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RESEARCH NOTE

Energy Bars made with Popped with Amranth

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ABSTRACT

The aim of this study was to develop energy bars by incorporating popped amaranth seeds. The control was prepared using puffed rice whereas the other bars were formulated with puffed rice and popped amaranth in different proportions (65%:35%, 45%:55%, 25%:75%). The samples were subjected to proximate analysis, mineral analysis, microbial analysis, and sensory evaluation and shelf-life studies. It was revealed that as the proportion of amaranth increased in the samples, the protein, crude fiber, iron, and phosphorus and calcium contents increased whereas the fat and carbohydrate contents decreased. Microbial analysis showed that the microbial load was within the acceptable limits for a period of 3 months. Based on the sensory evaluation, the sample with 55% popped amaranth was the best.

Keywords: amaranth, dates, energy bar, nutritional quality, sensory evaluation.

The food bars are snacks of good sensory and nutritional characteristics due to their high carbohydrates, proteins, lipids, and mineral contents. Children need nutritious foods due to their enhanced body development requirements (Padmashree *et al*. 2012). Food consumed by them should be rich in vitamins, minerals and balanced with respect to major nutrients like carbohydrates, proteins and fats. The products that are developed by utilizing dried fruit, processed legumes, and cereals along with nuts would be an attractive snack food for the school going children and for those people working outside their homes are becoming more dependent on snacks for the supply of a part of their daily nutritional requirements (Maning *et al*. 2002).

Energy bars are supplemental bars containing cereals and other high energy foods targeted at the people who require quick energy but do not have time for a meal. They are different from energy drinks, which contain caffeine whereas bars provide food energy. Energy is obtained from three main sources that is fat, protein, and carbohydrates present in foods. A typical energy bar weighs between 45 and 80 g and is likely to supply about 200–300 Cal (840–1,300 kJ), 3–9 g of fat, 7–15 g of protein, and 20–40 g of carbohydrates (Mridula *et al*., 2011). In order to provide instant energy most of the carbohydrates are made available in the form of various types of sugars like fructose, glucose, maltodextrin in different ratios. Fats in energy bars are kept to minimum level and their main sources are often cocoa butter and dark chocolate.

Amaranth classified as cereal grown for its edible starchy seeds like cereals, but it is not from the same family as cereals such as wheat and rice. Raw amaranth grain is inedible to humans and cannot be digested because it blocks the absorption of nutrients. Thus it has to be prepared and cooked like other grains. About 100 gram of cooked amaranth provides 103 Calories and is moderately–rich source of dietary minerals, including phosphorus and manganese (Corke *et al*. 1998). Amaranth grain is high in protein and lysine, an amino acid found in low quantities in other grains. Amaranth grain is free of gluten, which makes it a viable grain for people with gluten intolerance (Escobar *et al*. 1994) and which is good for those who suffer from Celiac disease. Prevalence of this disease has increased dramatically in recent years, partly explained by improved detection and testing techniques, but also due to a general change in dietary tolerances due to a wide range of environmental and dietary factors (Hegazy *et al*. 2009). Amaranth is a good source of a number of essential vitamins and minerals that are required for good health, including B vitamins, calcium, iron and zinc (Bavec *et al.* 2009 (b)). Amaranth grain can also be germinated for sprouts and malted for beer production (traditional beer *chicha* in Peru), and fermented (as compound for *ogi* – traditional product of lactic fermentation of cereal porridges in Africa, or could be used instead of soy in shoyu). It can serve as a starchy material in spirit production and from the grain or green material, protein concentrates and flours can be produced (Bavec *et al*. 2009 (a)). The phytosterols found in amaranth grain have been associated with cholesterol lowering effect, while the significant levels of dietary fiber contribute to lowering the chances of developing atherosclerosis and subsequently, heart attack or stroke (Faber *et al*. 2015).

Date fruits have enormous scope and potential for use as food because of their nutritional and economical value. Date fruit is a key food security resource in the arid lands that require intensive efforts for valorization (Al-Alawi *et al*. 2017). There is a large potential to especially develop healthy food products utilizing the high value fiber and phenolic antioxidants, iron found in the fruit flesh and seeds. The significant amounts of minerals found in dates make them a super food (Hogan *et al*. 2012). The high level of iron in dates balances out the inherent lack of iron in anemic patients, increasing energy and strength while decreasing feelings of fatigue and sluggishness (Jan *et al*. 2012). Quality and price are key factors for the development of a competitive product. To achieve this objective, economical under-utilized but abundantly produced food sources with good nutritional value such as dates and amaranth were explored for preparation of energy bars with varying proportions of puffed rice and popped amaranth.

MATERIALS AND METHODS

Ingredients

Different ingredients used in the study included puffed rice, amaranth seeds, dates, honey, jaggery, almonds and sesame seeds which were procured from the local market.

The energy bars of different treatments were formulated as detailed in table 1.

Table 1: Formulation of energy bars

Sample	Puffed rice (%)	Popped amaranth (%)
Control sample (C)	100	0
Sample 1 (S_1)	65	35
Sample 2 (S_2)	45	55
Sample 3 (S_3)	25	75

Preparation of Energy bars

The energy bars were prepared as per the following flow diagram:

All the ingredients were collected.

↓

Almonds and dates were combined in a food processor. Pulsed a few times just to break them up. Processed continuously for 30 seconds.

↓

Amaranth seeds were popped in a pan and combined with the other dry ingredients.

↓

Jaggery was added to a wide deep bottomed pan and heated it on a very low heat, till it melted completely. To test if the Jaggery is caramelized, we dropped a little of the melted Jaggery into ice-cold water. When it turned hard and brittle, it is removed from the flame.

↓

Dry ingredient mixture and honey were added to Jaggery in the pan and mixed well till they blended together. The mixture was continuously stirred to prevent any burning.

↓

Continuously processed for another 1 to 2 minutes until the ingredients clumped together and gathered into a ball.

↓

Then we laid a piece of plastic wrap or parchment paper on work surface and dumped the ball on top. Pressed until it formed a thick square. Sesame seeds were put on the top. Wrapped and allowed it to cool for at least an hour.

↓

Then unwrapped the cooled mixture and transferred it to a cutting board and cutted into bars.

↓

The bars were stored in polyethylene zip lock pouches at room temperature.

Physico-chemical, microbial and sensory analysis of products

The samples were evaluated for moisture, ash, fat, crude fiber, protein, carbohydrates, energy and minerals (calcium, phosphorus and iron) content by AOAC (2005) method. The samples were subjected to microbial analysis - Total Plate Count test (IS 5402: 2012) and fungal count test (IS 5403: 1999). They were also subjected to sensory evaluation -hedonic rating test (Ranganna, 2001) by using a panel of 20 semi-trained panel members. Ranking test (Ranganna, 2001) was also conducted when panelists were presented with samples which were coded and were asked to rank the samples according to their taste preference.

RESULTS AND DISCUSSION

Proximate analysis of the energy bars

It is seen from table 2 that moisture content of samples ranged between 10.23 % (Control) to 12.31% (S_3). The protein content increased as the proportion of popped amaranth increased and was maximum for S3 with 15%, whereas the fat content decreased.

Table 2: Proximate analysis of energy bars

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fiber (%)	Carbohydrates (%)	Energy (kcal)
Control C	10.23	2.42	7.1	7.4	5.93	66.92	362.68
Sample 1 S_1	10.72	2.86	10.3	7.2	6.58	62.34	355.36
Sample 2 S_2	11.13	3.23	12.7	6.9	7.76	58.28	346.02
Sample 3 S_3	12.31	3.41	15	6.3	8.46	54.52	334.78

Crude fiber content increased as popped amaranth proportion increased and was high in S3 8.46%. Carbohydrates percentage decreased eventually from C to S3. Similar observations were reported by Mridula *et al*. (2011) in their study. They prepared energy bars with different levels of flaxseed (0–20%) in addition to cereals and pulses with varying levels of sweeteners (45, 50, and 55%) along with a control sample. The total calories obtained from the energy bar showed a significant increase with the increasing levels of flaxseed, the maximum (397.95 kcal) being for bars with 20% flaxseed and 45% sweeteners. These energy bar samples contained maximum protein (12.41%), crude fat (11.86%), ash (1.65%), iron (3.77 mg/100 g) and crude fiber (2.18%). Munhoz *et al*., (2014) prepared two formulations of cereal bars containing pulp and kernel of bocaiuva. Cereal bars presented on average, in g 100 g^{-1}, 4.83 moisture, 8.01 protein, 12.93 lipids, 1.30 ash, 53.75 total carbohydrate, 19.78 fiber and 363.41 kcal 100 g^{-1} total caloric value. Bhat *et al*., (2014) formulated and prepared fortified cookies using the amaranth grain, oats and refined wheat flour. From their nutritional analysis, it was observed that the cookies were a good source of protein, carbohydrates, and dietary fiber and hence a potential source of energy. A study has been conducted by Silva *et al*. (2016) in which they incorporated jeriva flour into the formulation

Table 3: Mineral analysis of energy bars

Minerals (mg/100g)	Control (C)	Sample 1 (S_1)	Sample 2 (S_2)	Sample 3 (S_3)	RDA values given by ICMR
Iron	5.52	5.73	5.85	5.97	5-35 mg/day
Phosphorus	123.9	216.09	268.77	321.45	500-1200 mg/day
Calcium	182.68	211.45	227.89	244.33	500-1200 mg/day

by partial substitution of the standard ingredients of snack bars. The presence of increasing amounts (up to 20%) of jeriva fruit flour resulted in a significantly increased protein (7.12%) and 6.66% of dietary fiber. Ho *et al*. (2016) made the snack bar using banana, glutinous rice flour, and coconut milk. The developed snack bar containing 13.23% of moisture, 1.13% of ash, 6.36% of protein, 22.39% of fat, 1.16% of crude fibre, 56.89% of total carbohydrate, and 454.51 kcal of energy.

Mineral analysis of the energy bars

It is evident from table 3 that as the proportion of popped amaranth increased, the content of minerals increased from Control to Sample 3. The iron content ranged between 5.52 to 5.97 mg/100g, phosphorus content from 123.9 to 321.45 mg/100g and calcium content from 182.68 to 244.33 mg/100g. The increase in the minerals is desirable because the prepared energy bars cover a major proportion of Recommended Daily Allowance (RDA) mineral requirements given by ICMR. Similar observations were made by Munhoz *et al*. (2014) and Faber *et al.* (2015)in their studies that is increase in minerals such as phosphorus, iron and manganese

Microbial analysis of the energy bars

Table 4: Microbial analysis of energy bars

Sample	Total Plate Count (TPC) (CFU/g)	Fungal count (CFU/g)
Control	1.2×10^2	Nil
S_1	1.7×10^2	Nil
S_2	1.8×10^2	Nil
S_3	1.3×10^2	Nil

From table 4 it is observed that the fungal count was very much within the standard limits (100 cfu/g for cereal products) according to standards set by the Food Safety and Standard Authority of India Act, 2006. The TPC count was within the safe limit (5000 cfu/g for cereal products), according to standards set by the Food Safety and Standard Authority of India Act, 2006. Microbial load was within the limits for a period of 3 months. Studies conducted by Munhoz *et al.* (2014) revealed similar observations in their products.

Sensory evaluation

Results given in table 5 revealed that all the products prepared by incorporating popped amaranth at different levels were acceptable. Among the different samples, sample 2 and 3 were found to be highly acceptable by both the hedonic rating test and the ranking test. Similarly, Mridula *et al*., (2011) prepared energy bars with different levels of flaxseed (0–20%) in addition to cereals and pulses with varying levels of sweeteners (45, 50, and 55%) along with the control sample. The overall mean sensory scores for overall acceptability for samples with 10% flaxseed and 55% sweeteners and 15% flaxseed and 45% sweeteners were at par with each Munhoz *et al*. (2014) prepared two formulations of cereal bars containing pulp and kernel of bocaiuva. In sensory analysis of all the bars showed that they were acceptable for consumption. Silva *et al*. (2016) incorporated jeriva flour into the formulation by partial substitution of the standard ingredients of snack bars. The presence of increasing amounts (up to 20%) of jeriva fruit flour resulted in sensory acceptable snack bars, without significant differences among the formulations. Ho *et al*. (2016) made the snack bar using banana, glutinous rice flour, and coconut milk. The "energy" snack bar was highly acceptable with desirable sensory quality

Table 5: Sensory evaluation of energy bars (hedonic test)

Sample	Appearance	Colour	Aroma	Texture	Chewiness	Taste	Overall acceptability
Control	7.7 ± 0.36	8 ± 0.52	7.2 ± 1.43	6.7 ± 0.73	7.6 ± 1.0	8 ± 0.23	7.07 ± 0.5
S_1	7.6 ± 1.21	8.1 ± 0.55	7.3 ± 0.27	7.5 ± 0.56	7.3 ± 0.54	8.05 ± 0.3	8.5 ± 0.27
S_2	7.8 ± 1.02	8.05 ± 0.36	7.17 ± 1.3	8.4 ± 0.3	7.2 ± 0.2	8.3 ± 0.4	8.8 ± 0.51
S_3	8 ± 0.47	8.2 ± 0.43	7.23 ± 0.3	8.1 ± 1.01	7.4 ± 0.2	8.1 ± 0.53	8.6 ± 0.32

by all consumers. Bower *et al*. (2000) prepared cereal bar snack foods which included chocolate. In the sensory analysis majority of the consumers ranked taste as the most important characteristic influencing their purchase intent, followed by textural features, price and appearance. It showed that the sensory aromas and flavours having a great influence on consumer acceptance. Ayo (2007) reported that different levels of amaranth grain flour at 0 to 50% (w/w) were mixed with the wheat flour and other ingredients, fermented, molded, pan-proved and baked. The baked products were evaluated for sensory qualities and compared with bread made from 100% wheat flour. The sensory mean scores of the odor, taste, colour and texture decreased. Samples containing, above 15% (w/w) amaranth grain flour were significantly different ($p \leq 0.05$) in the evaluated sensory qualities and the product were unacceptable. All the above studies showed that the energy bars prepared were fairly accepted by the people.

Shelf-life studies

Shelf-life studies were conducted for a period of 3 months and the samples were kept in zip lock pouch bags (polyethylene) at room temperature. Studies included analyzing the effect of storage period on moisture content of energy bars and microbial analysis of energy bars every month. It was evident that, there was a slight increase in the moisture content and TPC increased slightly every month and fungal growth was seen after a period of 60 days, but the count was within the safety limits. So, the recommended shelf-life for the developed energy bars would not be more than 3 months. Similarly, Farajzadeh *et al*. (2011) formulated and experimentally produced energy bars for emergency conditions such as patrol, cold weather and heights.

CONCLUSION

It can be concluded from the study that all the products in which popped amaranth was incorporated were acceptable and sample with 55 per cent popped amaranth was rated the best by sensory tests. The results revealed that the protein, crude fiber, iron, phosphorus and calcium content in the samples increased as the proportion of popped amaranth increased whereas the fat and carbohydrate content decreased. Results of shelf-life studies concluded that and the samples were acceptable for a period of the 3 months and microbial load of all was within the permissible limits. Thus, amaranth could be successfully used to enrich energy bars by giving alternative utilization opportunity for producers and a healthy choice option for the consumers.

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