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Development and quality evaluation of stevia based cake and biscuits

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The present study was undertaken to develop cake and biscuit with sugar, sucralose, stevia leaf powder and stevia liquid extract. Organoleptic evaluation of cake and biscuit based on stevia leaf powder, stevia liquid extract, sucralose and sugar was carried out using nine point hedonic rating scale. Non-significant difference in mean overall acceptability scores was observed between sucralose and stevia liquid extract based samples with maximum scores for control samples. Stevia leaf powder based samples scored minimum. Biscuit samples could be stored at room temperature till 15 days with non-significant variations and thereafter the scores kept declining till two months, thereby falling in the category of "liked slightly to "disliked slightly". During storage the moisture content and CFU count of the products was found to be satisfactory.

Key Words : Biscuit, Cake, Stevia, Sucralose, Organoleptic evaluation, Shelf-life

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INTRODUCTION

Now-a-days, food industry is searching for solutions to replace the levels of certain ingredients in their products, such as sugars, salt, and fats, in order to produce healthier foods that meet the consumer's expectations. It is generally accepted that diets with low calorie are very important in management of healthy life and consequently may help in preventing life style related diseases like obesity, diabetes, hypertension, CVD etc. So there is fundamental need for an alternative sweetener in place of sugar. Over time there have been many sugar substitutes available in the market.

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Although products containing artificial sweeteners have fewer calories, such additives may exert adverse health effects such as increased risk of weight imbalance, toxicity, allergy, fetal malformations and physiological effect on body metabolism. Consumption of high concentrations of such compounds may induce many proliferative and genetic disorders (Alizadeh *et al.*, 2012). Accordingly, a safe natural sweetener such as stevia may be useful in preparation of various food products.

Stevia is an amazing plant from the rain forest of Amazone. It is a natural sweetener plant known as "sweet weed", "sweet leaf", "sweet herb" and "honey leaf" which is estimated to be 200-300 times sweeter than sugar (*www.webstevia.com*).It is a magical plant which offers sweetness with fewer calories and do not show any side effects after consumption on human health (Gupta *et al.*, 2013). It is used for the treatment of various conditions such as cancer, diabetes, obesity, cavities, hypertension, fatigue, depression and in cosmetic and dental preparations (Snehal and Madhukar, 2011). Stevia leaves have sensory

and functional properties superior to those of many other high-potency sweeteners and is likely to become a major source of natural sweetener for the growing food market (Goyal *et al.*, 2010). It is commercially well known to exert beneficial effects on human health and has become an interesting area of research these days.

Biscuits and cakes are popular bakery products consumed by nearly all because of their ready to eat nature, affordable cost and appreciable shelf-life. These products are generally high in sugar and fat contents, their by making them unfit for health conscious population groups. Replacement of sugar in such products with a natural sweetening agent like stevia is a need of hour.

Keeping in mind the sweetening property and other medicinal uses of Stevia, an attempt has been made to explore the uses of stevia as a sweetener in baked products as compared to sugar.

METHODOLOGY

For the preparation of cake and biscuit, dried stevia leaves, stevia liquid extract, and other raw materials namely sugar, pearl millet, refined flour etc. were procured in single lots to avoid varietal differences. Sucralose, an artificial sweetener is heat stable and is easiest to use in baking and cooking without any adverse effect (*www.everydayhealth.com*) hence, was also procured to carry out the comparative study. Ingredients used for the preparation of the products have been indicted in Table A and B along with the methods

Dry ingredients were mixed together for each sample separately. Ground sugar / sucralose / stevia liquid extract / stevia leaf powder were added as per requirement to the flour. Oil, milk and vanilla essence were added and mixed thoroughly. The mixture was baked at 160°C for 20 minute.

Table A : Ingredients and methods used for cake preparation

Ingredients	Cake samples			
	Control	$C_{sucralose}$	C_{SLE}	C_{SLP}
Pearl millet flour (g)	25	25	25	25
Refined flour (g)	75	75	75	75
Refined oil (g)	50	50	50	50
Sodium bi-carbonate (tsp)	1/4	1/4	1/4	1/4
Baking powder (tsp)	1/2	1/2	1/2	1/2
Vanilla essence (tsp)	1/4	1/4	1/4	1/4
Milk (ml)	45	45	45	45
Ground sugar (g)	50	-	-	-
Sucralose (g)	-	4	-	-
Stevia liquid extract (ml)	-	-	20	-
Stevia leaf powder (mg)	-	-	-	20

Note – C – Cake, C_{SLE}- Cake with stevia liquid extract and C_{SLP} – Cake with stevia leaf powder

Table B : Ingredients and methods used for biscuit preparation

Ingredients	Biscuit samples			
	Control	$B_{Sucralose}$	B_{SLE}	B_{SLP}
Pearl millet flour (g)	25	25	25	25
Refined flour (g)	75	75	75	75
Butter (g)	50	50	50	50
Ammonia powder(tsp)	1/8	1/8	1/8	1/8
Baking powder (tsp)	1/2	1/2	1/2	1/2
Vanilla essence (tsp)	1/4	1/4	1/4	1/4
Milk (ml)	20	20	10	20
Ground sugar (g)	50	-	-	-
Sucralose (g)	-	4	-	-
Stevia liquid extract (ml)	-	-	20	-
Stevia leaf powder (mg)	-	-	-	20

Note - B – Biscuit, B_{SLE}- Biscuit with stevia liquid extract and B_{SLP} – Biscuit with stevia leaf powder

Dry ingredients were mixed together for each sample separately. Butter and ground sugar / sucralose / stevia liquid extract / stevia leaf powder was mixed as per requirement and creamed until light and fluffy. Sieved mixture then ammonia powder, vanilla essence and milk were added to get soft dough. After a rest of ten minutes, the dough was rolled and cut into biscuit shapes and baked at 175°C for 30 minutes.

Organoleptic evaluation of cake and biscuit:

The sensory quality evaluation of prepared cake and biscuit samples was carried out by a panel of ten semi trained judges on nine point hedonic rating scale in their fresh forms. The ratings were given on the sensory attributes like colour, appearance, flavour, texture, taste and overall acceptability (Swaminathan, 1986). Shelf-life of biscuit samples was evaluated on the basis of organoleptic evaluation, moisture (AOAC, 2012) and microbial analysis (APHA, 1984). For this purpose the biscuit samples were packed in polythene bags of 200 gauge density and stored in stainless steel containers separately at room temperature for a period of two months

Statistical analysis :

The obtained data were statistically analyzed by using SPSS statistics (Ver. 20) software for mean ± SD and one way of analysis of variance ANOVA. Significance of difference between means of tested parameters was carried out using Turkey Post hoc test (Gupta, 2002).

OBSERVATIONS AND ASSESSMENT

Mean scores for the organoleptic evaluation of the products given by the panel members are summarized in Table 1 to 5.

For the development of the cake and biscuit, different combinations of ingredients were tried including sugar, sucralose, stevia liquid extract and stevia leaf powder. Table 1 clearly reveals a non-significant difference between control, sucralose and stevia liquid extract based cake samples for each of its sensory attribute. It is important to note that these three samples (control, $C_{sucralose}$ and C_{SLE}) were almost "liked extremely" by the panelists, showing extremely acceptable replacement of either sugar or artificial sweetener with natural sweetener like stevia liquid extract. Although among the test samples, cake made with stevia leaf powder (C_{SLP}) was least acceptable with significantly lower scores but still it was "liked moderately" by the panel members.

In case of the biscuit samples, the difference

Table 1 : Organoleptic evaluation of cake

Cake samples	Mean ±SD organoleptic scores on 9 point hedonic rating scale					
	Colour	Appearance	Flavour	Texture	Taste	Mean overall acceptability
Control	8.90±0.31	8.90±0.31	9.00±0.00	9.00±0.00	9.00±0.00	8.96±0.62
$C_{sucralose}$	8.70±0.48	8.70±0.48	8.50±0.52	8.70±0.48	8.60±0.51	8.64±0.49
C_{SLE}	8.80±0.42	8.90±0.31	8.70±0.48	8.80±0.42	8.80±0.42	8.80±0.41
C_{SLP}	7.40±0.51	7.30±0.48	6.80±0.78	8.60±0.51	6.80±0.78	7.38±0.61
S.E. ±	0.11	0.12	0.15	0.06	0.16	0.12
F value	25.5**	35.8**	34.4**	1.72^{NS}	38.5**	30.5**
C.D. (P=0.05)	0.54	0.52	0.59	-	0.58	0.53

** indicates significance of value at P=0.01, NS = Non-significant, C– Cake, C_{SLE} – Cake with stevia liquid extract and C_{SLP} – Cake with stevia leaf powder

Table 2 : Organoleptic evaluation of biscuit

Biscuit samples	Mean ±SD organoleptic scores on 9 point hedonic rating scale					
	Colour	Appearance	Flavour	Texture	Taste	Mean overall acceptability
Control	8.90±0.31	8.90±0.31	8.90±0.31	9.00±0.00	8.90±0.31	8.92±1.24
$B_{Sucralose}$	7.40±0.51	7.30±0.67	7.40±0.51	8.70±0.48	7.40±0.51	7.64±0.43
B_{SLE}	7.60±1.07	7.70±1.05	7.50±0.97	8.80±0.42	7.60±0.96	7.84±0.89
B_{SLP}	6.40±0.69	6.40±0.69	6.50±0.70	8.50±0.70	6.50±0.70	6.86±0.69
S.E.±	0.17	0.18	0.17	0.07	0.17	0.16
F value	21.0**	19.8**	21.6**	1.9^{NS}	21.7**	14.5**
C.D. (P=0.05)	0.69	0.65	0.66	-	0.66	0.68

**indicates significance of value at P=0.01, NS = Non-significant, B – Biscuit, B_{SLE} – Biscuit with stevia liquid extract and B_{SLP} – Biscuit with stevia leaf powder

between the mean scores obtained by the sample $B_{Sucralose}$ and B_{SLE} was found to be non-significant and both the samples were "liked very much" by the panel members as shown in Table 2. Statistically significant difference in the mean scores of all the test samples was observed when compared with control biscuit sample.

The lower mean overall acceptability scores obtained by C_{SLP} and B_{SLP} samples must be due to their slight greenish colour and appearance as well as slight bitter after taste and flavour imparted by it. Abouarab *et al.* (2010) reported that bitter taste, common to many stevia species, is probably due to volatile aromatic or essential oils, tannins and flavonoids, which contribute to flavour associated with stevia.

Organoleptic evaluation during the entire storage period of biscuit samples clearly revealed that the product could be stored at the room temperature till 15 days with non significant variations in the initial sensory scores. Thereafter the acceptability reduced slightly at 30th day and it kept declining further at the end of storage period for flavour, taste and overall acceptability. However, it is also evident from the shelf-life evaluation that the colour,

Table 3 : Effect of storage on the organoleptic acceptability of biscuit

Storage(days) of biscuit samples		Mean scores on 9 point hedonic rating scale					
		Colour	Appearance	Flavour	Texture	Taste	Mean overall acceptability
Control	0	8.90±0.31	8.90±0.31	8.90±0.31	9.00±0.00	8.90±0.31	8.92±1.24
	15	8.70±0.48	8.80±0.42	8.60±0.51	8.90±0.31	8.70±0.48	8.74±0.44
	30	8.60±0.69	8.60 ±0.69	7.40±0.69	8.80±0.42	7.40±0.69	8.16±0.63
	45	8.70±0.67	8.70±0.48	6.30±0.94	8.70±0.48	6.40±0.96	7.76±0.70
	60	8.50±0.70	8.60±0.51	5.60±1.57	8.70±0.48	5.70±1.49	7.42±0.95
S.E.±		0.08	0.07	0.10	0.05	0.21	0.10
F value		.619^{NS}	0.671^{NS}	21.8**	1.14^{NS}	24.5**	21.8**
C.D. (P=0.05)		-	-	0.53	-	0.76	0.53
$B_{Sucralose}$	0	7.40±0.51	7.30±0.67	7.40±0.51	8.70±0.48	7.40±0.51	7.64±0.43
	15	7.30±0.67	7.30±0.67	7.30±0.48	8.60±0.51	7.30±0.48	7.56±0.56
	30	7.10±0.56	7.20±0.63	6.60±0.84	8.40±0.96	6.60±0.84	7.18±0.76
	45	7.20±0.42	7.30±0.48	6.40±0.51	8.30±1.05	6.40±0.51	7.12±0.59
	60	7.10±0.56	7.00±0.47	5.80±0.42	8.00±1.41	5.80±0.42	6.74±0.65
S.E.±		0.07	0.13	0.11	0.13	0.11	0.08
F value		.550^{NS}	.481^{NS}	13.9**	.823^{NS}	13.2**	*9.23***
C.D. (P=0.05)		-	-	0.61	-	0.61	0.55
B_{SLE}	0	7.60±1.07	7.70±1.05	7.50±0.97	8.80±0.42	7.60±0.96	8.20±0.31
	15	7.50±1.17	7.60±1.17	7.40±0.51	8.60±0.42	7.40±0.96	7.70±0.84
	30	7.50±1.17	7.60±1.07	6.70±0.67	8.70±0.42	6.80±0.42	7.46±0.75
	45	7.60±1.07	7.50±1.17	6.30±0.48	8.50±0.42	6.50±1.08	7.28±0.84
	60	7.40±1.26	7.60±1.07	5.70±0.48	8.30±0.47	5.80±0.42	6.96±0.74
S.E.±		0.15	0.15	0.12	0.08	0.14	0.11
F value		0.52^{NS}	0.40^{NS}	19.5**	0.97^{NS}	7.70**	16.8**
C.D. (P=0.05)		-	-	0.59	-	0.73	0.60
S_{SLP}	0	6.40±0.69	6.40±0.69	6.50±0.70	8.50±0.70	6.50±0.70	8.20±0.63
	15	6.40±0.96	6.30±0.82	6.40±0.96	8.30±0.48	6.40±0.96	6.76±0.83
	30	6.30±0.82	6.40±0.96	6.00±0.66	8.40±0.51	6.20±0.63	6.66±0.71
	45	6.10±1.28	6.20±1.28	5.40±0.84	8.20±0.63	5.40±0.84	6.26±0.97
	60	6.20±1.39	6.10±1.39	4.30±1.49	8.30±0.82	4.40±1.50	5.86±1.31
S.E.±		0.15	0.15	0.17	0.08	0.17	0.13
F value		.138^{NS}	.138^{NS}	8.09**	350^{NS}	7.44**	27.3**
C.D. (P=0.05)		-	-	0.81	-	0.82	0.60

** indicates significance of value at P=0.01, NS=Non-significant, B – Biscuit, B_{SLE} – Biscuit with stevia liquid extract and B_{SLP} – Biscuit with stevia leaf powder

Table 4 : Moisture content of biscuit (on dry weight basis)

Biscuit samples	Moisture content (g %) during storage period					
	0 day	15th day	30th day	45th day	60th day	F value
Control	6.30±0.26	6.30±0.26	6.31±0.27	6.33±0.29	6.25±0.31	1.9^{NS}
$B_{Sucralose}$	7.76±0.23	7.76±0.23	7.77±0.24	7.79±0.26	7.81±1.12	1.7^{NS}
B_{SLE}	8.48±0.25	8.48±0.25	8.50±0.27	8.51±1.09	8.53±1.13	2.2^{NS}
B_{SLP}	8.18±0.23	8.18±0.23	8.19±0.25	8.20±0.27	8.22±1.03	1.2^{NS}

NS = Non-significant, B – Biscuit, B_{SLE} – Biscuit with stevia liquid extract and B_{SLP} – Biscuit with stevia leaf powder

Table 5 : Microbial evaluation of biscuits during storage

Biscuit samples	CFU /g during the storage period (Days)				
	0	15	30	45	60
Control	0.2×10^4	0.3×10^4	0.5×10^4	0.6×10^4	0.7×10^4
$B_{Sucralose}$	0.3×10^4	0.4×10^4	0.6×10^4	0.7×10^4	0.8×10^4
B_{SLE}	0.3×10^4	0.4×10^4	0.6×10^4	0.7×10^4	0.8×10^4
B_{SLP}	0.2×10^4	0.3×10^4	0.5×10^4	0.6×10^4	0.7×10^4

B – Biscuit, B_{SLE} – Biscuit with stevia liquid extract and B_{SLP} – Biscuit with stevia leaf powder

texture and appearance of the products remained almost constant throughout the storage period of 60 days.

The statistical analyses clearly revealed a non significant effect of storage on the moisture content of the biscuit samples. However, moisture content of biscuits was found to be varied with the variation in the type of sample where the stevia containing products had higher values. This must be due to differences in the ingredients used for the development of different samples of biscuit. Serna *et al*. (2014) also found significant ($p<0.05$) increase in the percentage of moisture of the biscuits when sucrose was substituted with stevia.

It can be interpreted from the results that microbial quality of the biscuit samples developed during present investigation remained satisfactory during two months of storage period with reference to CFU count of pure water which ranges between<1000 -10000 (Pelczar *et al.*, 2003). It must be due to the low moisture content of the product. Srivasthava and Kumar (2002) have also stated that micro-organism require at least 13 per cent free moisture for their growth whereas during present study the moisture content of the product ranged between 6.30±26 to 8.53±1.13 only.

Conclusion :

It can be revealed from the overview of organoleptic evaluation that stevia liquid extract followed by stevia leaf powder can be a better choice as natural sweetening agent as compared to sugar and artificial sweeteners for those who are health conscious. The consumers demand for herbal foods may encourage stevia cultivation and production and would help to enjoy the sweet taste with minimal calories for those who have to restrict carbohydrate / sugar in their diet.

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