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Shelf Life Study of Optimized Low Calorie Herbal Basundi with Sucralose, *Hemidesmus indicus* and *Bougainvillea glabra*

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ABSTRACT

The present study was conducted to examine the feasibility of using herbs Hemidesmus indicus and Bougainvillea glabra in low calorie basundi where sugar was replaced with sucralose. The experiment comprised of analyses of changes in sensory, physico-chemical and microbiological properties taking place during refrigerated storage (7±1°C). The control and developed product samples were packed in polypropylene cups. Low calorie herbal basundi was prepared by incorporating sucralose at 70.98 ppm, Hemidesmus indicus at 0.98 per cent and Bougainvillea glabra at 0.20 per cent levels obtained through optimization using Response Surface Methodology (RSM). The developed product possessed a significantly superior quality in terms of chemical (Thiobarbituric acid reactive substances-TBARS value, free fatty acid-FFA content and tyrosine value) characteristics. Shelf life of prepared product was recorded as 25 days which was 10 days higher than that of control samples when stored at 7±1°C. During storage, developed low calorie herbal basundi exhibited superior sensory characteristics.

Key words: *Basundi, Sucralose, Hemidesmus indicus, Bougainvillea glabra and Shelf life*

INTRODUCTION

Basundi is a sweet delicacy popular in Maharashtra and some parts of northern India. It is a medium viscous product with a pleasant caramelized flavour and having a characteristic light brown colour. Milk and sugar are the ingredients used for its preparation (Aneja et al., 2002). The high fat and sugar content in basundi makes it less acceptable to health conscious consumers. Thus the current research was planned to develop a low calorie herbal basundi incorporating sucralose as low calorie sweetener and *Hemidesmus indicus* and *Bougainvillea glabra* as beneficial herbs.

Sucralose, a non-nutritive sweetener is the one commonly used that is about 320 to 1000 times as sweet as sugar has been effectively used in traditional beverages, baked products, confectionery, dairy desserts, flavoured milks, kulfi, kheer and basundi (Morlock & Prabha, 2007).

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Among the herbs are *Hemidesmus indicus* and *Bougainvillea glabra* native to state of Kerala have been documented to have health benefits. As stated by Khanna and Kannabiran (2007), *Hemidesmus indicus* is also known as Anantamul in Hindi, Nannari in Tamil whose root extracts are used as a coolant and a blood purifier. Various effects of *Hemidesmus indicus*, such as hypoglycemic, hypolipidemic, antioxidant, antiulcerogenic etc., have been reported (Lakshmi & Rajendran, 2013). Bougainvillea is a genus of bright flowering plants belonging to the Nyctaginaceae family and is also called as paper flower having shiny green and magenta or purple colored bracts (Kumar et al., 2013). Among the Bougainvillea's varieties include *Bougainvillea glabra*, *Bougainvillea spectabilis*, and *Bougainvillea harrisi* (Adebayo et al., 2009). Bougainvillea spectabilis is used in herbal combination for the treatment of diabetes (Simmonds & Howes, 2006). Information also exists about the use of *Bougainvillea glabra* in the cure of ulcer, diarrhoea, and having anti-microbial activities (Edwin et al., 2007).

MATERIALS AND METHODS

Central Composite Rotatable Design (CCRD) Response Surface Methodology (RSM) of was used to optimize different levels of sucralose, *Hemidesmus indicus* and *Bougainvillea glabra* on the responses such as flavour, colour, mouth feel, body and texture and overall acceptability. The quadratic model obtained by RSM produced a satisfactory fit to data with respect to flavour (R^2= 0.96), colour (R^2=0.97), mouth feel (R^2=0.87), body and texture (R^2= 0.96) and overall acceptability (R^2=0.97). The formulation with 70.98 ppm sucralose, 0.98 per cent *Hemidesmus indicus* and 0.2 per cent *Bougainvillea glabra* was selected. Low calorie herbal basundi was prepared by continuous heating of cow milk with occasional stirring at the bottom and the heat treatment was carried out till desired consistency is obtained in the final product. Sucralose was added during condensing while the herbs *Hemidesmus indicus* and *Bougainvillea glabra* were added after the product is cooled. The low calorie herbal basundi thus prepared was then packed in poly propylene cups and kept for storage under refrigeration (7±1°C).

As basundi is considered to be a rich source of fat, protein and lactose which makes it highly vulnerable to spoilage, the changes in physico–chemical, and sensory qualities during storage were assessed at five day interval.

pH - pH of low calorie herbal basundi sample was determined by blending 10g of basundi with 10 ml of distilled water and dipping the electrode of Eutech pH meter directly into the slurry as per the procedure followed by O' Keeffee et al. (1976).

Titratable acidity - Titratable acidity of low calorie herbal basundi sample was determined as per IS:1166-1973 procedure prescribed for condensed milk.

Thiobarbituric acid (TBA) value - TBA value of low calorie herbal basundi sample was determined according to the method recommended by Sidwell et al. (1955).

Free Fatty Acid (FFA) value - The FFA content of low calorie herbal basundi samples was determined by extraction titration method suggested by Deeth et al. *(*1975).

Tyrosine value - Tyrosine value of low calorie herbal basundi was estimated as per the modified method of Juffs (1973).

Sensory evaluation - The low calorie herbal basundi samples were evaluated organoleptically for quality attributes like flavour, colour, mouth feel, body and texture and overall acceptability by a selected panel of six judges. A hedonic scale score card was used for evaluation.

Statistical analysis and optimization - The variation between different periods of measurements in the case of data related to physico-chemical and microbiological qualities was analysed using repeated measures ANOVA. In the case of sensory scores between measurements variability was analysed using Friedman's test followed by Mann-Whitney u-test. The results of statistical analysis are presented in Tables 1 and 2.

RESULTS AND DISCUSSION

Changes in chemical quality during storage of low calorie herbal basundi

Change in pH - The results concerned to change in pH of low calorie herbal basundi when stored at 7±1°C are illustrated in Table 1. The pH of traditional basundi decreased from an initial mean value of 5.54 to 5.19 during 15 days of storage. However in low calorie herbal basundi, the drop in pH was from an initial value of 5.55 to 5.18 over a period of 25 days. The effect of the period of storage on drop in pH was found to be significant ($p<0.01$) in traditional basundi. A significant ($p<0.05$) decrease in pH of low calorie herbal basundi was observed from 10th day of storage at 7 ± 1°C. A similar observation on pH reduction in storage was reported by Anandh et al. (2014) in rose flavoured milk and Grace (2015) in paneer.

Change in acidity - The increase in acidity owing to microbial activity produces lactic acid and its concentration beyond a terminal threshold value, imparts sourness thereby affecting sensory characteristics of the product. The data on change in acidity of low calorie herbal basundi stored at 7±1°C is presented in Table 1. During storage, the acidity of traditional basundi increased from a mean value of 0.36 to 0.45 per cent lactic acid after 15 days and for low calorie herbal basundi stored at same temperature the acidity increased from a mean value of 0.35 to 0.46 over a period of 25 days. The rate at which the acidity changed in traditional basundi samples was significantly ($p<0.01$) affected by the period of storage while for the low calorie herbal basundi samples the change in rate was significant only after tenth day of storage. The changes in acidity among the two products during storage was found to be significant ($p<0.01$) only after fifth day of storage. The increase in acidity of kheer stored under refrigerated storage has been reported by Shivkumar et al. (2014) in paneer.

Change in Free Fatty Acid (FFA) value - The results concerning to changes in Free Fatty Acid (FFA) values as a function of storage temperature at 7±1°C are presented in Table 1. The extent of lipolysis is measured by level of free fatty acid in the product. The FFA values of traditional basundi stored increased from 0.48 µeq/g to 0.66 µeq/g during 15 days of storage and an increase from an initial value of 0.47 µeq/g to 062 µeq/g was observed in low calorie herbal basundi in 25 days of storage. The FFA values of both traditional basundi and low calorie herbal basundi samples increased significantly ($p<0.01$) with the progression of storage period. The increase in lipolytic activity during storage may be due to release of free fat during high temperature processing of basundi and also due to high moisture content in the product. Similar increase in FFA in different dairy products during storage has been reported by Jha et al. (2014) in kheer mix powder and Kumar et al. (2005) in kheer.

Change in TBA^{rase} value - The extent of oxidation of fat in low calorie herbal basundi was measured in terms of Thiobarbituric acid (TBA^{rase}) value. The changes in TBA^{rase} values of low calorie herbal basundi at 7±1°C are summarized in Table 1. The TBA^{rase} value increased from a initial value of 0.032 to 0.053 over a period of 15 days for traditional basundi, whereas the increase in TBA^{rase} values noted for low calorie herbal basundi were from 0.032 to 0.054. The effect of storage on the rate of increase in TBA^{rase} value of both traditional and low calorie herbal basundi was found to be significant ($p<0.01$). Among the two types of basundi samples, significant difference ($p<0.01$) was observed after fifth day of storage. The results are in agreement with the findings of Neetha (2015) in dietetic palada.

Change in tyrosine value - Tyrosine value is used as an indicator of proteolysis in milk and milk products. The tyrosine content of traditional and low calorie herbal basundi stored at 7±1°C is summarized in Table 1. The tyrosine content of traditional basundi increased significantly ($p<0.01$) from initial mean value of 22.33 mg/100ml to a value 35.62 mg/100ml in 15 days, whereas the tyrosine content of low calorie herbal basundi increased significantly ($p<0.01$) from 22.60 mg/100ml to 34.60 mg/100ml during 25 days of storage. The effect of storage on the rate of increase in tyrosine content of both traditional and low calorie herbal basundi was found to be significant. Significant difference ($p<0.01$) was observed between two types of basundi samples only after tenth day of storage. Increase in tyrosine content occurs due to the proteolytic activity of native milk proteases and bacterial proteases. The results are in agreement with the findings of Grace (2015) in spiced paneer.

Change in sensory quality of low calorie herbal basundi during storage

Sensory qualities of traditional basundi and low calorie herbal basundi decreased significantly ($p<0.01$) while stored at 7±1°C (Table 2). The flavour reduced significantly from 7.58 to 5.73 over a period of 15 days for traditional basundi at 7±1°C, whereas the flavour score of low calorie herbal basundi reduced to 5.28 from an initial mean value of 8.08 at 7±1°C during a storage period of 25 days. The decrease in flavour score was significant only after 10th day in both the samples. This decrease was due to off flavour development in the product.

Significant reduction in colour scores was observed in both traditional basundi and low calorie herbal basundi during storage at 7±1°C. Colour score decreased from 7.30 to 6.12 over 15 days for traditional basundi. Similar trend was noted in scores for colour of low calorie herbal basundi which decreased from initial value of 8.47 to 7.58 during 25 days of storage time.

Significant reduction in mouth feel scores was observed in both traditional basundi and low calorie herbal basundi during storage at 7±1°C (Table 2). The mouth feel scores of traditional basundi samples decreased from 7.58 to 5.73 after 15 days. Similar trend in reduction of mouth feel scores was observed from 8.08 to 5.63 in low calorie herbal basundi at the end of 25 days storage.

The results presented in Table 2 showed that body and texture scores of both traditional basundi and low calorie herbal basundi decreased significantly during storage at 7±1°C. The body and texture score for traditional basundi decreased from a mean value of 7.66 to 5.73 at the end of 15 days storage and from a mean value of 8.23 to 7.03 over 25 days period for low calorie herbal basundi.

The overall acceptability scores of traditional basundi and low calorie herbal basundi decreased significantly ($p<0.01$) while stored at 7±1°C. The overall acceptability decreased from an initial mean value of 7.38 to 5.78 over a period of 15 days for traditional basundi. A significant decrease in overall acceptability from 8.20 to 5.40 was noted for low calorie herbal basundi over 25 day period. The decrease in sensory scores of basundi during storage has been reported by Gaikwad and Hembade (2011a) in ujani basundi.

Table 1: Effect of storage on physico-chemical properties of low calorie herbal basundi at 7±1°C

Sample	DAYS OF STORAGE						
	0th day	5rd day	10th day	15th day	20th day	25th day	30th day
A	CHANGE IN pH DURING STORAGE						
Traditional basundi	5.54±0.004^{ax}	5.43±0.005^{bx}	5.38±0.006^{cx}	5.19±0.005^{dx}	Spoiled	Spoiled	Spoiled
Low calorie herbal basundi	5.55±0.004^{ax}	5.54±0.005^{ay}	5.53±0.006^{by}	5.39±0.005^{by}	5.32±0.007	5.18±0.006	Spoiled
B	CHANGE IN ACIDITY DURING STORAGE (% Lactic acid)						
Traditional basundi	0.36±0.006^{ax}	0.37±0.006^{bx}	0.41±0.005^{cx}	0.45±0.004^{dx}	Spoiled	Spoiled	Spoiled
Low calorie herbal basundi	0.35±0.005^{ax}	0.35±0.003^{ay}	0.36±0.004^{ay}	0.39±0.003^{by}	0.43±0.003	0.46±0.004	Spoiled
C	CHANGE IN FFA DURING STORAGE (µeq/g)						
Traditional basundi	0.48±0.007^{ax}	0.52±0.006^{bx}	0.58±0.005^{cx}	0.66±0.006^{dx}	Spoiled	Spoiled	Spoiled
Low calorie herbal basundi	0.47±0.006^{ax}	0.49±0.007^{by}	0.51±0.005^{cy}	0.54±0.006^{dy}	0.57±0.01	0.62±0.01	Spoiled
D	CHANGE IN TBA^{rase} DURING STORAGE						
Traditional basundi	0.032±0.001^{ax}	0.041±0.001^{bx}	0.047±0.001^{cx}	0.053±0.001^{dx}	Spoiled	Spoiled	Spoiled
Low calorie herbal basundi	0.032±0.001^{ax}	0.036±0.001^{by}	0.039±0.001^{cy}	0.042±0.001^{dy}	0.046±0.001	0.054±0.001	Spoiled
E	CHANGE IN TYROSINE VALUE DURING STORAGE (mg/100g)						
Traditional basundi	22.33±0.31^{ax}	26.80±0.37^{bx}	31.04±0.35^{cx}	35.62±0.34^{dx}	Spoiled	Spoiled	Spoiled
Low calorie herbal basundi	22.60±0.31^{ax}	26.18±0.36^{bx}	28.48±0.35^{cy}	30.53±0.34^{dy}	32.63±0.36	34.60±0.41	Spoiled

Figures are mean ± standard error of three replications, $^{a-d}$ Means with different superscript vary significantly within a row, $^{x-y}$ Mean with different superscripts vary significantly within a column

Table 2: Effect of storage on the sensory quality of low calorie herbal basundi at 7±1°C

Attribute	Sample	DAYS OF STORAGE							
		0^{th} day	5^{th} day	10^{th} day	15^{th} day	20^{th} day	25^{th} day	30^{th} day	Chi square value
Flavour	Traditional basundi	7.58±0.06^{a}	7.10±0.05^{ac}	6.62±0.03^{bc}	5.73±0.04^{b}	Spoiled	Spoiled	Spoiled	18.00**
	Low calorie herbal basundi	8.08±0.06^{a}	7.81±0.04^{ac}	7.20±0.10^{bc}	6.65±0.11^{b}	6.07±0.05^{c}	5.28±0.07^{d}	Spoiled	
	Z - value	2.89**	2.90**	2.91**	2.88**	-	-	-	
Colour	Traditional basundi	7.30±0.05^{a}	7.13±0.06^{ac}	6.82±0.07^{bc}	6.12±0.06^{b}	Spoiled	Spoiled	Spoiled	18.01**
	Low calorie herbal basundi	8.47±0.05^{a}	8.28±0.06^{ac}	8.08±0.06^{bc}	7.95±0.04^{b}	7.78±0.06^{c}	7.58±0.03^{d}	Spoiled	
	Z - value	2.89**	2.90**	2.89**	2.91**	-	-	-	
Mouth feel	Traditional basundi	7.58±0.06^{a}	7.10±0.05^{ac}	6.61±0.03^{bc}	5.73±0.04^{b}	Spoiled	Spoiled	Spoiled	17.99**
	Low calorie herbal basundi	8.08±0.06^{a}	7.82±0.04^{ac}	7.20±0.10^{bc}	6.65±0.11^{b}	6.41±0.10^{c}	5.63±0.08^{d}	Spoiled	
	Z - value	2.88**	2.89**	2.91**	2.89**	-	-	-	
Body and Texture	Traditional basundi	7.66±0.06^{a}	7.17±0.05^{ac}	6.75±0.07^{bc}	6.35±0.06^{b}	Spoiled	Spoiled	Spoiled	18.00**
	Low calorie herbal basundi	8.23±0.91^{a}	8.08±0.10^{ac}	7.90±0.11^{bc}	7.70±0.10^{b}	7.50±0.09^{c}	7.03±0.06^{d}	Spoiled	
	Z - value	2.89**	2.88**	2.87**	2.90**	-	-	-	
Overall acceptability	Traditional basundi	7.38±0.08^{a}	6.98±0.09^{ac}	6.65±0.07^{bc}	5.78±0.06^{b}	Spoiled	Spoiled	Spoiled	18.00**
	Low calorie herbal basundi	8.20±0.05^{a}	7.85±0.04^{ac}	7.38±0.06^{bc}	6.73±0.09^{b}	6.27±0.08^{c}	5.40±0.07^{d}	Spoiled	
	Z - value	2.88**	2.90**	2.89**	2.89**	-	-	-	

Figures are mean ± standard error of three replications, **-Significant at one per cent level ($p<0.01$), $^{a-d}$ Means with different superscript vary significantly within a row

CONCLUSION

In the present study low calorie herbal basundi was developed incorporating sucralose, *Hemidesmus indicus* and *Bougainvillea glabra*. The herbs addition hindered reaction rates in basundi, thereby contributing to better sensory and keeping quality. The experiment, by virtue of its simple nature is highly reliable and flexible for practical application. Additionally, superior results can be achieved by using better packaging material and/or techniques and commercial production of basundi incorporating herbs can also be attempted. Further, *Hemidesmus indicus* and *Bougainvillea glabra* at optimized levels can be very much effective in enhancing the sensory, biochemical and functional quality of food products. These herbs have potential to emerge as promising food additives as they are safe and rather healthy with a wide range of functional properties.

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