Studies on soft centered coated snacks

A. S. Pavithra · Ramakrishna Chetana · R. Babylatha ·
S. N. Archana · K. K. Bhat

Revised: 2 March 2011 / Accepted: 8 March 2011 / Published online: 16 April 2011
© Association of Food Scientists & Technologists (India) 2011

Abstract Roasted groundnut seeds, amaranth and dates pulp formed the center filling which was coated with sugar, breadings, desiccated coconut and roasted Bengalgram flour (BGF) to get 4 coated snacks. Physicochemical characteristics, microbiological profile, sorption behaviour and sensory quality of 4 coated snacks were determined. Centre filling to coating ratio of the products were in the range of 3:2–7:1, the product having BGF coating had the thinnest coating. Center filling had soft texture and the moisture content was 10.2–16.2% coating had lower moisture content (4.4–8.6%) except for Bengal gram coating, which had 11.1% moisture. Sugar coated snack has lowest fat (11.6%) and protein (7.2%) contents. Desiccated coconut coated snack has highest fat (25.4%) and Bengal gram flour coated snack had highest protein content (15.4%). Sorption studies showed that the coated snack had critical moisture content of 11.2–13.5%. The products were moisture sensitive and hence require packaging in films having higher moisture barrier property. In freshly

prepared snacks coliforms, yeast and mold were absent. Mesophilic aerobes count did not show significant change during 90 days of storage at 27 °C and 37 °C. Sensory analysis showed that products had a unique texture due to combined effect of fairly hard coating and soft center. Flavour and overall quality of all the products were rated as very good.

Keywords Snacks · Soft centered · Coated snacks · Center filling · Coating material

Snack foods include everything from chips to confections, from salty to sweet. They may be eaten at every mealtime, or in between from breakfast to midnight and are popular in all age group (Hollingsworth 1995). In India organized snack food production is mainly confined to deep- fat fried snacks such as potato chips and flour based extruded snacks. Expanded snacks are the other category manufactured by the organized sector. Although deep- fat fried snacks are very much in demand, a variety of other kinds of snacks prepared without deep- fat frying is being marketed. Coated snack belongs to this category.

Much of the success of snack foods is due to the coatings that are applied. Coatings are added to a variety of foods because they add novelty, give an attractive appearance, define the product shape, improve taste, increase shelf-life, protect ingredients, prevent migration of core constituents, create texture, or maintain structural integrity. Changes in lifestyle, particularly in the modern world have consolidated the availability and sales of convenience foods providing considerable support for the expansion and globalization of coated foods. Automation of manufacturing, innovation in the cooking methods, the demand for more sophisticated foods, diversification, and a concern to develop healthier products that contain less fat are the

A. S. Pavithra · K. K. Bhat
Department of Sensory Science,
Central Food Technological Research Institute,
Mysore (Council of Scientific and Industrial Research),
Mysore 570020, India

R. Chetana (✉) · R. Babylatha
Department of Lipid Science and Traditional Foods,
Central Food Technological Research Institute,
Mysore (Council of Scientific and Industrial Research),
Mysore 570020, India
e-mail: rchetana@yahoo.com

S. N. Archana
Department of Human Resource Development,
Central Food Technological Research Institute,
Mysore (Council of Scientific and Industrial Research),
Mysore 570020, India

factors that dominate the latest research trends (Fizman and Salvador 2003).

Coatings are especially important in the snack food industry where the base often have an unattractive appearance and tastes bland, mealy, sticky, dusty or dry. The secret to the popularity of these snacks is coatings, which give an appealing colour and flavour (Barringer 2002). Coatings are also used to reduce oil uptake improve effectiveness of a product. Studies have shown that protein based coatings with carboxymethylcellulose (CMC) can be effectively implemented to improve quality and reduce oil uptake of coated peanuts (Hana et al. 2009). Edible coatings have also been used effectively for protecting perishable foods such as strawberries to improve quality and storage time. A batter with high protein content produces a more nutritious coating than batters based purely on cereal flours. Bhardwaj (1990) proposed a batter with a high concentration of a pulse with a particular particle size in order to obtain fried battered products of high quality and with a crispy, chewy crust.

Migration of moisture from the centre to the coating occurring during storage of such products results in textural changes. Moisture and composition of filling and coating materials are important criteria in determining the shelf-life of coated snacks. The present study comprises formulation, preparation and quality analysis of soft centered coated snacks with different coating materials.

Material and methods

All the ingredients necessary for the preparation of soft centered coated snacks were procured from the local market.

Processing of raw materials

Dates (Phoenix dactylifera) Weighed quantity of dry dates was mixed with equal quantity of water, and kept for 1 h. Seeds were manually removed and the pulp was ground in a electric grinder for about 10 min to get a paste.

Groundnut (Arachis Hypogea) Groundnuts were roasted at 110–115 °C for 5–6 min and cooled. The roasted nuts were fed into the hammer mill fitted with a suitable sieve (size 8), to obtain groundnut pieces of 2–3 mm size. Groundnut skin was removed by aspiration.

Amaranth (Amaranthus Caudatus) seed Amaranth seeds were washed with water to remove foreign particles and sand; and then dried at 60–65 °C for 4–5 h. Dried seeds were popped in an open pan at 190–200 °C and the popped seeds were sieved using 18 mesh sieve to remove fines and unpopped grains.

Preparation of filling material Date paste was heated on a low flame till the paste attains 85–90 °C. Roasted groundnut bits and popped amaranth seeds were added and heating was continued with thorough mixing till the ingredients form a single mass. This was transferred to a tray coated with thin layer of corn flour and hot mass was sheeted manually to a thickness of about 2 mm. The material was allowed to cool and then cut into small bits which were manually made into spherical balls of about 1 cm diameter. The formed filling material balls were dried in hot air drier at 50–60 °C for 20–30 min.

Preparation of coating material Sugar and liquid glucose in the ratio 3:1 were dissolved in water and syrup was prepared by heating the solution till the soluble solids content reached 78–80°B. The 4 coating materials used were powdered sugar, breadings, desiccated coconut, and roasted BGF containing spices.

Coating Filling material in the form of spherical balls was taken in a coating pan revolving at 15 rpm. Hot syrup was added in small quantities with continuous tumbling under a stream of hot air (80–85 °C). Each layer of syrup coating was followed by dusting with corn starch and coating materials. Syrup and the coating materials were added in succession till required thickness of the coating was achieved. Coated products were dried in a hot air dryer at 60 °C for 25–30 min. Four coated snacks were prepared with the 4 different coating materials were prepared.

Physicochemical analysis Weights of the filling material and coating were determined to find out the ratio between the filling and the coating. Mean values of 10 readings were calculated. Coating thickness measured using a digital vernier caliper and mean values reported. Proximate composition was estimated in duplicate by standard procedures (AOAC 1995). Iron and calcium was estimated by the method of Ranganna (2000). All the analyses were carried out in triplicate.

Equilibrium relative humidity (ERH) studies Saturated solution of lithium chloride, potassium acetate, magnesium chloride, potassium carbonate, magnesium nitrate, sodium nitrate, sodium chloride, potassium chromate, and ammonium phosphate were used to obtain different RH combinations having water activity (a_w) values of 0.11, 0.22, 0.33, 0.44, 0.54, 0.64, 0.72, 0.86, and 0.92 respectively and loss or gain in moisture contents were estimated periodically. All chemicals used of were analytical grade (AR). Saturated solutions were taken in different desiccators. Prior to keeping the coated snacks in these desiccators, the samples were conditioned to 65% at 27 °C for 12 h. The initial moisture content (IMC) was estimated in triplicate by

Table 1 Mean weight and filling: coating ratio of coated snacks

Sample	Filling, g	Coating, g
Sugar coated	3.2±0.13 ^{ax}	4.7±0.57 ^{ax}
Breadings coated	6.7±0.29 ^{bx}	7.6±0.34 ^{bx}
Desiccated coconut coated	5.8±0.19 ^{bx}	8.1±0.51 ^{ay}
Bengal gram flour coated	4.1±0.23 ^{ax}	7.1±0.54 ^{by}

Mean values bearing different superscripts in a row or column are significantly different ($p \leq 0.05$) ($n=10$)

oven method (AOAC 1995). Weighed samples of about 10 g after conditioning at 27 °C and 65% RH were placed in each desiccator. At frequent intervals the samples were removed from the desiccators and immediately weighed in order to record the percent loss or gain in weight. Studies were continued till there was no change in weight indicating moisture equilibration.

Texture analysis The hardness/shear of coated snacks was determined with a Universal Texture Testing Machine, UTM (Model LR 5K Llyods instruments, UK). The product was sheared using a load cell of 1 KN with a Warner Bratzler shear attachment at a crosshead speed of 50 mm/min. The maximum force required for complete shearing of coated snack into 2 pieces was reported an average of 8 replicates has been reported. The maximum force required to compress the coated snack by 50% was recorded as compression force or hardness. Mean values of 10 readings were noted.

Microbiological analysis All glass wares and other materials used in the present study were sterilized by steam in autoclave at 121 °C for 20 min. All the chemicals required for the media used in this study were procured from Hi Media Private Limited., Mumbai, India. The following 3 media's were prepared according to the manufacturers instructions.

1. Plate count agar to detect mesophilic aerobes
2. Potato dextrose agar to detect yeasts and molds
3. MacConkey agar to detect coli forms

Sensory evaluation Fresh samples were analyzed in terms of colour, texture, aroma, taste, and overall quality. A

trained panel of 12 judges participated in this study. Representative samples of coated snacks were presented to the panelists for discussion of the sensory attributes of the product. The definitions of the attributes were also discussed and descriptors developed by asking the panelists to describe the product with the suitable descriptive terms for development of a score card, which consisted of each attribute on a 15 cm line scale. Quantitative descriptive analysis methods were adopted and the panelists were asked to mark the intensity of each attribute (Stone and Sidel 2004).

Results and discussion

Physicochemical characteristics The coated snacks had spherical shape and their weight ranged from 9 to 14 g. The difference in weight was mainly due to the thickness and weight of the coating which was lowest (4.7 g) in sugar coated snack and highest (8.1 g) in desiccated coconut coated snack. This was reflected in the variations in weight ratio's of filling and coating. Sugar coated snack had filling to coating ratio of 3:5 whereas breadings coated snack had proportionately heavier filling as shown by the ratio 6.7:7.6. No significant differences were observed between the mean weights of filling and coatings of sugar and breadings coated snacks but significant differences were observed in the other two i.e., desiccated coconut and BGF coated samples (Table 1). The filling of all the samples showed no significant difference among the different types of coatings of sugar and breadings coated snacks but significant differences were observed in the other two i.e., desiccated coconut and BGF coated samples. Considering the weight of the coatings it was found that, sugar and roasted BGF coatings were more compact as given by coating thickness of 2.7 mm for both the products (Table 2).

Proximate composition

Moisture Table 3 gives the moisture content of the whole snacks, filling and coating. The snacks were soft centered because moisture content of filling material ranged 10.2–

Table 2 Diameter and coating thickness of coated snacks

Sample	Product dia, mm	Coating Thickness, mm	Compression, N	Shear, N
Sugar coated	11.7±0.21 ^a	2.7±0.12 ^a	230±0.87 ^c	80±0.67 ^d
Breadings coated	19.1±0.18 ^c	3.4±0.11 ^b	217±0.91 ^b	78±0.66 ^c
Desiccated coconut coated	21.3±0.17 ^d	3.6±0.12 ^c	214±0.79 ^{ab}	77±0.87 ^b
Bengal gram flour coated	14.5±0.22 ^b	2.7±0.13 ^a	211±0.71 ^a	76±0.88 ^a

Means followed by different superscripts in a column are significantly different ($p \leq 0.05$) ($n=3$)

Table 3 Moisture content of coated snacks

Sample	Whole,%	Filling,%	Coating,%
Sugar coated	7.9±0.14 ^a	10.2±0.16 ^a	4.4±0.14 ^a
Breadings coated	8.8±0.16 ^a	12.3±0.21 ^a	8.5±0.15 ^c
Desiccated coconut coated	10.3±0.13 ^b	16.2±0.22 ^b	6.9±0.18 ^b
Bengal gram flour coated	12.0±0.13 ^b	15.0±0.20 ^b	11.1±0.15 ^d

Means followed by different superscripts in a column are significantly different ($p \leq 0.05$) ($n=3$)

16.2%. Comparatively coatings had lower moisture with sugar coating having the lowest moisture 4.4%. This made the product slightly crunchy. But BGF coated snack had higher moisture content (11.1%) in the coating resulting in a soft textured product. No significant differences were observed between the sugar and breadings coated snacks but in desiccated coconut and BGF coated differences were observed in the percentage of coating.

Filling material was same in all the 4 products. However, proximate compositions of the snacks were found to vary (Table 4) with the type of coating material. Sugar coated snack had the lowest content of fat (11.6%) and protein 7.2%, whereas in breadings coated snacks, it had a fat content of 14.5% and protein 8.4%. When desiccated coconut powder was used in the coating material, it increased the fat and protein levels to 25.4% and 10.1% respectively. BGF snack had the lowest sugar (19.4%) and the sugar coated snack had the highest content of 36.7%.

Crude fibre content was lowest in sugar coated snack. Presence of desiccated coconut increased the crude fibre content and the use of red chilli powder in BGF coating was found to increase the crude fibre to 5.62%. Ash content was high in BGF coated snack because of the addition of salt in the coating material. This product also had higher iron content of 9.07 mg/100 g. Calcium content varied from 23.6 to 43.2 mg/100 g.

Sorption studies In all the 4 samples equilibrium moisture contents (EMC) were lower than the initial moisture content (Fig. 1) when stored under humidity condition of 11, 22,

and 33% RH. Sugar coated snack showed a rapid increase with RH of the storage atmosphere. Pattern of increase in EMC was not the same for all the products, because sorption characteristics are dependent on product composition. Sugar coated snacks had 29.0 and 30.8% EMC when stored at RH of 86 and 92%. On the other hand, desiccated coconut coated snack had corresponding EMC values of 16.6 and 17.6% respectively.

Sugar being more hygroscopic had higher moisture absorption capacity than other coating material, and the sample became sticky at RH of 76, 85 and 92%. Sugar modifies the moisture sorption behaviour depending on its physical form. It binds the water and restricts its mobility. Chinachoti (1993) has reported that the physical form of sugar rather than the proportion modifies the mobility of water molecules in the system. In the case of BGF coated sample at 44% RH, the EMC (10.8%) was lower than IMC, whereas desiccated coconut and breadings coated snacks at to 44% RH had EMC values that are slightly higher than IMC. It has been reported that moisture loss in flour based sweets at RH<50% is a combined effect and interactions of different ingredients. Factors which control moisture sorption characteristics of flour based sweets include proportion of hydrophilic and hydrophobic components such as proteins, soluble and complex carbohydrates and fat (Shreedhar et al. 1996). Proportion of flour solids has been identified as one of the factors that modify the EMC of fried snacks (Rao et al. 1990a, b; Thakur and Arya 1990) and this effect is probably due to water binding capacity of flour proteins and carbohydrates (Pratap et al. 1982).

All the samples stored at 56% RH and above had visible mold growth, at the end of 30 days of storage. This corresponded to moisture contents of 17.0, 15.1, 11.6 and 16.6% in snacks coated with sugar, breadings, desiccated coconut and BGF respectively. The sorption behavior of the snacks revealed that they are moisture sensitive and hence require packaging in films with high moisture barrier property.

Texture analysis Texture of coated snack measured in terms of shear and compression varied depending on the nature of the coating materials. Sugar coated snack was more firm

Table 4 Proximate composition of coated snack

Sample	Moisture, %	Fat,%	Protein,%	Total Sugar,%	Crude fibre,%	Total ash, %	Acid insoluble Ash,%	Fe, mg/100gm	Ca, mg/100gm
Sugar coated	7.9±0.14 ^a	12.0±0.14 ^a	7.2±0.14 ^a	36.8±0.14 ^b	2.4±0.14 ^a	1.4±0.14 ^a	0.01±0.14 ^a	2.8±0.14 ^b	40.1±0.14 ^c
Breadings coated	8.8±0.14 ^a	14.5±0.14 ^b	8.4±0.14 ^a	32.8±0.14 ^b	2.6±0.14 ^a	1.4±0.14 ^a	0.01±0.14 ^a	1.5±0.14 ^a	43.2±0.14 ^c
Desiccated coconut coated	10.2±0.14 ^b	25.4±0.14 ^d	10.1±0.14 ^b	34.8±0.14 ^b	3.2±0.14 ^b	1.2±0.14 ^a	0.02±0.14 ^a	4.3±0.14 ^c	23.6±0.14 ^a
Bengal gram coated	12.0±0.14 ^b	18.2±0.14 ^c	15.4±0.14 ^c	19.4±0.14 ^a	5.6±0.14 ^c	3.9±0.14 ^b	0.3±0.14 ^b	9.0±0.14 ^d	30.4±0.14 ^b

Means followed by different superscripts in a column are significantly different ($p \leq 0.05$) ($n=3$)

Fig. 1 Sorption behavior of coated snacks. SC Sugar Coated; BC Breadings Coated; DC Desiccated coconut coated; BGFC Bengalgram Coated

and harder than other samples as shown by the compression force of 210N–230N, and shear value of 76N–80N (Table 2). Sugar coating had the lowest (4.44%) moisture content which resulted in a harder product requiring more force for shearing and compression. BGF coated snacks has higher moisture both in filling and coating. This is reflected in shear and compression values of 76N and 211N respectively. No significant differences were observed among shear values of the coated snacks.

Microbiological quality Table 5 gives microbial quality of coated snacks. Coliforms and yeast and molds were found to be absent in the fresh samples. However, in samples packed in HDPE pouch (150 gauge) and stored

at 27 and 37 °C growth of yeast and mold was observed. This indicates the possibility of post processing contamination. The microbial qualities of various commercial Indian sweets have been studied. Dwarakanath and Venkatasubbaiah (1985) have reported high values of total bacterial count, yeasts and molds in many of the preparation. Counts of mesophilic aerobes observed in fresh samples did not show any significant change at the end of 90 days of storage at both temperatures. The counts may not suggest any health risk but it is preferable to keep the mesophilic aerobes count between 1.5 and 2.0 $\log_{10}$ cfu/g. Coliforms indicative of contamination which may lead to health hazard were found to be absent in all the samples. The results also indicate that care should be taken to avoid post-processing contamination with yeasts and molds.

Sensory analysis The sensory quality is represented in the Fig. 1. All the snacks except BGF coated snack had high firmness as shown by the sensory score of 11–12. Since the filling material was same in all the products, not much variation was seen in the attribute “granular”. All the products had almost same score for hardness probably due to very little variation in the moisture content.

Sugar coated product had higher sweetness score whereas presence of spices in BGF coated snack contributed to a high spicy note. Dessicated coconut snack had

Table 5 Microbiological profile of coated snacks

Sample	Storage Period, days	Storage Temp, °C	Viable microbial counts ^a $\log_{10}$ cfu/g $\pm$ SD Mesophilic aerobes	Yeasts and molds
Sugar Coated	0	27	3.1 $\pm$ 0.2	<1.00
	90	27	3.4 $\pm$ 0.26	3.2 $\pm$ 0.17
	90	37	4.1 $\pm$ 0.3	3.6 $\pm$ 0.1
Breadings Coated	0	27	4.0 $\pm$ 0.1	<1.00
	90	27	3.6 $\pm$ 0.26	4.2 $\pm$ 0.4
	90	37	3.7 $\pm$ 0.26	3.3 $\pm$ 0.17
Dessicated Coconut Coated	0	27	4.2 $\pm$ 0.28	<1.00
	90	27	3.3 $\pm$ 0.17	3.3 $\pm$ 0.11
	90	37	3.7 $\pm$ 0.15	2.3 $\pm$ 0.26
Bengal Gram flour Coated	0	27	4.5 $\pm$ 0.26	<1.00
	90	27	4.6 $\pm$ 0.17	3.4 $\pm$ 0.15
	90	37	4.7 $\pm$ 0.31	3.3 $\pm$ 0.26

Samples were devoid of coliforms

^a Average of three values

Fig. 2 Sensory profile of soft centered coated snacks. SC Sugar Coated; BC Breadings Coated; DC Desiccated coconut coated; BGFC Bengalgram Coated

highest acceptability as given by overall quality score and sugar coated snack had lowest score. However all products were acceptable as they had an overall quality score of 10–14. Results of sensory evaluation show that one filling material can be used to prepare a variety of snacks by varying the composition of the coating.

Conclusion

Novel coated snack containing oilseeds and dates as the center filling can be prepared. Use of different types of coating material will add variety to the nature and quality of the product. With the growth of the processed food industry, the demand for novel foods is increasing. Speciality coatings can provide a number of functional benefits to snack foods, and that use is likely to increase due to demand for tasty and appealing products.

References

- AOAC (1995) Official methods of analysis, 16th edn. Association of official analytical chemists, Washington DC
- Barringer S (2002) In: Hui YH (ed) Coating snack foods, in Hand book of food Science and technology and engineering, vol 4. CRC, New York, pp 169–1–169–8
- Bhardwaj SC (1990). Method for cooking involving high protein frying batter that eliminates the need for breadding and produces crispy and chewy crust. US patent 4, 963, 378
- Chinachoti P (1993) Water mobility and its relation to functionality of sucrose containing food systems. J Food Technol 47:134–140
- Dwarakanath CT, Venkatasubbaiah S (1985) Microbiological quality and growth of *Staphylococcus aureus* in liquid type of traditional Indian sweets. J Food Sci Technol 22:394–397
- Fiszman SM, Salvador A (2003) Recent developments in coating batters. Trends in Food Sci Technol 14:399–407
- Hana J, Bourgeois S, Lacroix M (2009) Protein-based coatings on peanut to minimise oil migration. Food Chem 115:462–468
- Hollingsworth P (1995) Healthier products breathe new life into languishing category. Food Technol 49:58–62
- Pratap V, Singh BPN, Maran M (1982) Equilibrium moisture content of some flours. J Food Sci Technol 19:153–158
- Ranganna S (2000) Handbook of analysis and quality control for fruit and vegetable products, 2nd edn. Tata McGrawHill, Publ Co Ltd, New Delhi
- Rao TSS, Kaverappa NM, Reddy TH, Jayaraman KS (1990a) Development of ready to eat traditional Indian sweet dishes based on Jaggery and coconut. J Food Sci Technol 27:355–358
- Rao TSS, Kaverappa NM, Reddy TH, Jayaraman KS (1990b) Development of shelf stable ready to eat Indian sweet meats based on sugar and coconut. J Food Sci Technol 27:359–361
- Shreedhar A, Deoskar AV, Bhotmange MG, Rao BY, Shastri PN (1996) Moisture sorption behavior of some flour based traditional sweets. J Food Sci Technol 33:516–519
- Stone H, Sidel JL (2004) Sensory evaluation practices, 3rd edn. Elsevier, London
- Thakur BR, Arya SS (1990) Packaging requirement and stability of wheat snacks. J Food Sci Technol 27:76–81