproducts of normal population we go for statistical analysis of the data represented in tables 6-9 on the basis of ANOVA test and Post ANOVA Tuckey test. ANOVA reveals whether there are any significant differences among the means of the samples whereas Tuckey test tells us which of the two pairs are the most significant. One-way ANOVA table is given as follows:

Table 10: Results (of Normality Test)

Table No.	Type	Sample size	p-value	Skewness shape	Kurtosis shape	Result
12	Young age	30	0.7754	Potentially symmetric	Potentially Mesokurtic	Data distribution is normal
13	Middle		0.7755			
14	Old		0.925			
15	Young age		0.4993			
16	Middle		0.26			
17	Old		0.6704			
18	Young age		0.8713			
19	Middle		0.2706			
20	Old		0.8432			
21	Young age		0.6729			
22	Middle		0.6156			
23	Old		0.9534			

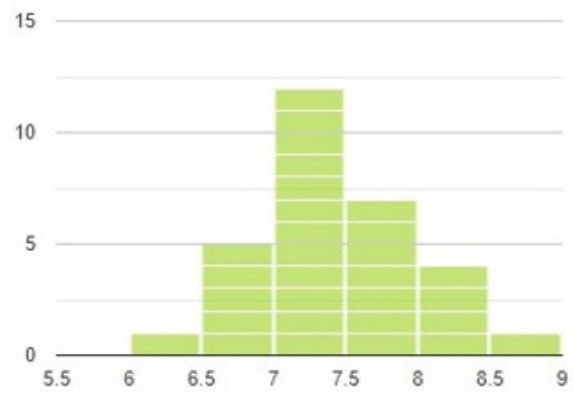


Table 6 (Young Age)

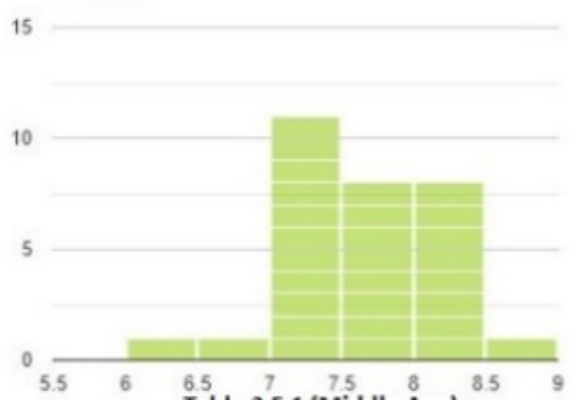
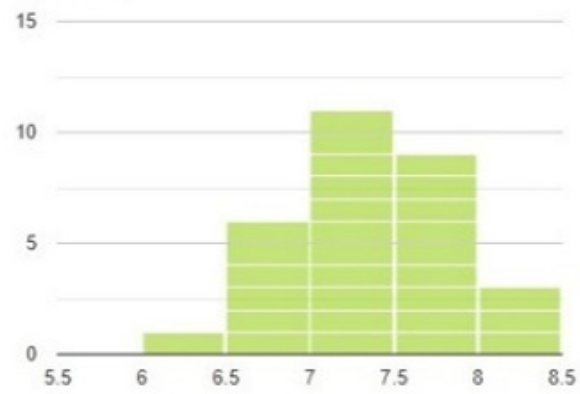


Table 6 (Middle Age)



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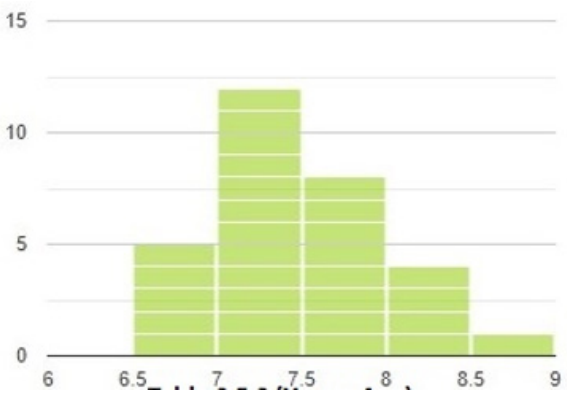

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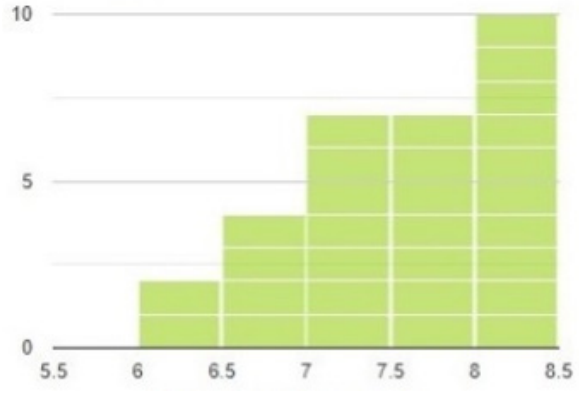

Table 7 (Middle Age)

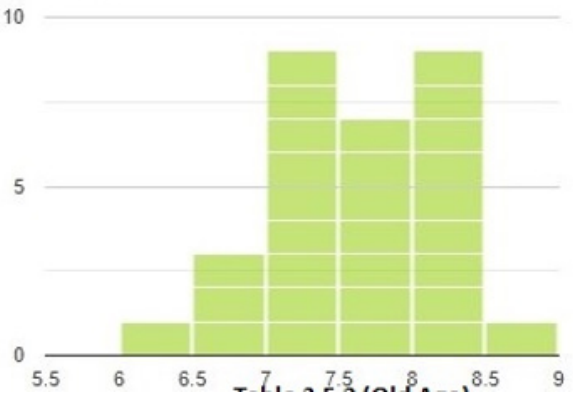

Table 7 (Old Age)

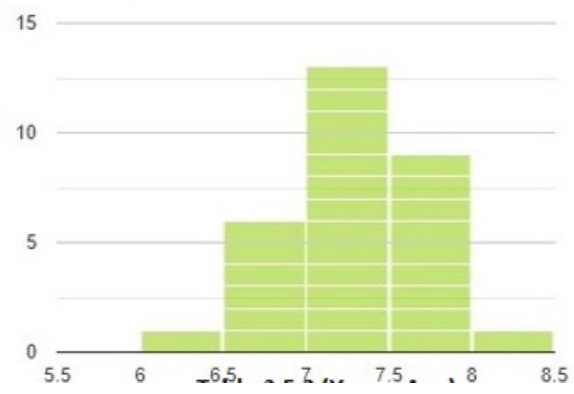

Table 8 (Young Age)

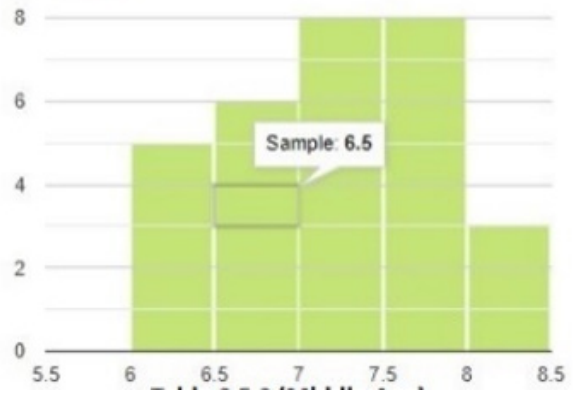

Table 8 (Middle Age)

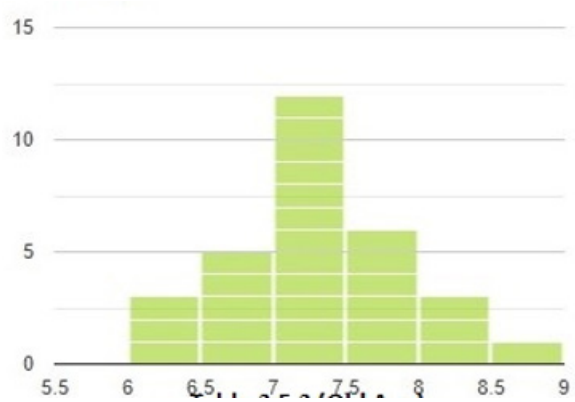

Table 8 (Old Age)

Table 9 (Middle Age)

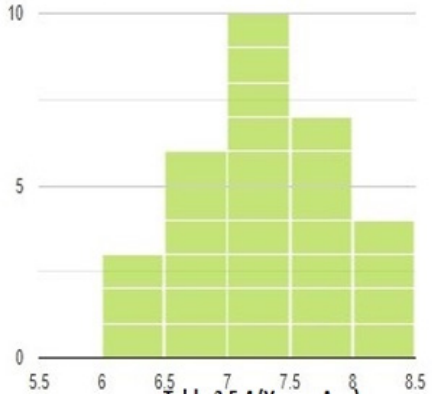

Table 9 (Young Age)

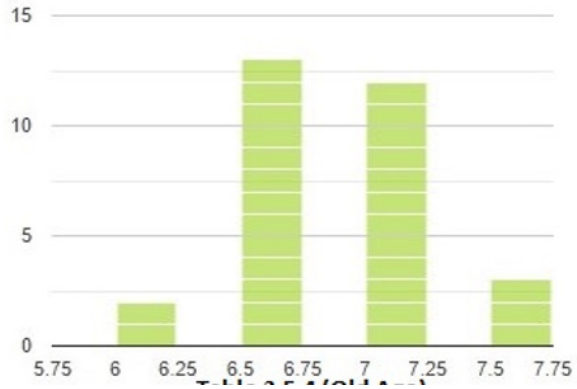

Table 9 (Old Age)

Figure 9: Graphical representation of the normality of the data

Table 11: One-way ANOVA

Source	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	$k-1$	$SSG=\sum_{I=1}^{K} n_i\left(\overline{x_i}-\overline{x}\right)^2$	$MSG=\frac{SSG}{k-1}$	$F=\frac{MSG}{MSE}$, $MSG>MSE$	$P(x>F)$
Error (within groups)	$n-k$	$SSE=\sum_{I=1}^{K} s_i^2(n_i-1)$	$MSE=\frac{SSE}{n-k}$		
Total	$n-1$	$SS(Total)=SSG+SSE$	Sample variance $=\frac{SS(Total)}{n-1}$		

where number of groups; sample size of group ; overall sample size, includes all the groups (i.e.); average of group ; grand mean and standard deviation of group . For the test, we have considered 5% level of significance. We summarize our findings below. Our null hypothesis is as follows:

H_0: There is no significant difference between group means

H_1: There is significant difference between group means (Here different groups are Taste, Texture, Appearance, Colour, Odour, Flavour, Gumminess, Chewiness, Mouthfeel and Overall Acceptability)

In each of the above Table 12, 13, 14, it is evident that the value is greater than 0.05 (the level of significance), hence based on the provided data, the null hypothesis, H_0 will not

Table 12: ANOVA-Tuckey test A

Source Young Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	2.4083	0.2676	0.7832	0.6343
Error (within groups)	20	6.8333	0.3417		
Total	**29**	**9.2417**	**0.3187**		

Table 13: ANOVA-Tuckey test B

Source Medium Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	2.7	0.3	1	0.4711
Error (within groups)	20	6	0.3		
Total	**29**	**8.7**	**0.3**		

Table 14: ANOVA-Tuckey test C

Source Old Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	2.875	0.3194	1.369	0.2658
Error (within groups)	20	4.667	0.2333		
Total	**29**	**7.5417**	**0.2601**		

be rejected. We hereby conclude that there is no significant difference among group means. However, Tuckey test reveals that there is no such significant difference between the means of any pair.

In each of the above Table 15, 16, 17, For medium age group and old age group we see that the value is greater than 0.05 (the level of significance), hence based on the provided data we do not reject the null hypothesis, H_0. and we conclude that there is no significant difference among group means. However, Tuckey test reveals that there is no significant difference between the means of any pair. On the other hand, for young age group, the value is much less than the level of significance and so null hypothesis is rejected. Tuckey test consequently reveals that the pairs texture-flavour and texture-chewiness are significantly different.

Table 15: ANOVA-Tuckey test A

Source Young Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	4.3667	0.4852	2.7725	0.02758
Error (within groups)	20	3.5	0.175		
Total	**29**	**7.8667**	**0.2713**		

Table 16: ANOVA-Tuckey test B

Source Medium Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	0.7417	0.08241	0.1498	0.997
Error (within groups)	20	11	0.55		
Total	**29**	**11.7417**	**0.4049**		

Table 17: ANOVA-Tuckey test C

Source Old Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	4.3417	0.4824	1.608	0.1799
Error (within groups)	20	6	0.3		
Total	**29**	**10.3417**	**0.3566**		

In each of the above Table 18, 19, 20, it is evident that the value is greater than 0.05 (the level of significance), hence based on the provided data we do not reject the null hypothesis, H_0. hence is accepted and we conclude that there is no significant difference among group means. However, Tuckey test reveals that there is no significant difference between the means of any pair.

Table 18: ANOVA-Tuckey test A

Source Young Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	1.0704	0.1189	0.5265	0.8375
Error (within groups)	20	4.2917	0.2259		
Total	**29**	**5.3621**	**0.1915**		

Table 19: ANOVA-Tuckey test B

Source Medium Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	1.3	0.1444	0.2842	0.9715
Error (within groups)	20	10.1667	0.5083		
Total	**29**	**11.4667**	**0.3954**		

Table 20: ANOVA-Tuckey test C

Source Old Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	5.2	0.5778	2.0392	0.08854
Error (within groups)	20	5.6667	0.2833		
Total	**29**	**10.8667**	**0.3747**		

In each of the above Table 21, 22, 23 it is evident that the value is greater than 0.05 (the level of significance), hence based on the provided data we do not reject the null hypothesis, H0. hence is accepted and we conclude that there is no significant difference among group means. However, Tuckey test reveals that there is no significant difference between the means of any pair.

Table 21: ANOVA-Tuckey test A

Source Young Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	2.5083	0.2787	0.7271	0.6798
Error (within groups)	20	7.6667	0.3833		
Total	**29**	**10.175**	**0.3509**		

Table 22: ANOVA-Tuckey test B

Source Medium Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	5.2417	0.5824	2.3296	0.05531
Error (within groups)	20	5	0.25		
Total	**29**	**10.2417**	**0.3532**		

Table 23: ANOVA-Tuckey test C

Source Old Age Group	Degrees of freedom	Sum of squares	Mean square	F-statistic	p-value
Groups (between groups)	9	1.7	0.1889	1.4167	0.2461
Error (within groups)	20	2.6667	0.1333		
Total	**29**	**4.3667**	**0.1506**		

Proximate Composition of Low-Calorie Cakes Prepared

According to the proximate analysis of various trials moisture% was reported highest in Trial 1 and within a moderate value in trial 2 and trial 3. Similar moisture percentage was observed in the literature by (Souza *et. al.*, 2013). The high value of moisture content in trial 1 may be of using curd which will be in favour of increasing water absorption of protein and starch in micro matrix. (Borges *et. al.*, 2011). Moderate value of moisture content in trial 2 and trial 3 as well as trial 4 indicates less viability of growth of microorganism and more durability of the said products with a better nutritional quality (Rodrigues *et. al.*, 2011).

Ash content for all trials were more or less equivalent as observed value remained within 0.5 to 0.6 percentage. The determination of ash content quantifies the total mineral present in food (Rodrigues *et. al.*, 2011). The functional cakes which were developed in the various trial resulted the presence of mineral oxide according to specification and well accepted for consumption. The study by (Celestino, 2011).

Protein percentage was estimated in different trials in the range of 10.59-11.73 percentage which represent more or less good protein content for snacks bakery product. The reported crude protein content for functional bakery product is almost similar found by (Essam, H. *et. al.*, 2011)

Total carbohydrate was reported for different trials 49.43 -58.56 percentage which represent admissible amount of total carbohydrate and maybe comparable with low calorie cakes prepared with different fat and sugar replacer level investigated by (Essam, H. *et. al.*, 2011)

Highest percentage of crude fat was recorded in trial 4

Table 24: Proximate composition of low-calorie cakes prepared

Proximate Composition	Trial 1(control)	Trial 2 (Pre-probiotic 0.5)	Trial 3 (Pre-probiotic 0.25)	Trial 4 (stevia)
Protein%	11.08	10.68	10.59	11.73
Crude fat%	8.6	9.86	9.2	10.6
Total ash%	0.49	0.51	0.6	0.58
Total carbohydrate%	49.43	57.95	58.56	54.89
Moisture%	30.4	21	21.05	22.2

as 10.60% were as least content was recorded in trial 1 an 8.6%. The total crude fat content value represents the concept of low-calorie cake production on nutritional point of view and almost similar with the fat replacement data to generate low calorie cakes by replacement of 75% of fat done with the co-worker (Alaa, E., *et. al.*, 2011). The proximate composition of Protein%, Crude Fat%, Total Ash%, Total carbohydrate%, Moisture% is mentioned in Table no 24.

Table 25: Comparison of calorific value of market sample with the developed trials

Sample of trials	Total Calorific Value
Control	319.44
Pre-probiotic 0.5	363.26
Pre-probiotic 0.25	372
Stevia	361.88
Market Sample Product	
Valina Cup Cake (Country Harvest)	440.03
Britannia Cake Muffills (Valina)	429.7
Sobisco Desire Cake (Valina Cake)	535.69

Calculated Calorific Value

Comparing with market samples of different variety the developed trials showed low total calorific value in the range of 319 – 361 on 100 gm product basis. Whereas the market sample values are recorded in the range of 440-535 on 100 gm basis. Thus, the calorific values of different trials show the significant decrease in energy values per 100 gm of product and maybe stated as potential low calorie functional product. Calculated Calorific value is mentioned in Table no 25

Analysis of Antioxidant

The antioxidant activity was measured by spectrophotometric analysis to evaluate total polyphenolic content in terms of gallic acid equivalent. The highest content of polyphenol is recorded in the combination of prebiotic-probiotic (2.25-2.32) gm per 100 gm of sample and stevia (3.98) gm per 100 gm in terms of gallic acid equivalent. The highest antioxidant capacity is shown with the stevia included cake and moderate value of antioxidant capacity is shown by prebiotic-probiotic. The eggless cake of these varieties are called as functional cake with the bioactive phyto components. (Sargi, *et al.*, 2013). Analysis of Antioxidant is mentioned in Table no 26.

Table 26: Analysis of Antioxidant

Sample name	Polyphenol Content (in term of galic Acid equivalent) in gm per 100 gm of sample
Trial 1Control	1.08
Trial 2 Pre-probiotic 0.5	2.25
Trial 3 Pre-probiotic 0.25	2.32
Trial 4 Stevia	3.98

Microbial Analysis and Shelf Life Study

The shelf studies of the different trials were made in different packaging material (low density polyethylene,

Figure 10: Serial dilution 10^1

Figure 11: Serial dilution 10^3

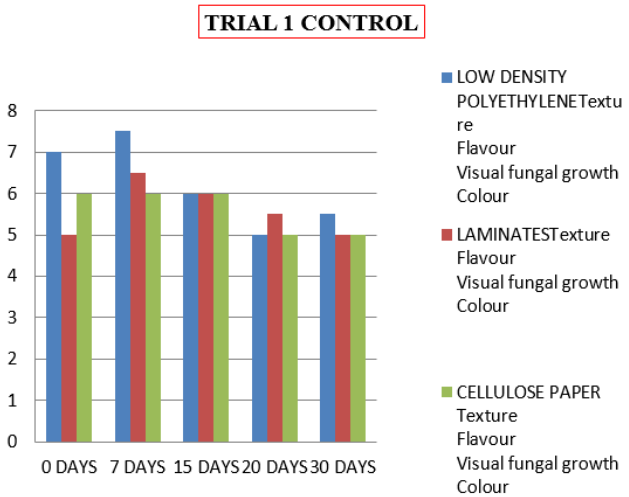

Figure 12: Shelf life observation of studies from 0 days to 30 days

cellulose paper, aluminum laminates) for one-month basis. The observed results are correlated in the figures below Fig 12 Trial 1, Fig 13, Trial 2, Fig 14 Trial 3, Fig 15 Trial 4. The shelf profile indicates the better durability up to 15 days in LDPE and Cellulosic paper where as in laminates the product quality was not good. The overall shelf life acceptability with respect to texture flavour, colour and visual microbial growth was good enough up to 25 days, in LDPE. In addition to observe the keeping quality of the baked product, the probiotic count was also measured in the selective medium, MRS agar for LAB, and observed colony counts were measured in serial dilution 10^1, 10^3 and represented in fig no 10 and 11 for Trial 2. The mean CFU was calculated 300 cfu /ml per gm and shown the significant bacterial count (friendly bacteria) which might be giving the better shelf life profile in the preserved product kept in LDPE and the good profile for cellulosic paper.

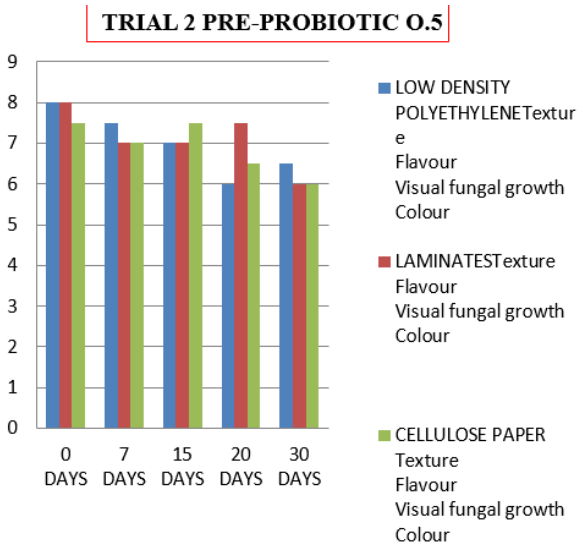

Figure 13: Shelf life observation of studies from 0 days to 30 days

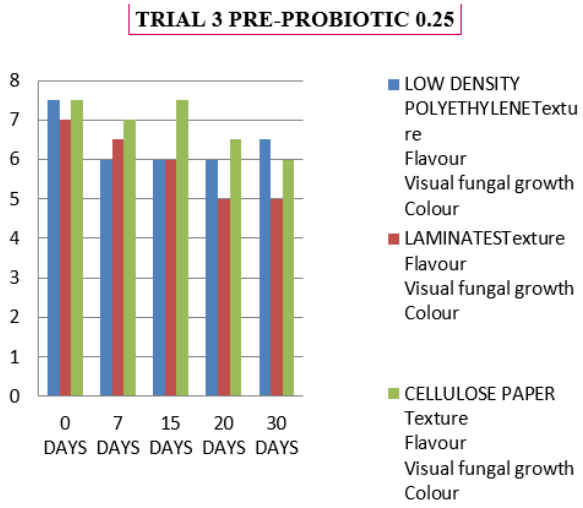

Figure 14: Shelf life observation of studies from 0 days to 30 days

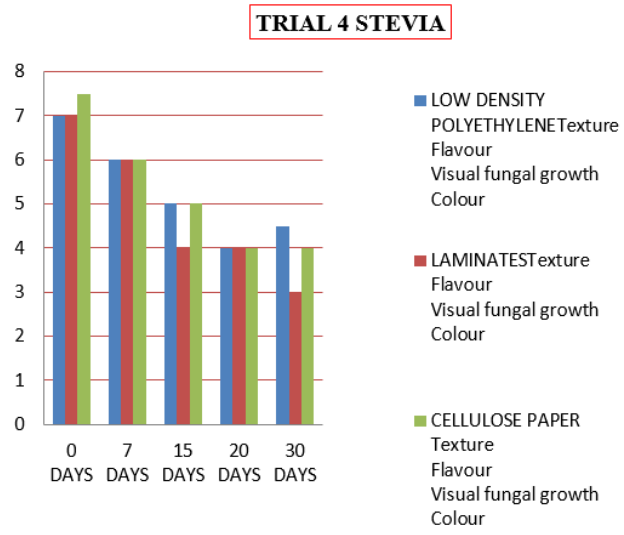

Figure 15: Shelf life observation of studies from 0 days to 30 days

CONCLUSION

In the current work, the final products developed with probiotic, prebiotic, stevia, and curd were accepted among various age groups. With respect to sensory analysis and texture profile study, probiotic prebiotic inclusion of 0.5% was highly accepted among the medium age group. The shelf life study also revealed that the highly accepted eggless functional product (cake) can be stored in low-density polyethylene for a longer period of time instead of being kept in laminate or cellulosic packaging materials. The overall texture with respect to springiness and cohesiveness showed the best value for Trial 4 (with stevia), but Trial 2 (with probiotic-prebiotic 0.5%) had high springiness. Since springiness illustrates elastic behavior, Trial 2 can be considered as a characteristic of sponginess. The high antioxidant value in terms of gallic acid equivalent shows that the developed products have some functional benefits apart from nutrition. Compared to market cakes, the calorific values of the developed products are certainly lower than those available in

the market for consumers. Hence, the said developed products will be ready-to-eat snacks with some functional components along with nutrition.

The statistical analysis with the help of ANOVA shows that the significance level (p-value) is highly correlated with the sensory parameters in most of the age groups. Therefore, based on the provided data, the null hypothesis, H0, will not be rejected. We hereby conclude that there is no significant difference among group means. However, Tuckey-HSD test reveals that there are no significant differences between group means of any two pairs (except for one particular variety).

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