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Sensorial, Nutritional and Shelf Life Evaluation of Bio-fortified Millet based Cookies Supplemented with Carrot Powder and Sesame

Tanvi Bansal, Asha Kawatra, Veenu Sangwan

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ABSTRACT

Background: Micronutrient deficiency forms an important global health issue, leading to poor mental and physical development in children, predisposing deficient people to various diseases and losses in potential and productivity. To curb this form of malnutrition, fortification of foods via agronomic practices and manually can prove to be useful.

Methods: Bio-fortified pearl millets were used for the development of nutrient-dense cookies, that were enriched with micronutrients. Cookies were prepared in eight variations employing both varieties of pearl millets, separately. First, control-without carrot powder and sesame; Type 1, Type 2 and Type 3 products contained 20%, 30% and 40% carrot powder, respectively along with 20% sesame. The cookies were evaluated for their organoleptic attributes, nutritional composition and shelf life.

Result: Cookies were found highly acceptable for organoleptic scores. The nutritional parameters were found to be ranging between 5.26-6.17, 7.89-12.65, 23.31-27.61, 1.37-2.81 and 1.18-1.87 per cent for moisture, crude protein, crude fat, ash and crude fiber, respectively. Similarly 64.11-345.76, 7.05-8.98 and 2.77-3.95 mg/100 g for calcium, iron, and zinc, respectively, whereas β-carotene was evaluated varying from 13.27 to 583.01 µg/100 g for control and Type 2 cookies. The cookies contribute multiple macro and micro nutrients and also have a shelf life of two months when stored in air-tight containers with suitable ambient conditions.

Key words: Bio-fortification, Carrot, Millets, Nutritional composition, Sesame, Sensory evaluation, Shelf life.

INTRODUCTION

Malnutrition is a major setback for every country. Undernourishment can arise due to hunger and micronutrient deficiencies, which is defined as energy intakes below the minimum requirement to maintain health and shortage of essential minerals and vitamins that are needed by the body in small amounts but mandatory for proper growth and development, respectively. Nearly one in three people around the world has at least one form of malnutrition (WHO, 2019).

Pearl millet is known to have protein, essential fatty acids, dietary fiber, minerals such as calcium, iron and zinc, copper and magnesium, vitamins E and B-complex, therefore, termed as “Nutri-cereal” because of multiple nutritional benefits. It additionally possesses phyto-chemicals that lower cholesterol and has high energy content compared to other millets (Rao *et al*., 2017). For increasing the consumption of pearl millet, a variety of foods like biscuits, instant mixes, extruded products, *etc*. can be made employing the new prevailing food technologies.

Bio-fortification differs from conventional fortification and it is the practice by which the nutritional quality of food crops is improved through conventional plant breeding, agronomic practices, or modern biotechnology. Therefore, bio-fortification may, prove to be useful in reaching areas and populations where conventional fortification or supplementation activities are limited or difficult to be implemented (WHO, 2019). Bio-fortified crops could turn out to be an essential strategy for fighting micronutrient deficiencies in developing nations, which have noteworthy high rates of malnutrition (Bouis, 2011).

Department of Foods and Nutrition, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125 004, Haryana, India.

Corresponding Author: Tanvi Bansal, Department of Foods and Nutrition, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125 004, Haryana, India. Email: tnvbnsl@gmail.com

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Carrot is one of the important root vegetables rich in dietary fiber and carotenoids with considerable amounts of various other functional components having major health-promoting characteristics. Apart from carrot roots being historically used in salad and preparation of curries, these could commercially be converted into processed powders that can be incorporated into various food products.

Sesame seeds are important sources of dietary protein with high-quality amino acids that are essential for the growth and maintenance of body tissues. It is a primary source of phytonutrients such as antioxidants, omega-6 fatty acids, flavonoids, vitamins and dietary fiber with potential anti-cancerous as well as health-promoting benefits.

Food enrichment refers to improvement in the nutritional quality of food by adding the nutrients that the food product is lacking. Poor dietary quality is more often characterized

by micronutrient deficiencies or reduced mineral bioavailability, than by insufficient energy intake (Murgia *et al.*, 2012). Therefore, keeping all this into consideration, the current work has been done to formulate cookies by employing two bio-fortified varieties of pearl millet, with their further enrichment with micronutrients using carrot powder and sesame. Carrot and sesame in concentrated form can be used to fill the nutrient gap that is otherwise not being met by the individual's intake of food and may become a part of a healthy diet.

MATERIALS AND METHODS

The study was carried out during the period of December 2017 to May 2018 and was conducted in the premises of I.C. College of Home Science, Department of Foods and Nutrition, CCS HAU, Hisar-125 004.

Procurement of material

The bio-fortified variety of pearl millet HHB-299 and *Dhanshakti* was procured from the Bajra Section, Department of Genetics and Plant Breeding, College of Agriculture, CCS Haryana Agricultural University, Hisar. Carrots, sesame and other ingredients were procured from the local market in a single lot.

Processing of pearl millet

Both the bio-fortified varieties of pearl millet were blanched by the process of Chavan and Kachare (1994).

Preparation of carrot powder

Fresh carrots were washed, followed by peeling, slicing, drying and conversion into a fine powder. Mechanical dehydrator (tray dryer) was used for dehydrating the carrots.

Preparation of sesame seed powder

Sesame seeds were cleaned of dust. The cleaned sesame was dried, roasted and ground into a fine powder.

Preparation of sweet and salty cookies

The sweet and salty cookies were based on bio-fortified pearl millet and were enriched with micronutrients using carrot powder and sesame. Variants of cookies were prepared employing both the bio-fortified varieties of pearl millet (*i.e.,* HHB-299 and *Dhanshakti*) separately. The cookies were prepared in four combinations incorporating carrot powder (CP) at three different levels (Fig 2). Standard recipe was followed for preparing and baking the cookies.

- Control- pearl millet flour (PMF) 50 g; Wheat flour (WF) 50 g.
- Type 1- PMF 30 g; WF 30 g; Sesame 20 g; CP 20 g.
- Type 2- PMF 25 g; WF 25 g; Sesame 20 g; CP 30 g.
- Type 3- PMF 20 g; WF 20 g; Sesame 20 g; CP 40 g.

Organoleptic evaluation

The developed sweet and salty cookies were evaluated for their organoleptic attributes regarding co lor, appearance, aroma, texture, taste and overall acceptability (OA) scores based on 9-point Hedonic scale using a semi-trained sensory panel consisting of 10 judges drawn from I.C. College of Home Science at CCS Haryana Agricultural University, Hisar, India. Organoleptic evaluation was done at room temperature.

Nutritional analysis

Cookies with the highest organoleptic scores were analyzed for their nutritional parameters. The selected samples of cookies were taken in triplicates in dried and ground form for their nutrient estimation. The samples were analyzed for Moisture (oven dry method), crude protein (on the basis of nitrogen content), crude fat (soxhlet method using petroleum ether), Ash (using muffle furnace) and crude fibre (acid and alkali treatment using fibra plus) by the standard analytical procedures as per AOAC, (2000). Total minerals were estimated by digesting the samples using diacid mixture (HNO_3:$HClO_4$: 5:1, v/v). Calcium, iron and zinc in acid digested samples were determined by Atomic Absorption

Fig 1: Grains of bio-fortified varieties pearl millet.

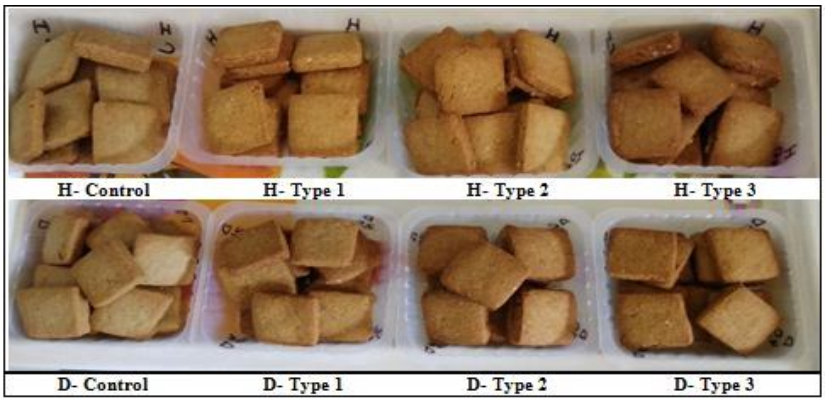


Fig 2: Enriched sweet and salty cookies.

Spectrophotometer AABQ-20 according to the method of Lindsey and Norwell (1969). β-Carotene was estimated by the spectrophotometric method of AOAC (2000), which involved sample dispersion in water saturated n-butanol.

Shelf-life evaluation

The cookies were stored for two months in air-tight low-density polyethylene (LDPE) bags at room temperature. The cookies were evaluated for their organoleptic attributes at regular intervals of 0, 15, 30, 45 and 60 days, using 9 point hedonic scale by a panel of ten judges.

Data analysis

All the data obtained from organoleptic evaluation and nutritional analysis was statistically analyzed, using mean, standard error and ANNOVA according to the standard method of Sheoran and Pannu (1999). Three replicates were used for experiments.

RESULTS AND DISCUSSION

Organoleptic evaluation

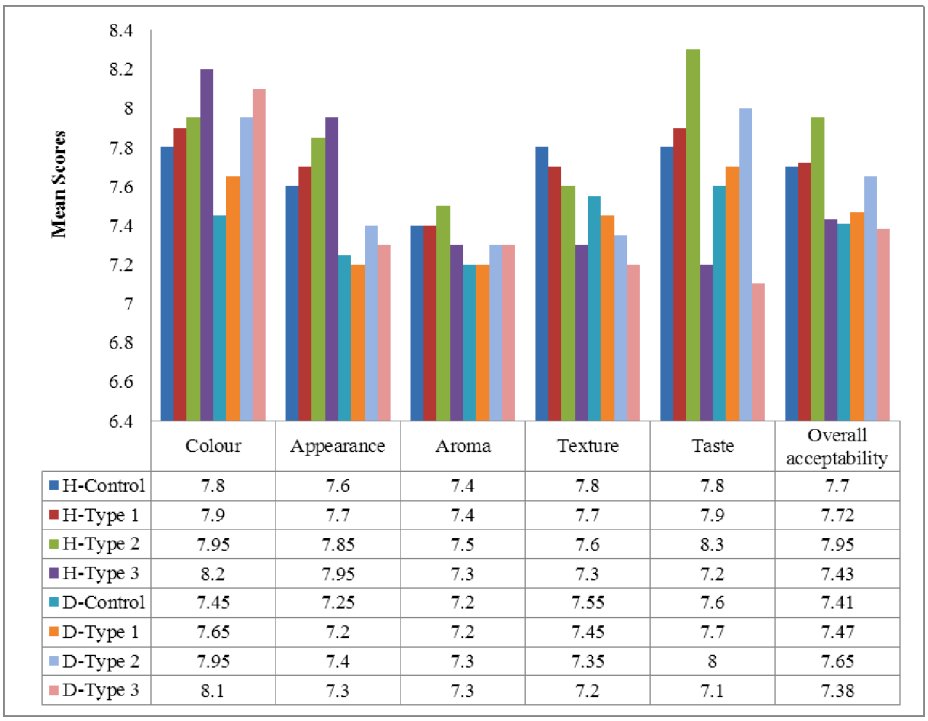
All the cookies were found to be organoleptically acceptable being in the 'liked moderately' category. The overall acceptability scores for all the variants of cookies ranged between 7.38 and 7.95. Mean scores of color and appearance improved with the incremental addition of carrot powder and sesame, ranging from 7.45 to 8.20 and 7.00 to 8.05, respectively whereas scores for aroma and texture were almost similar for all kinds of cookies. Taste of Type 2 cookies was 'liked very much' for both the varieties whereas all other variants of cookies were 'liked moderately'. Overall acceptability of all the cookies was in the 'liked moderately' category (Fig 3). Results were almost similar for both varieties of pearl millet. Likewise, Kulthe *et al*. (2018) prepared cookies from different varieties of pearl millet and found better results for *Dhanshakti* variety in comparison to *Shanti* and Pioneer 86M64 varieties for sensory and nutritional properties both. Previously, sweet biscuits prepared by Rani (2017) also yielded acceptable results for sensory evaluation and were 'moderately liked' by the panel of judges. In a similar study, sweet biscuits and sweet and salty biscuits were developed with a combination of refined pearl millet (blanched), wheat flour and green gram in different ratios and both the biscuits were liked very much by the panelists as reported by Anu *et al*. (2007).

Nutritional evaluation of sweet and salty cookies

Type-2 cookies based on both the pearl millet varieties obtained the highest organoleptic scores amongst all the variants. Therefore, both the control and Type-2 cookies were further evaluated for their proximate composition, total minerals and β-Carotene content.

Proximate composition

Analysis revealed that there were slight variations in the values of moisture, ash and crude fiber whereas significant differences were observed in the values of crude protein



	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
H-Control	7.8	7.6	7.4	7.8	7.8	7.7
H-Type 1	7.9	7.7	7.4	7.7	7.9	7.72
H-Type 2	7.95	7.85	7.5	7.6	8.3	7.95
H-Type 3	8.2	7.95	7.3	7.3	7.2	7.43
D-Control	7.45	7.25	7.2	7.55	7.6	7.41
D-Type 1	7.65	7.2	7.2	7.45	7.7	7.47
D-Type 2	7.95	7.4	7.3	7.35	8	7.65
D-Type 3	8.1	7.3	7.3	7.2	7.1	7.38

Fig 3: Organoleptic acceptability of enriched sweet and salty cookies (Mean scores).
Values are mean±SE of ten observations. Control- without carrot powder and sesame.
Type 1, Type 2 and Type 3 contains 20%, 30% and 40% carrot powder, respectively along with 20% sesame.

and fat for all the variants of cookies (Table 1). The highest crude protein content was observed in D-Type 2 cookies (12.65%), followed by H-Type 2 (11.48%), D-Control (8.77%) and H-Control (7.89%). Values for crude protein and fat were found to be almost similar for both the control cookies and for both the enriched Type 2 cookies. Both the Type 2 cookies showed tremendously higher values for crude fat and protein than the control cookies which is supposed to be a contribution of carrot powder and sesame enrichment. Similar results were reported by Rathi *et al*. (2004) for pearl millet biscuits containing higher fat (29.60%), ash (1.75%) compared to the control sample (*i.e*. 23.36 and 0.82, respectively). As per the results given by Kulthe *et al*. (2018) moisture, ash, fat, protein and crude fibre in pearl millet biscuits were 4.68, 1.69, 25.82, 6.19 and 1.14 per cent which was nearly within the range obtained in the present study. Similar trend of increased fat (19.71%) and ash content (0.93%) of pearl millet biscuits in comparison to control biscuit sample containing fat (16.95%) and ash (0.38%) was observed by Florence *et al*. (2014).

Total minerals

As evident from Table 2, H-Type 2 cookies had the highest amount of calcium (345.76 mg/100 g), iron (8.98 mg/100 g) and zinc (3.95 mg/100 g) amongst all the variants of cookies. HHB-299 pearl millet based cookies had higher mineral content than cookies based on *Dhanshakti* pearl millet and this was observed for control and Type 2 both. Calcium content was found to be almost 5 times in the carrot and sesame enriched cookies as compared to their control counterparts. Iron content of all the variants of cookies ranged from 7.05-8.98 mg/100 g whereas zinc ranged between 2.77 to 3.95 mg/100 g. Findings of the present work were observed to be higher in contrast to results earlier given by Rani (2017) and Johari (2017) who reported calcium to be 45.35 and 53.9 mg/100 g, iron 4.09 and 3.6 mg/100 g and zinc 2.77 and 1.7 mg/100 g, respectively in the pearl millet biscuits developed by them. Kulthe *et al*. (2018) reported calcium and zinc to be 22.75 and 4.84 mg/100 g, respectively in biscuits prepared by them, which was also lower than values quoted in the present study. Differences in the mineral values might be the result of using diverse ingredients and preparation procedures by all the researchers.

β-Carotene

Data (Table 2) elucidated significant differences in both Control and Type 2 cookies with a wide range varying from 13.27 to 583.01 µg/100 g. Values for β-Carotene increased remarkably for both Type 2 cookies on enrichment with Carrot powder and sesame. β-Carotene was almost 42-44 times higher in both Type 2 cookies than their control counterparts. Amount of β-Carotene in the present study was recorded to be different than results earlier revealed by Pheabean *et al*. (2017) and Sunitha *et al*. (2017) who reported β-Carotene to be 258 and 754 µg/100 g, respectively for the biscuits developed by them, which might be the result of using different ingredients and Carrot in different amounts while preparation.

Shelf-life evaluation of sweet and salty cookies

Mean scores for color, appearance, aroma and texture did not show any significant changes during the storage period (Table 3). All the cookies were in the 'liked moderately' range for all the attributes from zero till the last day of storage. Scores for taste were in the 'liked moderately' category for both the control cookies throughout the storage period whereas taste scores for H-Type-2 and D-Type 2 cookies changed from 'liked very much' to 'liked moderately' by the end of the storage period. The mean scores for OA were at par and no significant changes were noticed. All the cookies were acceptable and were

Table 1: Proximate composition of enriched sweet and salty cookies (g/100 g, on dry matter basis).

Variety	Type of cookies	Moisture	Crude protein	Crude fat	Ash	Crude fibre
HHB-299	H-Control	5.81±0.27	7.89±0.45	24.14±0.57	2.29±0.29	1.18±0.23
	H-Type 2*	6.17±.0.36	11.48±0.28	27.61±0.27	2.81±0.29	1.43±0.68
Dhanshakti	D-Control	5.26±0.30	8.77±0.36	23.31±0.54	1.37±0.32	1.53±0.24
	D-Type 2*	5.74±0.32	12.65±0.33	26.34±0.26	1.94±0.25	1.87±0.41
CD(P≤0.05)		0.48	1.18	1.42	0.94	1.41

Values are mean±SE of three independent determinations.

*Contains 20% sesame and 30% carrot powder.

Table 2: Total mineral (mg/100 g) and β-Carotene (µg/100 g) content of enriched Sweet and salty cookies (on dry matter basis).

Variety	Type of cookies	Calcium	Iron	Zinc	β-Carotene
HHB-299	H-Control	70.19±0.33	7.85±0.24	3.18±0.22	14.06±0.38
	H-Type 2*	345.76±7.13	8.98±0.18	3.95±0.23	583.01±1.54
Dhanshakti	D-Control	64.11±0.18	7.05±0.20	2.77±0.26	13.27±0.66
	D-Type 2*	332.61±0.53	8.54±0.30	3.54±0.23	582.51±2.90
CD(P≤0.05)		13.43	0.75	0.74	3.05

Values are mean±SE of three independent determinations.

*Contains 20% sesame and 30% carrot powder.

found in 'liked moderately' range for their sensory attributes and overall acceptability by the last day of storage. Variation in results was obtained in the studies earlier conducted by other researchers. Biscuits prepared by Hooda *et al*. (2005) were found storable up to one month whereas biscuits formulated by Pandey *et al*. (2016) were storable up to three months without any significant changes in their acceptability. Shelf-life of products varies with the composition and storage requirements of the product. The cookies developed in the current study can be conveniently stored in air-tight containers at room temperature for two months and keeps well without any deterioration in its organoleptic attributes.

Table 3: Effect of storage period on organoleptic characteristics of enriched sweet and salty cookies (Mean scores).

Organoleptic characteristics cookies		Days of storage					Mean
		0	15	30	45	60	
Colour							
HHB- 299	H-Control	7.80±0.20	7.80±0.18	7.70±0.30	7.65±0.15	7.60±0.26	7.70
	H-Type 2*	7.95±0.16	7.85±0.19	7.80±0.23	7.75±0.29	7.75±0.23	7.84
Dhanshakti	D-Control	7.45±0.32	7.35±0.18	7.30±0.10	7.20±0.21	7.20±0.18	7.01
	D-Type 2*	7.95±0.42	7.80±0.20	7.65±0.13	7.60±0.18	7.50±0.19	7.20
Mean		7.55	7.55	7.49	7.38	7.27	
CD(P≤0.05) type of product-0.2483, CD(P≤0.05) day-0.2777, CD(P≤0.05) interaction-0.554							
Appearance							
HHB- 299	H-Control	7.60±0.22	7.60±0.21	7.60±0.30	7.55±0.26	7.40±0.26	7.54
	H-Type 2*	7.85±0.16	7.80±0.19	7.70±0.20	7.65±0.30	7.55±0.17	7.80
Dhanshakti	D-Control	7.25±0.32	7.20±0.21	7.15±0.10	7.10±0.13	7.10±0.17	7.16
	D-Type 2*	7.40±0.52	7.40±0.23	7.40±0.16	7.40±0.27	7.25±0.27	7.40
Mean		7.52	7.52	7.42	7.35	7.23	
CD(P≤0.05) type of product-0.2656, CD(P≤0.05) day-0.2969, CD(P≤0.05) interaction-0.593							
Aroma							
HHB- 299	H-Control	7.40±0.15	7.40±0.14	7.30±0.30	7.25±0.20	7.20±0.23	7.30
	H-Type 2*	7.50±0.16	7.50±0.16	7.50±0.22	7.35±0.21	7.25±0.21	7.44
Dhanshakti	D-Control	7.20±0.42	7.15±0.24	7.10±0.22	7.10±0.31	7.00±0.24	7.11
	D-Type 2*	7.30±0.42	7.20±0.26	7.10±0.13	7.00±0.33	7.05±0.30	7.21
Mean		7.28	7.28	7.22	7.15	7.12	
CD(P≤0.05) type of product-0.2817, CD(P≤0.05) day-0.3149, CD(P≤0.05) interaction-0.629							
Texture							
HHB- 299	H-Control	7.80±0.22	7.70±0.21	7.70±0.27	7.60±0.14	7.55±0.20	7.41
	H-Type 2*	7.60±0.22	7.60±0.16	7.50±0.22	7.45±0.22	7.30±0.25	7.50
Dhanshakti	D-Control	7.55±0.63	7.55±0.31	7.50±0.23	7.40±0.18	7.40±0.21	7.01
	D-Type 2*	7.35±0.67	7.25±0.24	7.20±0.15	7.15±0.25	7.15±0.22	7.01
Mean		7.39	7.33	7.25	7.16	7.10	
CD(P≤0.05) type of product-0.275, CD(P≤0.05) day-0.308, CD(P≤0.05) interaction-0.615							
Taste							
HHB- 299	H-Control	7.80±0.24	7.80±0.22	7.70±0.30	7.65±0.21	7.60±0.14	7.74
	H-Type 2*	8.30±0.15	8.20±0.23	8.00±0.25	7.95±0.19	7.75±0.26	8.04
Dhanshakti	D-Control	7.60±0.52	7.50±0.23	7.50±0.22	7.45±0.30	7.30±0.21	7.50
	D-Type 2*	8.00±0.84	8.00±0.16	7.90±0.16	7.75±0.24	7.60±0.34	7.85
Mean		7.83	7.80	7.75	7.65	7.51	
CD(P≤0.05) type of product-0.289, CD(P≤0.05) day-0.323, CD(P≤0.05) interaction-0.644							
Overall acceptability							
HHB- 299	H-Control	7.70±0.18	7.62±0.14	7.54±0.27	7.50±0.15	7.42±0.18	7.53
	H-Type 2*	7.95±0.15	7.87±0.10	7.78±0.19	7.63±0.19	7.55±0.13	7.72
Dhanshakti	D-Control	7.40±0.27	7.29±0.18	7.20±0.13	7.15±0.17	7.05±0.15	7.01
	D-Type 2*	7.65±0.45	7.51±0.12	7.44±0.84	7.30±0.14	7.28±0.24	7.28
Mean		7.51	7.50	7.42	7.34	7.25	
CD(P≤0.05) type of product-0.205, CD (P≤0.05) day-0.2294, CD (P≤0.05) iinteraction-0.458							

Values are mean±SE of ten independent observations.

*Type 2 contains 20% sesame and 30% carrot powder.

CONCLUSION

Nutrition is the foundation of health and thus, good nutrition is essential for all. Consumption of nutritious food maintains health, protects from illness, shortens the recovery time, and reduces the risk of morbidities and mortalities. Considering the easy availability and nutritional quality of pearl millet, carrot and sesame, various supplementary food products can be prepared to utilize its potential and enhance product quality. Thus, bio-fortified pearl millet based cookies were enriched with carrot powder and sesame which improved its taste and increased energy, protein, calcium, iron and β-carotene content. The cookies were safely storable up to two months in LDPE bags without any alterations in its organoleptic attributes. The preparation of the product is convenient and cookies being rich in micro and macronutrients both, can be suitably adopted as a mid-meal in daily routine by people of all age groups. Already existing entrepreneurs dealing in pearl millet might be spurred to utilize mineral-rich bio-fortified pearl millets replacing the traditional varieties.

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