



Optimization of Traditional Snack for Children, by Using Bio-Fortified Pearl Millet, Carrot and Sesame for Its Formulation

Tanvi Bansal^{1*} and Asha Kawatra¹

¹*Department of Foods and Nutrition, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125004, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Authors TB and AK designed the study, wrote the protocol, performed the statistical analysis and wrote the first draft of the manuscript. Author TB managed the literature searches and analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2020/12i830275

Editor(s):

(1) Dr. Rasha Mousa Ahmed Mousa, University of Jeddah, Saudi Arabia.

Reviewers:

(1) Lam Weng Hoe, Universiti Tunku Abdul Rahman, Malaysia.

(2) Yenni Okfrianti, Poltekkes Kemenkes Bengkulu, Indonesia.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/59941>

Original Research Article

Received 02 June 2020
Accepted 08 August 2020
Published 22 August 2020

ABSTRACT

Purpose: Malnutrition has been a major setback for the development of various countries for a very long time. Together with insufficient food accessibility, unawareness about making the right food choices is also one of the contributing factors to malnourishment. Meeting up the nutritional requirements is extremely important for all the age groups and this arises the need for nutrient-dense food products.

Methodology: Keeping this in view, the study was planned for the utilization of biofortified pearl millet varieties (HHB-299 and *Dhanshakti*) for formulating a traditional snack (*gulgule*), with incorporation of carrot powder and sesame. Four combinations of *gulgule* were prepared based on both the varieties of pearl millet separately. Control- Without carrot powder and sesame, Type-1, Type-2, and Type-3 contained 20%, 30 and 40% of carrot powder, respectively and 20% sesame. Organoleptic evaluation of all variants was done based on a nine-point hedonic scale. Nutritional parameters including proximate composition and total minerals were assessed for variants with highest organoleptic scores.

*Corresponding author: Email: tnvbns1@gmail.com;

Findings: All the variants were found acceptable in terms of organoleptic attributes and the highest scores were obtained for H-Type-2 *gulgule*. The nutritional composition was evaluated for Control and Type-2 variants based on both the varieties of pearl millet. The results for moisture, crude protein, crude fat, ash, and crude fiber ranged from 30.65-32.62, 8.22-13.36, 33.86-39.18, 0.59-1.63 and 1.06-2.30 percent, respectively. Total mineral content increased significantly on the addition of carrot powder and sesame. The amount of calcium, iron, and zinc ranged between 39.44 & 320.33, 6.57 & 8.21, and 1.91. & 3.22 mg/100 g, respectively for both Control and Type-2.

Practical Implications: Just 50 grams of Type-2 *gulgule* accounts for almost 1/4thRDA of Calcium, iron, and zinc for 7-9 year children.

Value: The formulated product can be readily consumed by children, being rich in energy, protein, minerals, and β -carotene and convenient in preparation.

Keywords: Traditional food; biofortification; pearl millet; carrot; sesame; nutritional evaluation; sensory acceptability.

1. INTRODUCTION

Most commonly health is found at risk due to inadequate intake of vital nutrients. Therefore, people have become conscious of their daily diets and also the healthcare advisors, nutritionists, researchers, around the world have become determined to provide information that can help in uplifting the current nutrition situation. Many Asian and African countries use millet in preparation for diverse beverages and traditional foods such as porridges, snack foods, etc [1]. Millet grains are sturdy, due to their short-growing season with minimal inputs. They are termed as 'Nutri-cereals' because they are nutritionally superior to major cereals concerning energy, protein, minerals, and vitamins [2]. Among the millets, pearl millet (*Bajra*) has the highest content of micronutrients like iron, zinc, magnesium, phosphorous, folic acid, and riboflavin [3]. Pearl millet also has potential health benefits like reducing blood pressure, cholesterol, heart diseases, and supplies gastrointestinal bulk [4].

"Biofortification" or "biological fortification" is the process of nutritional enhancement of food crops in which conventional plant breeding, modern biotechnology, and agronomic practices are used to develop and grow them for increasing bioavailability of nutrients to the human population [5]. Pearl millet has been grown by farmers since ages, replacing the regular varieties with the bio-fortified crops can lessen micronutrient deficiencies in developing nations like India. Keeping this in view, various bio-fortified varieties of pearl millet have been released to fight iron and zinc deficiencies in India, to prevent varying degrees of impairment and complications in different human organs.

Carrot is one of the most commonly consumed vegetables all over the world. Human carrot consumption is about 37 million tons annually, as stated by the Food and Agricultural Organisation [6]. Carotenoids and β -carotene present in carrot, cannot be synthesized by the human body, are important for vision health, and thus, becomes necessary to be obtained through diet [7,8]. Carrot also contains edible fiber, health beneficial compounds like phenolic acids, flavonoids and other bioactivity components [9,10].

Sesame seeds have a rich nutty flavor and it is commonly used for oil extraction and preparation of various cuisines across the world [11,12]. It plays an important role in human nutrition. Sesame seeds are high in carbohydrates, proteins, and fats/oil, phytochemicals like flavonoids and phenol, it also possess several medicinal properties. If dietary intake of sesame is increased, it might play a chief role in curbing malnutrition among developing nations [13].

Insufficient dietary intake is the predominant cause of malnutrition among children, although there are many other reasons associated with it. To avoid the risk associated with inadequate intake of vital nutrients, Indian Council of Medical Research has set Recommended Dietary Allowance (RDA) for people of all age groups, which refers to an average daily level of intake sufficient to meet the nutrient requirements of nearly all (97%-98%), healthy people. RDA for children (7-9 years) is 1690 Kcal energy, 29.5g protein, 30 g visible fat, 600 mg calcium, 16 mg iron and 4800 μ g β -carotene, whereas recommendation varies for boys and girls between 10-12 years of age and is suggested to be 2190 & 2010 Kcal energy, 39.9 & 40.4 g protein, 21 & 27 mg iron, respectively and 35 g

visible fat, 800 g calcium and 4800 µg β-carotene, each [14].

The millet is for the most part utilized as whole flour for the preparation of food and is thus limited to customary buyers and individuals of lower monetary strata. For increasing the utilization of pearl millet, a wide variety of products can be prepared. Keeping in view, the high nutritional requirements of children, to maintain reserves for meeting the demands of approaching adolescence, bio-fortified pearl millet-based snack along with the incorporation of carrot powder and sesame was formulated and studied for its organoleptic attributes and nutritional composition.

2. MATERIALS AND METHODS

The study was conducted in the Department of Foods and Nutrition, College of Home Science, CCS Haryana Agricultural University, Hisar. The bio-fortified varieties of pearl millet, HHB-299 and *Dhanshakti* were procured from the Bajra Section, Department of Genetics and Plant Breeding, College of Agriculture, CCS HAU, Hisar. Carrot, sesame, and other ingredients required for product formulation were purchased from the local market of Hisar city.

2.1 Preparation of Carrot Powder

The carrots were thoroughly washed with water, peeled, and were thinly sliced using a food processor. Carrot slices were dehydrated at a temperature of 57°C for 14 hours, using a mechanical tray dehydrator. After drying, they were finely powdered in a grinder and stored in air-tight polyethylene bags.

2.2 Processing of Pearl Millet

Pearl millet grains were subjected to blanching for improving the nutritive value of grains by decreasing anti-nutritional factors and improving the digestibility. Distilled water was brought to boiling to 98°C in an aluminum container and the grains were subjected to it (1:5 ratio of seeds to boiling water) for 30 seconds and dried at 50°C. Pearl millet grains were processed according to the method of [15]. Blanched pearl millet grains were milled into flour, which was further utilized for the preparation of gulgule.

2.3 Product Formulation

The bio-fortified varieties of pearl millet grains (*i.e.*, HHB-299 & *Dhanshakti*) were used

separately for the preparation of *gulgule*, along with incorporation of carrot powder and sesame. Gulgule was prepared in four combinations incorporating carrot powder at three different levels in both the pearl millets. 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 in each.

Method: Pearl millet and wheat flour were mixed in a bowl. Fennel seeds and sugar were added, followed by water to make a thick batter. Ghee was heated in a pan and a small ball-sized batter from the bowl was dropped in the ghee like *pakor*s. They float to the surface and were stirred gently until golden brown. Taken out from pan and were dropped in an absorbent paper to soak the extra ghee.

- Control- Pearl millet Flour 50 g; Wheat flour 50 g; Sugar 40 g; Fennel seeds 5 g.
- Type 1- Pearl millet Flour 30 g; Wheat flour 30 g; Carrot powder 20 g; Sesame 20 g; Sugar 40 g; Fennel seeds 5 g.
- Type 2- Pearl millet Flour 25 g; Wheat flour 25 g; Carrot powder 30 g; Sesame 20 g; Sugar 40 g; Fennel seeds 5 g.
- Type 3- Pearl millet Flour 20 g; Wheat flour 20 g; Carrot powder 40 g; Sesame 20 g; Sugar 40 g; Fennel seeds 5 g.

2.4 Organoleptic Evaluation

The formulated snack was assessed for its organoleptic acceptability, regarding color, appearance, aroma, texture, taste, and overall acceptability by a panel of judges based on a nine-point hedonic scale.

2.5 Nutritional Analysis

Gulgule with the highest organoleptic scores was evaluated for its proximate composition and total mineral content using the standard analytical procedures. The selected samples were taken in three replications in dried and powdered form for their nutrient estimation.

2.6 Moisture

Ten g sample was weighed in a petri dish and dried in an oven at 105°C till a constant weight was obtained. The sample was weighed after cooling it in a desiccator [16].

$$\text{Moisture (\%)} = \frac{\text{Loss in weight}}{\text{Weight (g) of sample}} \times 100$$

2.7 Crude Protein

The total nitrogen was estimated by a standard method of [16]. The crude protein was calculated by using the conversion factor of $N \times 6.25$.

Reagents: Hydrochloric acid (N/100), Boric acid (4%), Sodium hydroxide (40%), Digestion mixture: 10 g K₂SO₄, 0.5 g CuSO₄.6H₂O, and 2 g FeSO₄ and Mixed indicator solution: Dissolved 0.5 g of bromocresol green and 0.1 g of methyl red in 100 ml 95 percent ethanol and the solution was adjusted with drops of dilute NaOH to bluish-purple color.

Procedure: 200 mg sample was taken and digested with 20 ml concentrated H₂SO₄ and a pinch of digestion mixture. The nitrogen, as ammonical salt, was distilled with 40 percent NaOH in a Microkjeldahl apparatus. The ammonia thus liberated was absorbed in a 10 ml boric acid solution containing a few drops of mixed indicator and was titrated against standard HCl (N/100). The endpoint was indicated by the change of color from bluish-green to pink.

$$\text{Crude protein (\%)} = \frac{0.00014 \times V \times (S-B) \times 100}{V_1 \times W} \times F$$

Where, W = weight (g) of sample taken, V = volume (ml) made, V₁ = volume (ml) of aliquot taken for distillation, S = volume (ml) of HCl (N/100) used in titration for blank, B = volume (ml) of HCl (N/100) used in titration for sample, 0.00014 = 10 ml of 0.1 N HCl neutralize 0.00014g of nitrogen and F = factor for converting N to protein (6.25).

2.8 Crude Fiber

Crude fiber in the sample was determined using the standard method of analysis (AOAC, 2000).

Reagents: Hydrochloric acid (%) v/v, Sulphuric acid stock solution (10%) v/v: Diluted 55 ml concentrated sulphuric acid to one liter, Sulphuric acid working solution (1.25%): Diluted 125 ml of stock solution to one liter, Sodium hydroxide stock solution (10%) w/v: Dissolved 100 g of NaOH in distilled water and diluted to one liter, Sodium hydroxide working solution (1.25%): Diluted 125 ml stock solution to one liter with distilled water and Antifoam (2%): Silicon in CCl₄.

Procedure: Two-gram fat-free dried sample was put in a one-liter tall beaker and to which 200 ml of 1.25 percent H₂SO₄ and a few drops of antifoam were added. The solution was kept for boiling for 30 minutes under bulb condenser. Beaker was rotated occasionally to mix the contents and remove the particles from sides. The contents were filtered into the beaker through the Buchner funnel. The sample was washed back into the beaker with 200 ml 1.25 percent NaOH and again boiled for exactly 30 minutes. All the insoluble mass was transferred to the sintered crucible (G-1) using boiling distilled water till acid-free. Washed twice with alcohol and thrice with acetone, and then dried at 100°C to constant weight. The dried material was ashed in a muffle furnace at 550°C for 1 hour. The crucible was cooled in a desiccator and weighed.

$$\text{Crude fiber (\%)} = \frac{W_2 - W_3}{W_1} \times 100$$

Where, W₁ = weight (g) of sample, W₂ = weight (g) of insoluble matter (wt. of crucible – insoluble matter – wt. of crucible) and W₃ = weight (g) of ash (crucible + ash – wt. of crucible).

2.9 Crude Fat

Crude fat was estimated using the soxhlet extraction apparatus [16].

Procedure: Five gram of moisture-free sample was taken and transferred to an extraction thimble and then weighed. The thimble was placed in a soxhlet extractor fitted with a condenser and flask containing sufficient petroleum ether. The extraction was carried out for six hours. After the extraction, the thimble was removed with the sample from the extraction apparatus and dried in hot air oven to a constant weight. It was cooled in a desiccator and weighed. The loss in weight of the thimble was the estimate of the ether extract in the sample.

$$\text{Fat (\%)} = \frac{\text{Loss of weight (g)}}{\text{Sample weight (g)}} \times 100$$

2.10 Ash

Five gram of oven-dried sample was weighed in the silica crucible. It was ignited till no charred particles remained in the crucible. The crucible was put in a muffle furnace (550°C) till a white ash was obtained (for 5-6 hours). The crucible

was weighed after being cooled in a desiccator [16].

$$\text{Ash (\%)} = \frac{\text{Weight (g) of ash}}{\text{Weight (g) of sample}} \times 100$$

2.11 Total Minerals

Iron, zinc, and calcium were estimated using acid digestion method. Two gram dried and ground sample was taken in a 150 ml conical flask. To this, a 20 ml diacid mixture (HNO₃:HClO₄: 5:1, v/v) was added and kept overnight. The next day it was digested by heating till clear white precipitates settled down at the bottom. The crystals were dissolved in double-distilled water. The contents were filtered through Whatman No. 42 filter paper. The filtrate was made to 50ml by adding double-distilled water. This acid digested sample was used for the determination of calcium, iron, and zinc. Calcium, iron, and zinc in acid digested samples were determined by Atomic Absorption Spectrophotometer according to the method of [17].

$$\text{Minerals (mg/100g)} = \frac{\text{Reading(conc.}\mu\text{g/ml)} \times \text{volumemade}}{\text{Weight of sample (g)} \times 1000} \times 100$$

2.12 Data Analysis

Statistically analysis for data obtained from the organoleptic and nutritional evaluation were conducted in triplicates. Data was subjected mean, standard error, and Analysis of Variance (ANOVA) according to the standard method [18], differences were considered significant at 95% (P ≤ 0.05).

3. RESULTS AND DISCUSSION

3.1 Organoleptic Evaluation

Mean scores for overall acceptability of all types of *gulgule* prepared using varying proportions of pearl millet with the addition of sesame and carrot powder was in the range of 'liked moderately' except for the H-Type 3 and D-Type *gulgule* containing 20% sesame and 40% carrot powder, which had scores 6.94 and 6.86, respectively (Fig. 1). Mean scores for color, appearance, aroma, and taste appeared to be almost similar for all the variants and lied in the 'liked moderately' category. The mean scores for texture were lowest for Type 3 *gulgule* of

Dhanshakti variety (6.30) followed by Type 3 *gulgule* based on HHB-299 variety (6.40) which probably happened to be due to high level of carrot powder (40%). Slight variations were found in the mean scores of organoleptic characteristics for various *gulgule* but all were acceptable. Earlier, [19] had also prepared pearl millet-based traditional products like *mathi*, *sev*, and *matar* with the addition of amaranth leaves powder. Products with 5% powder were 'liked moderately' while the products prepared by using 10% powder was found in the 'liked slightly' range for its sensory parameters. Supplementary foods are generally high cost that limits its use for poor children and to fill this gap, an attempt was previously made by [20], to develop low-cost supplementary foods using carrot powder, papaya powder, black gram powder and groundnut powder, which were found to be acceptable based on their organoleptic attributes.

- 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.

3.2 Nutritional Evaluation of *Gulgule*

3.2.1 Proximate composition

Data about the proximate composition of *gulgule* prepared from bio-fortified pearl millet varieties is presented in Table 1. Moisture content of different types of *gulgule* was at par with each other. The crude protein ranged from 8.22 to 13.11 percent for all the variants of *gulgule*, with both Type-2 containing a significantly higher amount of protein due to the incorporation of sesame and carrot powder. Analogous pattern of increase in protein content was quoted by [21] on fortification of weaning food formulation with sesame seeds.

The values for crude fat varied statistically lying between 33.86 to 39.18 percent. Ash and crude fiber were recorded to be higher in H-Type 2 and D-Type 2 *gulgule* than their control counterparts. The values for crude fiber and ash varied between 1.06-2.30 and 0.59-1.63 percent, respectively for all the variants. The significant increase in crude fiber and ash content of both Type 2 *gulgule*, incorporated with sesame and carrot powder might be due to their appreciably higher content in sesame than pearl millet. Similarly, [22] has previously reported a

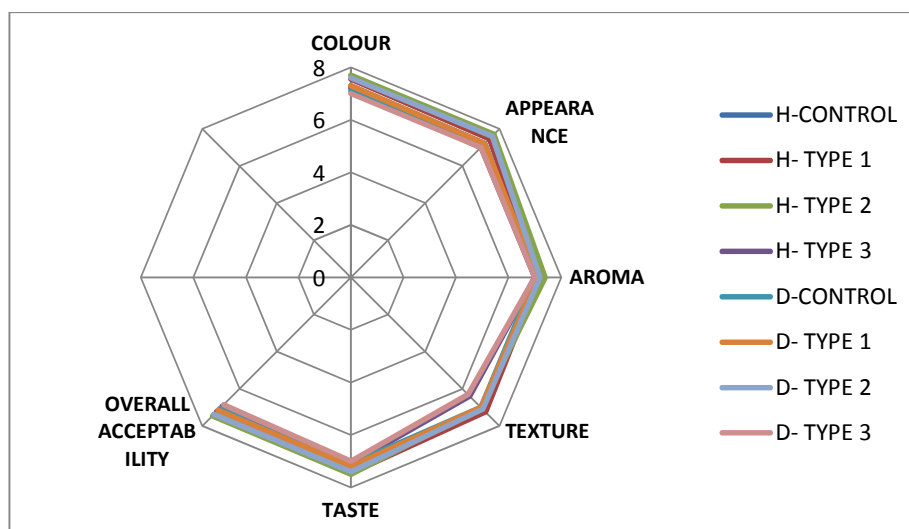


Fig. 1. Organoleptic acceptability of bio-fortified pearl millet-based *Gulgule* incorporating carrot powder and sesame (Mean scores)
 Values are mean \pm SE of ten observations

Table 1. Proximate composition of bio-fortified pearl millet-based *Gulgule* incorporating carrot powder and sesame (g/100 g, on dry matter basis)

Variety	Type of <i>Gulgule</i>	Moisture	Crude protein	Crude fat	Ash	Crude fibre
HHB-299	H-Control	31.93 \pm 0.80	8.22 \pm 0.23	34.35 \pm 0.30	0.99 \pm 0.19	1.06 \pm 0.20
	H-Type 2*	32.62 \pm 0.89	12.03 \pm 0.38	39.18 \pm 1.00	1.63 \pm 0.18	1.41 \pm 0.32
<i>Dhanshakti</i>	D-Control	30.65 \pm 0.63	9.13 \pm 0.41	33.86 \pm 0.78	0.59 \pm 0.19	1.79 \pm 0.25
	D-Type 2*	31.21 \pm 0.40	13.36 \pm 0.32	38.63 \pm 0.89	1.15 \pm 0.40	2.3 \pm 0.32
CD(P\leq0.05)		2.30	1.11	2.57	0.61	0.90

Values are mean \pm SE of three independent determinations
 *Contains 20% sesame and 30% carrot powder

significant increase in protein, fat and crude fiber content in pearl millet *laddoo* as a result of supplementation with gingelly seeds as compared to control. Despite having a good nutritional value, *gulgule* is not recommended to be consumed in large amounts, especially by adults and aged. As along with having a high amount of protein, it also possesses high fat. Children have high energy requirements, so they can consume it in moderate amounts to fill in the gaps between meals rather than replacing meals containing all the essential food groups.

3.3 Total Minerals

The results for total mineral content presented that total calcium in different types of *gulgule* ranged from 39.44 to 320.33 mg/100 g, on a dry matter basis (Fig. 2). H-Type 2 and D-Type 2 *gulgule* had significantly (P \leq 0.05) higher amount of calcium than their control counterparts which

was almost 7-8 times higher. Iron content lied between 6.57-8.21 mg/100 g whereas zinc content varied from 1.91 to 3.22 mg/100 g. These results for total minerals were within the proximity of iron and zinc content reported by [23,24] for the pearl millet-based traditional food products developed by them. As per the present results, a higher amount of minerals were found in *gulgule* based on HHB-299 than *gulgule* made using *Dhanshakti* pearl millet variety. All types of *gulgule* differed significantly in terms of their iron and zinc content as well, although not as remarkable as calcium. As, both the control and Type 2 products were composed of iron and zinc bio-fortified pearl millet, whereas sesame being a major contributor of calcium in the H-Type 2 and D-Type 2 was not present in both the controls. Similarly, mineral compositions reported by [25] showed increase in mineral content of pearl millet food product on blending it with sesame seed flour.

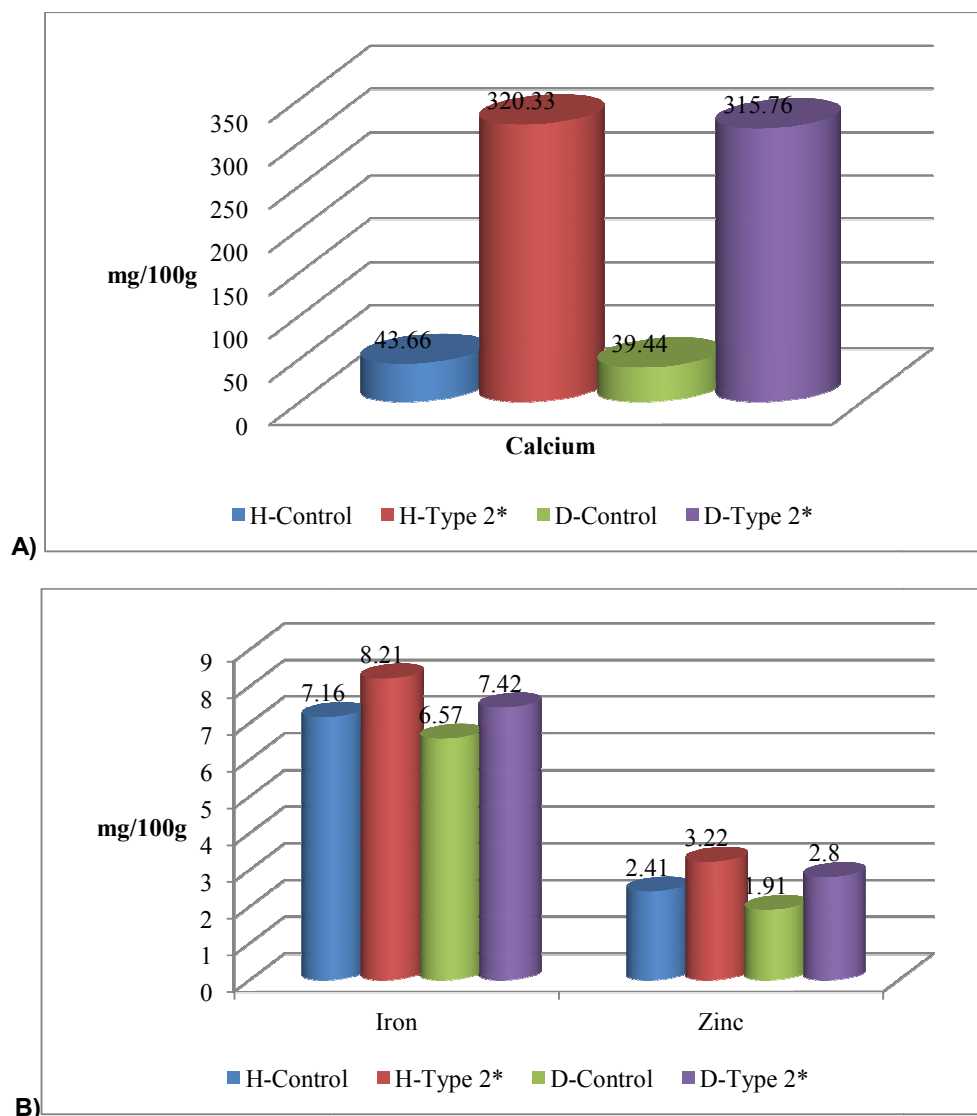


Fig. 2. Total mineral content of bio-fortified pearl millet-based *Gulgule* incorporating carrot powder and sesame (mg/100 g, on dry matter basis); a) Calcium; B) Iron and Zinc

Values are mean ± SE of three independent determinations

**Contains 20% sesame and 30% carrot powder*

4. CONCLUSION

Keeping an eye over the food consumption pattern of children is very important to make sure that nutritional requirements are being met, which further ensures adequate growth and development of children. *Gulgule*, being one of the popular snacks since the traditional times, needs to be introduced to children, especially the ones belonging to the urban community as they are more influenced by the advertisements and are more inclined towards the readily available packed foods in the market. *Gulgule* can be

conveniently prepared at the household level and have a good nutritional profile, being rich in energy and protein, both and also possess a good amount of minerals and β -carotene as contributed by iron and zinc bio-fortified pearl millet and the incorporation of concentrated carrot powder and sesame. Inclusion of pearl millet-based snacks in routine diets of young and the children can increase its consumption at the mass level. Also, the utilization of bio fortified crops in place of traditional varieties can expand micronutrient intake among people sufficiently.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Chandrasekara M, Naczk F, Shahidi. Effect of processing on the antioxidant activity of millet grains. *Food Chemistry*. 2012;133:1-9.
- Sehgal S, Kawatra A. Processing and utilization of pearl millet for nutrition security. *Recent Trends in Millet Processing and Utilization*. 2003;1-6.
- Jaybhaye RV, Pardeshi IL, Vengaiyah PC, Srivastav PP. Processing and technology for millet based food products: A review. *Journal of Ready to Eat Food*. 2014;1(2): 32-48.
- Gupta N, Srivastava AK, Pandey VN. Biodiversity and nutraceutical quality of some Indian millets. *Proceedings of the National Academy of Sciences India Section B: Biological Sciences*; 2012.
- Bouis HE, Hotz C, McClafferty B, Meenakshi JV, Pfeiffer WH. Biofortification: A new tool to reduce micronutrient malnutrition. *Food and Nutrition Bulletin*. 2011;32(1):31S–40S.
- FAOSTAT. Production/Crops Carrots and turnips (crops combined). *Food and Agriculture Organization of the United Nations: Division of Statistics*. In; 2013.
- Albanes D, Heinonen OP, Huttunen JK, Taylor PR, Virtamo J, Edwards BK, et al. Effects of alpha tocopherol and beta carotene supplements on cancer incidence in the alpha tocopherol and beta carotene cancer prevention study. *American Journal of Clinical Nutrition*. 1995;62(6):1427S–1430S.
- Knockaert G, Pulissery SK, Lemmens L, Van BS, Hendrickx M, Van LA. Isomerisation of carrot β -carotene in presence of oil during thermal and combined thermal/high pressure processing. *Food Chemistry*. 2013;138(2–3):1515–1520.
- Samman S, Sivarajah G, Man JC, Ahmad ZI, Petocz P, Caterson ID. A mixed fruit and vegetable concentrate increases plasma antioxidant vitamins and folate and lowers plasma homocysteine in men. *Journal of Nutrition*. 2003;133:2188–2193.
- Azam A, Khan I, Mahmood A, Hameed A. Yield chemical composition and nutritional quality responses of carrot radish and turnip to elevated atmospheric carbon dioxide. *Journal of the Science of Food and Agriculture*. 2013;93:3237–3244.
- Oplinger S, Putnam DH. *Sesame*. Purdue University Press; 1990.
- Hansen R. *Sesame*. Profile; 2011. Available:http://www.agmrc.org/commodities/products/grains/oilseeds/sesame_profile.com
- Samuel NC, Attamah CG. Proximate analysis and phytochemical properties of sesame (*Sesamum indicum* L.) seeds grown and consumed in Abakaliki Ebonyi State Nigeria. *International Journal of Health and Medicine*. 2017;2(4): 1-4.
- Nutrient Requirements and Recommended Dietary Allowances for Indians. A report of the expert group of Indian Council of Medical Research. Hyderabad: National Institute of Nutrition. Indian Council of Medical Research; 2010.
- Chavan JK, Kachare DP. Effect of seed treatment on lipolytic deterioration of pearl millet flour during storage. *Journal of Food Science & Technology*. 1994;31(1):80-81. Available:<https://eurekamag.com/research/008/545/008545482.php>
- AOAC. Official methods of analysis. Association of Official Analytical Chemists. Arlyngton Virginia, USA. 2000;16.
- Lindsey WL, Norwell MA. A new DPTA_TEA soil test for zinc and iron. *Agronomy*. 1969;61:84.
- Sheoran OP, Pannu RS. Statistical package for agricultural workers. "O. P. Stat" College of Agriculture, Kaul, CCS Haryana Agricultural University, Hisar. India; 1999.
- Singh G, Sehgal S. Nutritional evaluation of *laddoo* prepared from popped pearl millet. *Journal of Nutrition and Food Sciences*. 2009;38:310-315.
- Singh V, Katiyar P. Nutritional evaluation of a mixture powder (fruits vegetables and pulses) for children as supplementary food. *Food Science Research Journal*. 2014;5: 72-73.
- Disseka WK, Faulet MB, Koné FMT, Gnanwa MJ, Kouame LP. Phytochemical composition and functional properties of millet (*Pennisetum glaucum*) flours fortified with sesame (*Sesamum indicum*) and moringa (*Moringa oleifera*) as a weaning food. *Advances in Research*. 2018;15(6):1-11.

22. Manu. Development and nutritional evaluation of traditional food products incorporating calcium rich underutilized grains and leaves. PhD Thesis. CCS Haryana Agricultural University Hisar, India; 2006.
23. Rani S. Nutritional evaluation and utilization of biofortified pearl millet in product development. MSc Thesis. CCS Haryana Agricultural University Hisar, India; 2017.
24. Rao R. Development of grits from processed and unprocessed pearl millet and its utilization in product development. MSc Thesis. CCS Haryana Agricultural University Hisar, India; 2015.
25. Aande TM, Agbidye IG, Adah CA. Formulation, proximate analysis and sensory evaluation of Mumu from pearl millet, Irish potato and sesame seed blend. *Agricultural Sciences*. 2020;11:235-246.

© 2020 Bansal and Kawatra; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<http://www.sdiarticle4.com/review-history/59941>