Modified method for preparation of *Halubai*—an Indian traditional sweet

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Revised: 22 August 2011 / Accepted: 10 October 2011 / Published online: 28 October 2011
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Abstract *Halubai*, a traditional Indian sweet is conventionally prepared by soaking and grinding whole cereals/millets to a fine paste, straining it through a cloth and cooking the resultant dispersion until it starts gelatinizing. Cooking is continued further with the addition of jaggery water, stirring constantly with intermittent addition of ghee. This process involves many unit operations, which are energy and time consuming. Hence a modified method was developed which is energy efficient and time saving without compromising the quality of the product. One fine fraction (200 mesh, BS) of cereal/millet flours were used in modified method instead of whole cereals. Sensory and instrumental analysis of the samples showed that quality of *Halubai* prepared using modified method was comparable to that of samples from conventional method. Correlation studies on sensory data of *Halubai* showed positive relation for the set ($r=0.94$) and smoothness ($r=0.84$); and negative relation for stickiness ($r=-0.94$) with the overall quality. Modified method of *Halubai* preparation which was simple and energy efficient, resulted in products with good sensory quality.

Keywords *Halubai* · Sensory analysis · Texture analysis · Principal component analysis

Introduction

The term ‘Halwa’ refers to a huge range of sweets made in India, Middle East and Central Asia. The word ‘Halwa’ is derived from the Arabic word ‘Hulw’ meaning sweet/dessert. Halwa can be made from a variety of fruits, vegetables, cereals, nuts, grains and their combinations. Dating back to 7th century, Hulw was a date paste kneaded with milk. This, over a period of time, evolved into other forms that included stiffer confections prepared using wheat or semolina flour with syrup or honey or fruit paste as sweetener.

Halubai is a popular traditional sweet in India, relished for its soft, smooth texture and delicate aroma. Conventionally it is prepared by soaking and grinding single whole cereals such as wheat and rice to a fine paste, starching it through a cloth, cooking the resultant dispersion over a low flame with constant stirring with intermittent addition of ghee. To this dispersion, jaggery solution is added and cooked further. Use of coconut milk is optional in this product (that provides considerable fat and contributes to the flavour). Traditionally, *Halubai* is prepared using wheat (*Triticum aestivum*) and rice (*Oryza sativa*). Use of finger millet commonly known as ragi (*Eleusine coracana*) in *Halubai* preparation is a lesser known practice traceable in some parts of southern India, but nutritionally beneficial. As in other cereals, starch forms a major component of ragi. Ragi is a good source of calcium and dietary fiber and its products are digested slowly (Malleshi and Hadimani 1993; Premavall et al. 2003). Research findings have shown that diet containing slowly digested and absorbed carbohydrates are beneficial to people with metabolic disorders such as obesity, diabetes and hypertension (Asp et al. 1983; Jenkins et al. 1985; Wuresh 1994)

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It can be observed that flour based halwa has a gelatinous texture while nut-butter-based one is more crumbly. Though spongy to some degree, *Halubai* is not thick, dense, elastic, stiff and chewy as some halwa varieties such as ‘Bombay’ halwa made from refined wheat flour. With a good set like jelly but not as firm, *Halubai* enjoys a special status in south Indian cuisine. Perception of the particular texture of starch based products by humans is also complex. In the context of a generalized three dimensional model for “in-mouth perceived texture” involving extent of structure, degree of lubrication and time, it was observed that as food is chewed/changed/deformed in the mouth, it follows its own unique breakdown path (Hutchings and Lillford 1988). For instance, a dry sponge cake may be easily broken down but cannot be swallowed instantly owing to insufficient lubrication (dry mouthfeel). In contrast, a grape fruit, when pressed between molars (deformed) oozes out liquid but after loosing the juice, the matrix cell wall material is perceptibly dry.

A process has been developed for *Halubai* ready mix involving the processing of finger millet starch, optimization of ingredients viz. rice, flour, sugar, jaggery, desiccated coconut, cardamom. Preparation of product from this ready mix has also been described (Premavalli et al. 2005).

As the preparation of *Halubai* involves many unit operations which are energy and time consuming making whole process tedious, an attempt was made to simplify the process without compromising sensory quality of *Halubai*, the details of which are presented in this paper. Objective of the present study was simplification of the preparation of *Halubai* eliminating drudgery. Systematic sensory, instrumental and multivariate analysis was carried out to generate sensory profiles and positioning of the samples.

Materials and methods

Rice flour, wheat flour, ragi flour, ghee and jaggery (round variety) were procured from local market.

Method

The flours were separately sieved using BS 200 mesh to obtain very fine fraction of the flours respectively. These fine flour fractions were used for the preparation of *Halubai*. Sensory quality of *Halubai* prepared using modified method, as compared to that of *Halubai* prepared using conventional method.

Halubai containing various fine flour fractions are represented as follows:

1. Wheat *Halubai* from conventional method–WH
2. Wheat *Halubai* from modified method–WFH

3. Ragi *Halubai* from conventional method–RGH
4. Ragi *Halubai* from modified method–RGFH
5. Rice *Halubai* from conventional method–RCH
6. Rice *Halubai* from modified method–RCFH

Conventional method

Hundred gram of Rice/wheat/ragi, 100 g jaggery, 800 ml water, 60 g ghee and 3 g powdered cardamom were the components of the *Halubai* formulation.

Method of preparation

One hundred grams of wheat/ragi/rice was soaked in water overnight (18 h). Soaked cereal was then ground with adequate (about 300 ml) water in a blender. The ground paste was strained through a thin cloth and extract was collected. Residue was further ground in the blender with 100 ml of water. This step was repeated 3 times. Jaggery was powdered, mixed with 100 ml of water and boiled for 4–5 min. This was filtered to obtain clean filtrate. Fifteen grams of ghee was taken in a thick, flat bottom vessel and heated. To this, the cereal extract and jaggery solution were added and kept stirring constantly over a low flame. When the product started thickening, rest of ghee was added intermittently. Powdered cardamom was added after 15 min. to ensure uniform distribution and maximum retention of volatiles. Once the thickened product left the sides of the vessel, it was transferred on to a flat steel plate greased with 1–2 g ghee and was allowed to cool at room temperature. After cooling, it was cut into square shapes. (Total time taken: soaking: 12 h, grinding & stirring: 1 h, draining extra water: 1 h, jaggery water preparation: 20 min., cooking: 40 min., Total time required: 15 h or 900 min. Total water used: 800 ml).

Modified method

Modified formulation of *Halubai* consisted of 100 g fine fraction of cereal/millet flour (200 mesh, BS), 200 g jaggery, 700 ml water, 30 g ghee and 1.5 g powdered cardamom.

Method of preparation

Cereal/millet flour procured from local market was sieved through 200 mesh, BS to obtain the fine flour fraction. Hundred grams of this fine flour was dispersed (without lumps) in 500 ml of water. Two hundred grams of jaggery was powdered and mixed well with 200 ml of water. This was boiled for 4–5 min. and filtered. Five grams of ghee was heated in a thick, flat bottom vessel to which well

stirred cereal flour dispersion was added. This was kept stirring, once it began to thicken slightly, filtered jaggery water was added with constant stirring to avoid lump formation. Rest of ghee was added intermittently during stirring and cooking. Powdered cardamom was added before the product became thick. (Rest as in conventional method) Total time taken: sieving: 15 min., jaggery water preparation: 20 min., cooking: 25 min. Total time required: 60 min. or 1 h, Total water used: 700 ml).

Sensory analysis

Sensory analysis of *Halubai* samples was carried out using 'Quantitative Descriptive Method' on a line scale of 15 cm for selected attributes obtaining using 'Free choice profiling'. The line scale was anchored at 1.25 cm on either end indicated as 'Low' and 'High' representing 'recognition threshold' and 'saturation threshold' respectively (Stone and Sidel 1998).

Samples of *Halubai* were presented in porcelain containers coded with 3-digit random numbers to panelists along with a glass of warm water. Samples were evaluated in 'sensory booths' maintained at temp. of $20 \pm 5^\circ\text{C}$ and RH $50 \pm 5\%$, by a trained panel of 10 assessors (ASTM 1996). Panelists were asked to indicate with a small vertical line on the scale, the perceived intensity of selected sensory attributes listed on the score and marking the respective code number of samples on top. Mean values of individual attributes were presented as 'sensory profiles'.

Instrumental analysis

Colour

Instrumental measurement of colour of *Halubai* samples was conducted using Hunter lab (Lab scan XE) by reflectance. The values L^* , a^* and b^* were recorded using illuminant 'C' with 2° observer angle and 1" slit width. Measurements were taken in triplicate for each sample.

Texture

Instrumental Texture Profile Analysis (TPA) of *Halubai* was carried out using a texture analyzer (SMS TA-HDi) under the following conditions: Pre test speed – 1 mm s^{-1} ; Test speed – 1 mm s^{-1} ; post test speed – 1 mm s^{-1} ; Compression – 50%.

Halubai samples made from Ragi, wheat and rice flours were subjected to TPA and firmness, adhesiveness, springiness stickiness and cohesiveness parameters were calculated.

Sensory evaluation

Halubai prepared with ragi, wheat and rice was subjected to descriptive sensory evaluation. Typical sensory descriptors were brown, surface glossiness, set, soft, smooth, chewy, sticky, cooked cereal jaggery, cardamom and sweetness.

Statistical analysis of data

Least significant different, principal component analysis and correlation coefficient were performed for sensory data by using Statistica (version 5.5 – Stasoft, Tulsa, USA). Mean separation significance was established at $p < 0.05$.

Results and discussion

Halubai is a traditional sweet in India relished for its delicate aroma and desirable texture which is neither too chewy nor stiff and jelly like. Its texture falls somewhere between that of burfi and *Bombay halwa* though several gradation in texture are possible and available in Indian cuisine, based on the combination of ingredients and their relative proportions. Processing also plays an important role in obtaining the unique texture desirable in that product.

Sensory analysis

A detailed study conducted on the sensory and instrumental analyses of textural properties of *Bombay halwa* highlighted the viscoelastic nature of the product. A comprehensive list of sensory impact attributes which characterized the product was also drawn. These included shine/gloss, smoothness, stickiness, cohesiveness, chewiness and overall quality (Nagin chand 1994). Since *Halubai* has some sensory properties similar to *Bombay halwa*, these sensory attributes were included in the score card while evaluating *Halubai*.

Halubai prepared using the conventional method had sensory quality comparable to those prepared using modified method (Fig. 1a). This was evident in the colour, surface gloss, set, softness and smoothness of RGH and RHFH. However chewiness and stickiness were slightly higher in RGH possibly due to very fine particle size and the difference in treatment—soaking time and grinding. Similar pattern was seen in wheat samples with an added advantage of higher smoothness in WFH (Fig. 1b).

In case of rice *Halubai*, the set of RCH was thicker with higher scores for chewiness compared to RCFH. As seen in Fig. 1c, there was no significant difference in the overall quality of samples between the sets prepared conventionally and those prepared using modified method from any of the cereal/millet.

Fig. 1 Sensory profile of (a) Ragi *Halubai*, (b) Wheat *Halubai* (c) Rice *Halubai* prepared by different methods

In the presence of excess water, starch undergoes gelatinization in the temperature range of 50°–90°C, depending on the botanical origin. As is well known, changes associated with gelatinization include loss of crystalline order, swelling of starch granule and solubilisation of amylose. Consequently, a thick fluid is formed, which, on cooling, forms a turbid viscoelastic paste or gel (Morris 1990). Starch based foods such as halwa or *halubai* are complex, multicomponent matrices comprising of starch, proteins, water, sugars, solutes and lipids. Mechanical energy is another significant factor in the structure development of these foods. According to Smith processing of starchy material may be categorized in to several stages such as mixing the ingredients, nature of the strain (mechanical treatment), temperature and time history ultimately affecting the product quality (Smith 1991). As it is evident, all these factors play important roles in obtaining *halubai* of desirable quality. The process variables of mixing operations include various combinations of time, shear/stress, temperature and ingredient composition. Further, introduction of other materials such as sugar/jaggery and fat/ghee also aid in the manipulation of the structure of such starch based end products. The last stage is the completion or stabilization of the structuring process achieved principally through attainment of some equilibrium and cooling resulting in the eventual glassy state, highly prized in products such as halwa and *halubai*.

When chewing (deforming) wheat based *halubai* and ragi based *halubai* in the mouth, the material was not broken down easily to reach a stage, where the samples were soft enough to be comfortably swallowed. What was perceived as firmer set (sensory score: 10.0 and 10.7 for wheat and ragi respectively) correlated well with stickiness (instrumental measures: −0.33 & −0.23 for wheat and ragi respectively) and firmness (instrumental measures: 2.5N & 4.6N for wheat and ragi respectively). In contrast, the soft set (sensory score: 6.2) of rice based *halubai* was reflected in the lower peak force (instrumental measures: 1.7N).

Preparation of multi grain halwa from cereal and millets has been reported. Ragi based spicy multi grain halwa was perceived to be harder and chewy in texture while wheat based sample was found to be softer (Itagi et al. 2011). Similar observation was made in ragi *Halubai* which was found to be firmer than wheat *Halubai* samples (Table 1).

As hydration rates of native and processed cereals/millets vary (Singh et al. 2010), these findings were applied to reduce the soaking time during preparation of *Halubai* using flours in the modified method instead of whole cereal as in the conventional method. Further, fine flour fraction was separated and used in the modified method in order to mimic the fine particle dispersion obtained in conventional method after grinding and filtering the soaked cereal/millet. This apparently resulted in good set, smooth, soft, texture.

Table 1 Instrumental colour and texture analysis of *halubai* samples

	Ragi		Wheat		Rice	
	Conventional	Modified	Conventional	Modified	Conventional	Modified
Colour parameters						
L*	36.00a	35.06a	56.54b	55.09a	45.83a	44.92a
a*	4.72a	3.94a	−1.62b	−1.501a	−0.09a	−0.081a
b*	17.96a	18.04a	21.06a	21.59a	17.62a	18.10a
Textural parameters						
Firmness, (N)	4.18a	4.6b	2.44a	2.50a	1.97b	1.70a
Adhesiveness, (N.s)	0.47a	0.51a	0.55a	0.58a	0.21a	0.22a
Springiness,	0.83a	0.86a	0.86b	0.75a	0.65a	0.62a
Stickiness, (N)	−0.23b	−0.18a	−0.33a	−0.27a	−0.20a	−0.18a
Cohesiveness, (−)	0.79a	0.81a	0.89b	0.75a	0.87a	0.89a

Mean scores in a column (within the cereal) with different letters differ significantly at $p < 0.05$ by LSD

Measurements were carried out in triplicate

Instrumental analysis

Colour

There was no significant difference in the L*, a* and b* values of *Halubai* samples prepared using conventional method compared to their respective counterparts prepared using modified method. Wheat *Halubai* had the highest L* value representing maximum lightness

followed by rice *Halubai*. Ragi based *Halubai* had the lowest L* value apparently because of its dark colour. RGH and RGFH had a slight tint of redness represented by positive a* values whereas WH and WFH had a slight tint of greenness shown by negative a* values. This trend was also reflected in RCH and RCFH but to a lesser extent. Among the samples WH and WFH had the highest yellowness followed closely by RGH and RGFH, RCH and RCFH (Table 1).

Fig. 2 Force deformation curves of *Halubai* made from (a) wheat, (b) ragi and (c) rice

Fig. 3 Principal component analysis of sensory attributes of *Halubai*

Texture

Foods such as starch-based or gelatin-based sweetmeats are considered semi-solid or soft-solid viscoelastic substances. As food texture is one of the key factors consumer evaluate while cognitively assessing food quality and acceptability, it is of vital importance to examine alternate choices of ingredients that could be used to generate a specific structure and deliver the same texture (Foegeding et al. 2011).

Different textural parameters measured relevant to the product, using texture analyzer are given below:

Firmness is expressed as height of the first peak (N). Firmness was maximum in ragi *halubai* followed by wheat and rice. Springiness was maximum (0.86) in wheat followed by ragi and rice. Stickiness was low in rice and was maximum in wheat. Cohesiveness was comparable in wheat and rice *halubai* and was low in ragi (Table 1). The typical texture profile analysis (TPA) curves for WFH, RGFH, and RCFH are given in Fig. 2a, b and c respectively.

Chewiness is defined as the product of gumminess and springiness. Chewiness, tenderness and toughness are measured in terms of the energy required to masticate a solid food (Jowitt 1974). It was seen in the study that WH, RGH and RCH had higher scores for chewiness 3.7, 4.2 and 3.9 respectively compared to their counterparts prepared using modified method, 3.1, 3.2 and 3.1 respectively. This indicated that WH, RGH and RCH needed more mastication in the mouth before they could be comfortably swallowed compared to WFH, RGFH and RCFH. The important contributors to oral food processing include interactions between the tongue and pallet. These are influenced by viscosity, consistency and volume of the bolus (Kieser et al. 2011)

Adhesiveness is defined as the negative force area for the first bite and represents the work required to overcome the attractive forces between the surface of a food and the surface of other materials with which the food comes into contact, i.e. the total force necessary to pull the compression plunger away from the sample. For materials

Table 2 Correlation matrix of sensory attributes

	Brown	Surface	Set	Soft	Smooth	Chewy	Sticky	Cooked	Jaggery	Carda	Sweet	OQ
Brown	1.00											
Surface	0.53	1.00										
Set	0.62	0.96	1.00									
Soft	0.82	0.16	0.39	1.00								
Smooth	0.39	0.84	0.87	0.21	1.00							
Chewy	0.12	0.02	0.21	0.40	0.02	1.00						
Sticky	-0.26	-0.87	-0.70	0.24	-0.70	0.40	1.00					
Cooked	-0.90	-0.70	-0.80	-0.75	-0.69	-0.01	0.44	1.00				
Jaggery	-0.75	-0.74	-0.63	-0.25	-0.45	0.24	0.74	0.68	1.00			
Carda	0.61	0.39	0.49	0.54	0.29	0.73	-0.06	-0.42	-0.43	1.00		
Sweet	-0.73	-0.92	-0.86	-0.30	-0.69	0.19	0.84	0.81	0.91	-0.34	1.00	
OQ	0.15	0.91	0.78	-0.26	0.75	-0.13	-0.94	-0.36	-0.58	0.16	-0.75	1.00

with a high adhesiveness and low cohesiveness, when tested, part of the sample is likely to adhere to the probe on the upward stroke. It was observed that ragi (0.47–0.51) and wheat (0.55–0.58) *Halubai* samples had higher adhesiveness compared to rice (0.21–0.22) samples. In other words, ragi and wheat samples required comparatively more work (mastication) when these samples were manipulated in the mouth between the molars (Miller and Watkin 1996).

Principal component analysis

PCA biplot indicated that PC axis 1 accounted 46.12% while PC 2 accounted for 29.81% of the variance of the data and both axes together explained nearly 76% of the variance. From this plot (Fig. 3) it is clear that ragi based *halubai* was more brownish positioned on the positive side y axis with greater weightage, while wheat based *halubai* was associated with more desirable sensory attributes with OQ, smooth, set properties. On the other hand, *halubai* from rice had more stickiness followed by higher levels of sweet, jagged and cooked notes which are undesirable.

Correlation matrix of sensory attributes

Correlation coefficient of different sensory attributes is presented in Table 2. OQ significantly and positively correlated with surface glossiness (0.91), while negatively correlated with stickiness (−0.94). Positive correlation was found between surface glossiness and set (0.96) and smoothness (0.84), indicating that high scores for surface glossiness was associated with good set and smoothness. In other words, when the product had good set, surface glossiness was enhanced. Surface glossiness correlated negatively with stickiness (−0.87) revealing that stickier the product was, lesser the surface glossiness. In essence, overall quality of *Halubai* was significantly influenced by surface glossiness, smoothness and set. When these desirable sensory attributes were perceived at higher intensity overall quality tended to be higher. In contrast, when stickiness was high surface glossiness and overall quality were adversely affected. To a lesser extent, overall quality was negatively impacted by higher intensity of sweetness in *Halubai* which was undesirable. This was reflected in the negative correlation between sweetness and OQ (−0.75).

Conclusion

Conventional method of *Halubai* preparation involving whole cereals/millet is tedious and time consuming. Hence a modified method for the same was developed using fine flour fractions, which was simple, energy efficient and time saving, most importantly without compromising the quality of the

product. Instrumental, colour and texture analysis of *Halubai* prepared using conventional and modified methods corroborated sensory data indicating that both the sets of samples had very close sensory quality. This modified method is useful in preserving the traditional culinary heritage of India.

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