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# Effect of beetroot powder incorporation on the shelf life of legume and oil seeds based snack bar

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**Abstract**
The present study was designed to evaluate the shelf life of legume and oil seeds based snack bar incorporated with beetroot powder (BPR). BRP incorporated snack bar was formulated using 15g of BRP, 16.5 g of bengal gram, 36 g of honey, 16.5 g of flax seeds, 8 g sesame seeds, 5 g of coconut chips and 3 g of peanuts. For shelf life study, both control snack bar and BRP incorporated snack bar were kept in high density polyethylene (HDPE) bags for 90 days at refrigeration (5 ºC) and ambient temperature (15-35 ºC) and analyzed for various parameters *viz*; sensory quality, moisture, free fatty acid (FFA) content, total plate count (TPC) and yeast and mold count. Results showed that control snack bar scored significantly ($p$<0.05) lower mean sensory scores at both the storage conditions when compared with BRP incorporated snack bar. An increase in moisture and FFA content was observed in both the snack bars however, control snack bar had significantly ($p$<0.05) higher FFA content than BRP snack bar. TPC, yeast and mold count were studied as <1 $\log_{10}$cfu $ml^{-1}$ in both the snack bars during the course of storage.

**Keywords:** Beetroot powder, snack bar, shelf life, free fatty acid content, total plate count, yeast and mold count

## Introduction
Consumer preference and acceptance for convenience foods has increased vigorously due to their ease of consumption as they reduce the input required from the part of consumers in preparation and cooking. In contrast to staple food items that we consume on a regular basis after a lot of pre-preparations and cooking, food items designated as convenience food require minimal preparation (typically just heating) and are generally sold as hot, ready-to-eat items; as room-temperature, shelf-stable; or as refrigerated or frozen food products. Ready-to-eat snacks are one of the sections of mostly consumed convenience foods which include confectionary, biscuits, fried chips and savoury snacks (Besbes *et al*., 2009) [1]. Snack foods are typically designed to be quick, less perishable, more durable, more portable and highly satisfying than prepared foods. They often contain substantial amounts of sweeteners, preservatives (within acceptable limits), appealing ingredients such as cream, peanuts, almonds, chocolate and specially-designed flavors (such as flavored potato chips).
Now a day's nutritional snack bars as ready to eat food items have become popular which are available in different varieties, with different ingredients, with wide variety of flavors and textures under different brand names. Snack bars are supplemental bars which may be prepared using cereals and other high energy foods targeted at people who require instant energy but do not have enough time for a meal. Mostly these energy bars are prepared using different cereals, millets, different fruits like-dates and berries, sweeteners like- sugar, honey and nuts like- cashew nuts, walnuts, almonds, pistachio nuts etc. The bars maybe fortified using a wide range of vitamins, minerals, herbs and other nutrients or energy rich ingredients (Gonzales and Draganchuk, 2003) [2]. Commercially several types of bars are available, such as; meal replacement bars, bars targeted to the nutritional needs of diabetics, women and children, high-protein, high fibre, high calorie, mineral and vitamin rich, bars with functional additives such as prebiotic, etc (Rawat and Darappa, 2015) [3]. These bars are generally packed in metallised polyester films and have a limited shelf life of 3 to 4 months (Padmashree *et al*., 2012) [4]. However, the use of synthetic colorants, flavors and antioxidants to enhance the sensory appeal and shelf life of these bars is of prime concern among health conscious consumers due to its adverse health effects (Shahidi and Ambigaipalan 2015) [5]. Therefore, use of natural food or food ingredients without addition of synthetic chemicals should be the major focus of manufacturers so that maximum possible health benefits of these nutritious bars can be attained.

Beetroot or red beet *Beta vulgaris* subsp. *vulgaris* (*conditiva*) is one such nutritious taproot which can be used for preparation of nutrient dense snack bars. Beetroot is a rich source of carbohydrates, fibres, minerals (sodium, potassium, calcium, phosphorus, iron), several bioactive compounds such as carotenoids, betacyanines, folates, biologically accessible antioxidants, polyphenols and flavonoids (Gokhale and Lele 2011) [6]. It also contains betalains; a highly bioactive water soluble pigment which imparts significant red color to the root and is also used as a natural colorant in variety of food systems. It has also been found to possess high antioxidant and anti-inflammatory activities (Georgiev *et al*., 2010; Zielinska- Przyjemska *et al.*, 2009) [7, 8].

Keeping in view the various aspects as mentioned above, the present study was designed to

1) Develop a nutritious snack bar utilizing beetroot powder and 2) to analyze the shelf life of beetroot powder incorporated snack bar.

## Materials and methods

### Procurement of raw ingredients

Fresh beetroots (Beta vulgaris) were procured from Pantnagar haat. Flax seeds, roasted bengal gram, honey, sesame seeds, roasted peanuts and dry coconut were purchased from the local market of Pantnagar, Uttarakhand, India.

### Preparation of beetroot powder (BRP) and other ingredients

Fresh beetroots were peeled, washed properly and cut evenly into thin round slices (<4mm) followed by its drying at a temperature of 60˚ºC for 6 hours. Dried beetroot slices were ground into fine powder using electric grinder. Other ingredients *viz*; dry coconut was grated into small chips, roasted peanuts were cut into small pieces after removal of skin, flax seeds and sesame seeds were roasted for 2 minutes separately and allowed to cool. Roasted bengal gram and roasted flax seeds were ground into coarse powder using electric grinder.

### Formulation of beetroot powder (BRP) incorporated snack bar

For the preparation of BRP incorporated snack bar BRP (15 g), bengal gram powder (16.5 g), flax seed powder (16.5 g) and honey (36 g) were well mixed with roasted sesame seeds (8 g), coconut chips (5 g) and roasted peanuts (3 g). Thereafter, well mixed mixture was placed and spread uniformly using rolling pin on aluminum tray and snack bar weighing approximately 50 g was cut out with the help of mould measuring 9×3×1.5 $cm^3$ size. Control snack bar was also prepared in the same way by adding 24 g of bengal gram powder and flax seed powder each while the quantity of other ingredients was same except BRP. Both the control and BRP incorporated snack bars were then packed in High Density Polyethylene bags (HDPE) using sealer machine.

### Shelf life of control bar and BRP incorporated snack bar

For assessing the shelf life, control bar and BRP incorporated snack bar were kept in clean HDPE bags at refrigeration (5ºC**)** and ambient temperature (15-35 ºC) for 90 days and were studied on successive period of 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage for various parameters *viz*; sensory quality, moisture, free fatty acid (FFA) content, total plate count (TPC) and yeast and mould count.

Snack bars were evaluated for their sensory quality by a semi-trained panel of 15 members from the department of Foods and Nutrition, G.B.P.U.A.T., Pantnagar. Various sensory parameters namely; taste, color and appearance, texture, after taste and overall acceptability were studied using Nine-point Hedonic scale, ranging from like extremely=9 to dislike extremely=1 (Amerine *et al*., 1965) [9]. Moisture and Free Fatty Acid (FFA) content were analyzed as per the standard method of AOAC (2000) [10]. Microbiological parameters like: TPC, yeast and mould count were studied as per the method of APHA (1992) [11].

### Statistical analysis

Statistical analysis was performed using WASP (Web Agri Stat Package) version 1, developed by ICAR-CCARI, Goa, India. For sensory evaluation observations of fifteen panel members were taken and analyzed using one way ANOVA. Data pertaining to moisture and FFA content were analyzed using three factor factorial experiment at $p< 0.05$ level of significance.

## Results and discussion

### Effect of storage on various sensory parameters of control bar and BRP incorporated snack bar

Changes in the mean sensory scores of stored bars for various sensory parameters have been presented in Table 1. Results revealed that sensory quality of both the snack bars declined with the advancement of storage period from 0 to 90 days. However, BRP incorporated snack bar showed higher mean sensory scores as compared to control snack bar, at both storage conditions; ambient (15-35 ºC) and refrigeration temperature (5 ºC). Both the snack bars at the refrigeration temperature (5 ºC) showed comparatively less reduction in mean sensory scores as compared to the snack bars stored at ambient temperature (15-35 ºC) which suggests refrigeration storage as more favorable condition. The most adversely affected sensory parameters were taste and after taste.

**Table 1:** Effect of storage on the sensory parameters of control snack bar and beetroot powder (BRP) incorporated snack bar

| Bar | Storage Temperature | Storage days | Taste | Color & appearance | Texture | After taste | Over all acceptability |
|---|---|---|---|---|---|---|---|
| Control bar | Ambient Temperature (15-35 ºC) | 0 | 7.60±0.47$^{a}$ | 7.39±0.40$^{ab}$ | 7.42±0.51$^{a}$ | 7.64±0.65$^{a}$ | 7.56±0.65$^{a}$ |
| | | 30 | 7.26±0.37$^{bcd}$ | 7.39±0.40$^{ab}$ | 7.38±0.62$^{ab}$ | 7.14±0.22$^{b}$ | 7.25±0.35$^{abcd}$ |
| | | 60 | 7.0±0.30$^{de}$ | 7.33±0.44$^{b}$ | 7.25±0.34$^{abc}$ | 6.60±0.43$^{c}$ | 7.10±0.26$^{cde}$ |
| | | 90 | 6.07±0.23$^{f}$ | 7.32±0.43 | 7.18±0.28$^{abcd}$ | 5.93±0.41$^{d}$ | 6.78±0.48$^{e}$ |
| | Refrigeration Temperature (5ºC) | 0 | 7.60±0.47$^{a}$ | 7.39±0.40$^{ab}$ | 7.42±0.51$^{a}$ | 7.64±0.65$^{a}$ | 7.56±0.65$^{a}$ |
| | | 30 | 7.42±0.48$^{abc}$ | 7.39±0.40$^{ab}$ | 7.15±0.53$^{abcde}$ | 7.26±0.44$^{b}$ | 7.38±0.62$^{abc}$ |
| | | 60 | 7.20±0.31$^{cd}$ | 7.37±0.43$^{ab}$ | 7.08±0.55$^{cde}$ | 6.60±0.22$^{c}$ | 7.27±0.36$^{abcd}$ |
| | | 90 | 6.83±0.44$^{e}$ | 7.35±0.42$^{b}$ | 6.96±0.35$^{cde}$ | 6.0±0.33$^{d}$ | 7.0±0.30$^{de}$ |
| BRP incorporated bar | Ambient Temperature (15-35 ºC) | 0 | 7.66±0.48$^{a}$ | 7.56±0.44$^{a}$ | 7.25±0.49$^{abc}$ | 6.16±0.48$^{d}$ | 7.50±0.59$^{ab}$ |
| | | 30 | 7.43±0.49$^{abc}$ | 7.46±0.44$^{ab}$ | 7.14±0.28$^{abcde}$ | 6.10±0.43$^{d}$ | 7.35±0.29$^{abc}$ |
| | | 60 | 7.20±0.31$^{cd}$ | 7.46±0.44$^{ab}$ | 7.08±0.30$^{cde}$ | 6.03±0.39$^{d}$ | 7.20±0.31$^{bcd}$ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 90 | 7.03±0.29$^{de}$ | 7.40±0.43$^{ab}$ | 7.10±0.26$^{bcde}$ | 6.0±0.46$^{d}$ | 7.13±0.27$^{cd}$ |
| | Refrigeration Temperature (5ºC) | 0 | 7.66±0.48$^{a}$ | 7.56±0.44$^{a}$ | 7.25±0.49$^{abc}$ | 6.16±0.48$^{d}$ | 7.50±0.59$^{ab}$ |
| | | 30 | 7.50±0.46$^{ab}$ | 7.46±0.42$^{ab}$ | 7.08±0.43$^{cde}$ | 6.13±0.44$^{d}$ | 7.42±0.48$^{abc}$ |
| | | 60 | 7.38±0.45$^{abc}$ | 7.46±0.42$^{ab}$ | 6.90±0.43$^{de}$ | 6.10±0.21$^{d}$ | 7.38±0.62$^{abc}$ |
| | | 90 | 7.18±0.28$^{cd}$ | 7.46±0.42$^{ab}$ | 6.86±0.39$^{e}$ | 6.08±0.26$^{d}$ | 7.29±0.38$^{abcd}$ |

All values are mean of fifteen observations± standard deviation
Means having different superscripts differ significantly in each column ($p$<0.05)

In case of control snack bar slight rancid flavor was observed which indicates lipid peroxidation during storage. Similarly, undesirable taste and after taste were also found in BRP incorporated snack bar upon storage which could be due to the occurrence of several physicochemical reactions accelerated by chemically heterogeneous environment (Kou *et al*., 2002) [12]. Undesirable changes in color and appearance were also observed during storage. Color of BRP incorporated snack bar turned into slightly brown during storage which may be suggestive of lower stability of betacyanin pigment responsible for red color in beetroot. Maity *et al*. (2016) [13] in a similar study reported degradation in color, appearance and taste of intermediate moisture compressed beetroot bar after 6 months of storage.

**Effect of storage on moisture, free fatty acid (FFA) content and microbiological profile of snack bars**

During storage period moisture content of both the snack bars increased. BRP incorporated snack bar showed higher moisture values at both, refrigeration (5 ºC) and ambient temperature (15-35 ºC) as compared to control snack bar. Increase in moisture content might be the result of absorption of minute quantity of moisture from the environment by the stored bars. Similar results of increased moisture content have been reported for composite cereal bar during 9 months of storage and for apricot bar during 6 months of storage (Padmashree *et al*., 2012; Sharma *et al*., 2013) [4, 14].

An increase in the FFA content was also observed during storage (Table 2). FFA values of control snack bar at both the storage conditions were higher than BRP incorporated snack bar. Moisture, fat content of product and relative humidity during storage are positively correlated with lipid auto-oxidation and formation of hydroperoxides (Thakur and Arya, 1990) [15] which may be the primary reasons for increased FFA content in control snack bar. Comparatively lower FFA values were observed in BRP incorporated snack bars which are possibly due to the antioxidant properties of inherent phytochemicals present in beetroot. Ranawana *et al*. (2018) [16] prepared cakes with beetroot and chocolate separately and in combination as well and reported that addition of beetroot alone was very effective in improving the oxidative stability and shelf life of cakes.

**Table 2:** Effect of storage on the moisture, FFA, total plate count and yeast and mould count of control snack bar and beetroot powder (BRP) incorporated snack bar

| Bar | Storage Temperature | Storage days | Moisture | FFA | Total Plate Count ($log_{10}$cfu $ml^{-1}$) | Yeast and mold ($log_{10}$cfu $ml^{-1}$) |
|---|---|---|---|---|---|---|
| Control bar | Ambient Temperature (15-35 ºC) | 0 | 8.0±0.0$^{h}$ | 0.15±0.01$^{hi}$ | <1 | <1 |
| | | 30 | 8.50±0.0$^{g}$ | 0.19± 0.02$^{efg}$ | <1 | <1 |
| | | 60 | 9.50±0.0$^{f}$ | 0.25±0.02$^{abc}$ | <1 | <1 |
| | | 90 | 10.50±0.0$^{d}$ | 0.28±0.02$^{a}$ | <1 | <1 |
| | Refrigeration Temperature (5 ºC) | 0 | 8.0 ±0.0$^{h}$ | 0.15±0.01$^{hi}$ | <1 | <1 |
| | | 30 | 10.0±0.01$^{e}$ | 0.17±0.02$^{fgh}$ | <1 | <1 |
| | | 60 | 10.5±0.0$^{d}$ | 0.20±0.02$^{def}$ | <1 | <1 |
| | | 90 | 11.0±0.0$^{c}$ | 0.24±0.02$^{bc}$ | <1 | <1 |
| BRP incorporated bar | Ambient Temperature (15-35 ºC) | 0 | 8.50±0.0$^{g}$ | 0.12±0.01$^{i}$ | <1 | <1 |
| | | 30 | 9.50±0.0$^{f}$ | 0.16±0.03$^{gh}$ | <1 | <1 |
| | | 60 | 10.5±0.0$^{d}$ | 0.23±0.01$^{bcd}$ | <1 | <1 |
| | | 90 | 11.5±0.0$^{b}$ | 0.26±0.03$^{ab}$ | <1 | <1 |
| | Refrigeration Temperature (5 ºC) | 0 | 8.50±0.0$^{g}$ | 0.12±0.01$^{i}$ | <1 | <1 |
| | | 30 | 10.50±0.0$^{d}$ | 0.15±0.01$^{hi}$ | <1 | <1 |
| | | 60 | 11.50±0.0$^{b}$ | 0.19±0.02$^{efg}$ | <1 | <1 |
| | | 90 | 13.50±0.0$^{a}$ | 0.22±0.0$^{cde}$ | <1 | <1 |

All values are mean of triplicate observations± standard deviation
Means having different superscripts differ significantly in each column ($p$<0.05)

In the present study, results pertaining to FFA content suggest that refrigeration temperature should be preferred over ambient one for the storage of snack bars. Mridula *et al*. (2013) [17] in their study formulated flax seed energy bar and stored it for 90 days which also resulted in increased FFA values with decrease in omega-3 fatty acid content.

Microbiological profile showed that total plate count (TPC) and yeast and mould count increased throughout the storage period (Table 2) however, it was within the acceptable range of total bacterial count of 4.7 $log_{10}$ cfu $ml^{-1}$ (Deshpande *et al*., 2004) [18]. Microbiological stability of both the snack bars could be attributed to incorporation of high amount of honey (36 g) because of its antibacterial and antifungal properties (Olaitan *et al*., 2007; Kumar *et al*., 2010) [19, 20].

**Conclusion**

The results of the present study revealed that snack bar prepared with 15 g of beetroot powder exhibited more stability against degradation (sensory attributes, FFA content and microbial count) at both the storage conditions (refrigeration temperature 5 ºC and ambient temperature 15-35 ºC) for 3 months, when compared with control snack bar. Being rich in antioxidant property due to higher content of betalains, beetroot may be used in preparation of various other nutritious snack foods to increase their shelf life.

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