AATCC Review

10 November 2024: Received
31 January 2025: Revised
23 February 2025: Accepted
26 February 2025: Available Online

https://aatcc.peerjournals.net/

Original Research Article

Open Access

Development and standardization of momos by using finger millet

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ABSTRACT

Momo is one of the most trending street foods consumed in India and worldwide. Also, the shifting of consumer preferences from fried food items towards steamed items like momo due to the high prevalence rate of life style related disorders in the post-COVID era has led to many modifications to increase its nutritive value. Millets are superfoods of low glycemic index with high macro- and micronutrients. The present study was conducted to develop momo by using finger millet flour. A total of five treatments of momo including the control (M_1, M_2, M_3, M_4, Co) were developed by mixing 20%, 40%, 60%, 80% and 0% malted finger millet flour with refined wheat flour during dough preparation. All the treatments were subjected to organoleptic evaluation by using a 9-point hedonic scale. The nutritional composition was evaluated according to standard AOAC methods. The M_3 treatment had organoleptic scores comparable with that of the control momo. M_3 momo contained a higher amount of crude fibre, total ash, calcium, phosphorus, magnesium, iron, zinc, sodium and potassium than control. Shelf-life evaluation of control and M_3 showed their organoleptic acceptability up to 15 and 18 days in PET bottles and LDPE pouches at super-chilling and frozen temperatures, respectively. The textural and rheological properties of finger millet based momos were inferior as compared to the refined wheat flour based momos and it might be due to absence of gluten in millet flour.

Keywords: *Finger millet, Malting, Momo, Nutritional composition, Organoleptic evaluation, Shelf-life*

1. Introduction

Momos are bite-size steamed dumplings of white refined wheat flour wrappers enclosing a spoonful of vegetables, meat, fish or chicken stuffing. Being similar to Chinese dumplings Shao Mai or Jiaozi, momos can be prepared by steaming, grilling, deep and pan frying. Dumplings originated in Nepal and Tibet and got their popularity during the Southern and Northern dynasties (420-589 AD). The earliest unearthed real dumplings were found in Astana Cemetery in between 499-640 AD [1]. 100 g chicken momo, buffalo momo, paneer momo and veg momo provide 10.47, 10.52, 10.05 and 4.31 g protein, 8.2, 8.9, 12.99 and 2.94 g fat, 24.78, 27.92, 24.42 and 28.34 g carbohydrates and 223.61, 235.20, 255.10 and 155.85 kcal energy, respectively (DFTQC, MOAC, Nepal, 2006) [2]. Thus, various types of momos contain appreciable amounts of carbohydrates, fat, protein, vitamins and minerals, though the amount of nutrients varies according to the ingredients of inner stuffing. Momo is microbiologically safe as compared to other street foods as it is served hot [2]. The steamed veg momo lowers the risk of coronary artery disorders, gastrointestinal ulcers and colon cancer and improves overall digestive health due to its high fibre content [3]. The only issue in consuming momos is the use of refined wheat flour as its outer wrapper which is devoid of many nutrients especially, fibre, vitamins and minerals and of a high glycaemic index, which can't be recommended for people with a sedentary life style and who suffers from diseases like obesity, atherosclerosis, diabetes mellitus etc. Thus, there is a need to incorporate any alternative, unconventional source of the outer coating prepared from low glycaemic index and nutrient-rich flours such as millets.

Millets are superfoods that are rich in macronutrients as well as micronutrients. Nowadays, millets are considered as the primary means of value addition of various processed products. Due to its valuable benefits for human health, people are shifting their preference towards millet-based foods [4]. Finger millet provides immense health benefits to pregnant and lactating women, adolescent people, children and elderly persons due to its high fibre, protein, calcium, iron and zinc contents [5]. Owing to its low glycaemic index and high fibre content, finger millet is very useful in the management of diabetes, obesity and other lifestyle-related diseases [6]. Finger millet is considered "Poor man's milk" due to its highest calcium and iodine contents. 100 g finger millet provides 305 kcal energy, 72 g carbohydrates, 11.5 g dietary fibre, 7.3 g protein, 1.3 g fat, 344 mg calcium, 3.9 mg iron, 137 mg magnesium, 283 mg of phosphorous, 408 mg potassium, 14 mg sodium and 2.3 mg zinc and 13.1% moisture [7, 8, 9].

Thus, millet flour can be used as a cheap and highly nutritious alternative source to be included in the preparation of outer

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DOI: https://doi.org/10.21276/AATCCReview.2025.13.01.490

wrapper of momos like many other attempts by various food scientists to develop wider range of millet-based functional and value-added RTE products [11-18]. The present study was planned to develop momos by utilizing finger millet flour in various proportions to enhance the overall nutritive value with the following objectives.

- To develop and evaluate the organoleptic parameters of millet-based momos
- To analyze the proximate and mineral composition of millet-based momos
- To study the shelf life of the developed momos

2. Materials and Methods

2.1. Collection and preparation of raw ingredients

All the raw ingredients to be used such as brown finger millet, refined wheat flour (RWF) and vegetables (cabbage, carrot, capsicum, chilli, ginger, garlic and coriander leaves) were collected from the local market of Parbhani. The finger millet grains were winnowed, cleaned, washed in running water and soaked overnight in a volume of water and grains in proportion of 4:1. The water used for soaking was strained and soaked grains were tied in white muslin cloth and kept completely covered in a vessel and left for germination. The germination was completed after 5 days and the germinated grains were opened to dry in air flow. The germinated finger millet grains were roasted in a pan. Both the germinated, roasted grains were rubbed to remove the germ shoot and milled and sieved (60 mesh sieve) to obtain fine finger millet flour and kept in air tight plastic jar for further use. All the vegetables were washed in running water, chopped and added to the pan with oil to be sauteed to prepare the stuffing.

2.2. Preparation of momos with and without incorporation of finger millet flour

The malted finger millet flour (FMF) was incorporated at four various levels that is 20, 40, 60 and 80 per cent separately in refined wheat flour to prepare the outer wrapper momos. Thus, one control (with 100% refined wheat flour only) with four treatments of momos i.e. Co, M_1, M_2, M_3 and M_4 was developed. 5 g dough was taken and rolled in a circular manner by using the rolling board and rolling pin. The previous vegetable stuffing was kept and the rolled dough was folded closed the stuffing inside it and steamed in an Idli cooker.

2.3. Organoleptic evaluation of various treatments momos

The organoleptic evaluation of developed momos was conducted to find out the maximum level of incorporation of finger millet flour in the selected momos. About twenty trained panel members were selected and requested to evaluate the developed momos for the organoleptic parameters of colour and appearance, flavour, texture, taste and overall acceptability by using a nine-point hedonic rating scale [19]. The treatment which obtained the highest organoleptic scores was selected for further nutrient analysis and shelf-life study.

2.4. Nutrient analysis of developed momos

The control and the highly accepted treatments of momos were subjected for their proximate analysis of moisture, fat, protein, mineral and crude fibre by following standard AOAC methods [20].

2.4.1. Moisture

Moisture content was assessed by implicating the standard

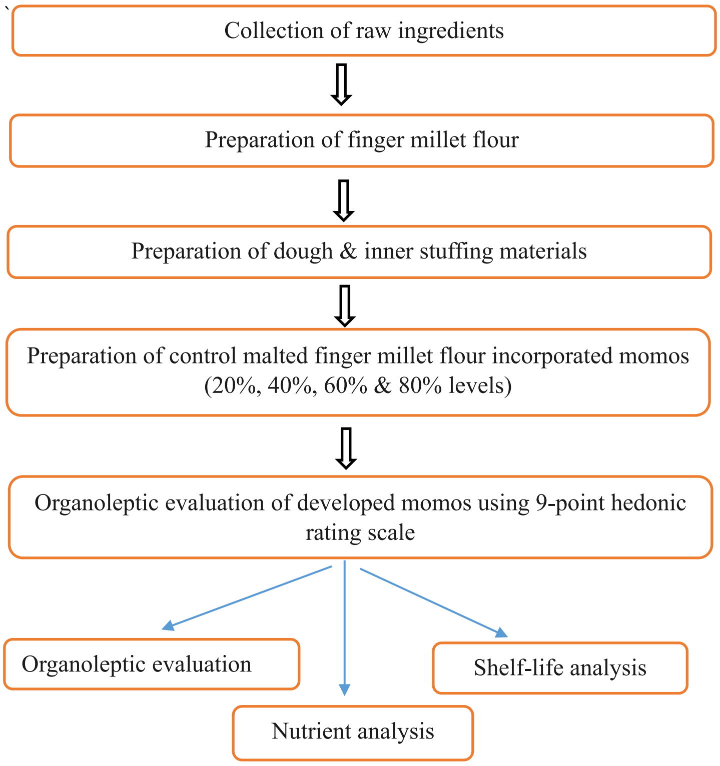

Fig. 1. Schematic diagram of experimental design of research work

Fig. 2. Different treatments of momos

method of analysis. 5 g of sample was taken in a pre-weighed petri dish and placed in an oven for drying at 105°C for 6 h The dried sample was allowed to cool in a desiccator and reweighted. The loss in weight of the sample was taken as the moisture percentage and calculated from the following equation

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

Where, W_1= weight of the sample (g), W_2=weight of the petri dish with sample before drying, W_3=weight of petri dish with sample after drying

2.4.2. Ash

Ash content in the sample was assessed by implicating the standard method of analysis. 5 g of sample was weighed and taken in a pre-weighed porcelain dish. The porcelain dish was charred and then converted into ash in a muffle furnace at 500°C for 6h till the ash was greyish or white in colour.

Then porcelain dish was cooled in a desiccator and reweighed. The residue is the ash content represented by the loss in weight and calculated from the following equation

$$\text{Ash (\%)} = \frac{W_2 - W_3}{W_1} \text{x} 100$$

Where, W_1=weight of sample (g), W_2= weight of porcelain dish with the sample, W_3= weight of porcelain dish with ash

2.4.3. Crude fat

The standard procedure was followed for the estimation of crude fat using the Automatic SOCS plus Solvent Extraction System. In pre-weighed extraction, thimble 1 g of moisture-free sample was taken and dried overnight. The washed beaker was dried in a hot air oven at 60°C for 20 minutes and weighed after cooling. The sample was kept in the beaker along with the thimble holder. Petroleum ether 90ml was taken as a solvent with boiling range of 40-60°C. The extraction was carried out for 1h at 90°C then the temperature was raised at 110°C and the stopper was closed in order to collect solvent. After completion of the solvent collection in the solvent compartment beaker was removed along with extracted fat and kept in hot air oven at 60°C temperature for few minutes. The fat collected beaker was cooled in a desiccator and weight was taken. Fat percentage was calculated from the following equation.

$$\text{Fat (\%)} = \frac{w_3 - w_2}{w_1} \text{x } 100$$

Where, W_1=weight of sample (g), W_2= weight of empty beaker, W_3= weight of beaker with fat

2.4.4. Crude fibre

Crude fibre content was determined by method of AOAC [20]. 1 g of moisture free and defatted sample was weighed and kept in a pre-weighed crucible. The crucible was placed in the crude fibre apparatus. Then sulphuric acid (1.25%) up to 150 ml notch was added and boiled for 30 minutes exactly from the onset of boiling. After boiling connected to vacuum for draining sulphuric acid. After completion of draining 150 ml of sodium hydroxide solution (1.25%) was added and allowed 30 minutes for boiling. The crucible was removed after cooled and reweighed with the insoluble matter then placed in oven for drying at 105°C for 1 hour up to constant weight. Reweighed the crucible with ash after cooled in a desiccator. The crude fibre percentage was calculated as follows.

$$\text{Crude fibre (\%)} = \frac{w_1 - w_2}{w} \text{x } 100$$

Where, W=weight of the sample (g), W_1= weight of crucible with insoluble matter, W_2=weight of crucible with ash (g)

2.4.5. Crude protein

To estimate the crude protein content in the sample, the Kjeldahl method was used. This included digestion followed by distillation and followed by titration by using the KELPLUS Automatic Nitrogen Estimation System. By the standard Kjeldahl method nitrogen content of the sample was estimated Temperature was set at 420°C in the controller. The sample was taken (0.25-0.3 g) and digested on the KELPLUS apparatus after adding 5 ml of commercial-grade sulphuric acids and 1.5 g of digestion mixture until it became clear. After the tube was cooled, water was poured slowly along the neck of the tube so that contents present on the neck of the tube would mix with the digested content present on the bottom of the tube.

Then the sample was followed for the distillation process. The digested sample was first loaded in the space provided in the apparatus and one empty conical flask was placed on the receiver side, then prog of the equipment was allowed to run for the distillation process. 20 ml of boric acid was automatically dropped into the conical flask and then 40 ml of 40% NaOH in automatically filled slowly in order of 10 ml each time in the tube. After completion of adding 40% NaOH in to the tube, the colour changed from blush green to brown precipitate. Then process was set and the colour in the conical flask changed from pink to green which indicate the end point of the distillation process. The solution present in the conical flask was titrated with 0.025N sulphuric acid till the colour changed from green to permanent pale pink colour. The value of the blank was subtracted from sample readings. The crude protein content of the sample was estimated by the following formula.

$$\text{Crude protein (\%)} \frac{14.01 \times [\text{titrant (ml)} - \text{blank (ml)}] \times N \times 6.25}{W \times 1000} \times 100$$

Where, 6.25 is the factor for converting nitrogen into the crude protein of the sample

N= Normality (0.1), W= Weight of the sample taken for digestion

2.4.6. Carbohydrate

The carbohydrate content of the sample was determined by the difference in the value obtained when all the proximate composition values were subtracted from 100%, 1.e.by subtracting the sum of the values (per 100 g) for moisture, total ash, crude fat, crude fibre and crude protein from 100 as follows.

Carbohydrate (%) = 100- (moisture% + ash% + crude fat% + crude fibre% + crude protein %)

2.4.7. Mineral estimation

0.5 g of sample was taken in a 100 ml conical flask. 10 ml of concentrated HNO_3, was added to each flask and kept undisturbed for overnight. Samples in the flask were heated on a hot plate till brown flame evolved. To each flask 5 ml of di-acid mixture (HNO_3:$HClO_4$ (70%)::3:2 by volume) was added and the heating process was continued till white fume evolved reducing the volume of content to about 2 ml. Then conical flasks were removed from hot plate and allowed to cool. Thereafter, 15 ml of warm distilled water was added to each flask. To a 50 ml volumetric flask content of the conical flask was transferred followed by twice rinsing with distilled water and the volume was made up to 50 ml. The aliquot was filtered through Whatman No.42 filter paper and the extract was kept for estimation of minerals. Perkin Elmer Avio™ 200 dual view instrument equipped with Syngistix™ software for inductively coupled plasma optical emission spectrometry (ICP-OES) was used to measure the calcium, iron, magnesium, sodium, zinc and phosphorous concentrations of the resultant sample solutions.

2.5. Texture analysis of developed momos

The textural parameters like hardness, cohesiveness, adhesiveness, gumminess, springiness, chewiness and resilience were analysed using TAXT.PLUS Texture Analyser. The test parameters were as follows: pre-test speed = 1.00 mm/sec, test speed = 0.80 mm/sec, post-test speed = 10.00 mm/sec, target mode: distance, distance = 5.000 mm, count = 2, trigger type: auto (force), trigger force = 5.0 g.

2.6. Shelf-life study of developed momos

The control and highly accepted treatment of momos were stored in PET bottles and LDPE pouch separately at two different temperature conditions such as super-chilling temperature (-2 ± 0.5^{0}C) and frozen temperature (-18 ± 0.5^{0}C) for 20 days and periodically evaluated for their organoleptic parameters of colour, texture, taste, flavour and overall acceptability at an interval of 3 days.

2.7. Statistical analysis of data

The collected data was organized, tabulated and analysed statistically by conducting a paired 't' test [21].

3. Results and discussion

3.1. Organoleptic evaluation of developed momos

It was observed that the colour scores of Co momos differed significantly from those of M_1, M_2, M_3 and M_4 treatments. Co momos obtained the highest score in terms of acceptability of colour. The mean score for texture, taste, flavour and overall acceptability of M_3 differed significantly from the control momos. The taste, flavour and overall acceptability scores of M_1, M_2 and M_2 were lesser than the scores of M_3. Overall, M_3 was found to be the most preferred one in terms of the consumer acceptability of organoleptic parameters. The scores for overall acceptability of momos prepared from 80 per cent finger millet flour i.e. M_4 differed significantly from scores of all other treatments. This decrease in flavour, taste and overall acceptability of M_4 treatment might be because of more gumminess attributed by the finger millet flour (Fig. 3).

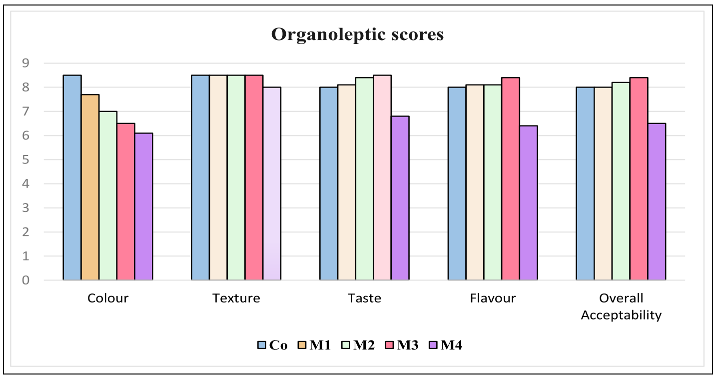

Fig. 3. Organoleptic scores of developed momos

3.2 Textural parameters of control and highly accepted momos

Table 1. Textural parameters of control and accepted treatments of momos

Sr. No	Textural parameters	Co (Mean ± SD)	M_3 (Mean ± SD)
1	Cohesiveness	0.632±0.003	0.746±0.004
2	Hardness (N)	1.168±0.001	1.104±0.003
3	Adhesiveness(g-s)	-0.006±0.002	-0.005±0.001
4	Gumminess	0.628±0.003	0.713±0.002
5	Springiness (mm)	-2.147±0.004	-1.892±0.003
6	Chewiness (g-mm)	-1.635±0.002	-1.632±0.002
7	Resilience	1.742±0.004	2.839±0.005

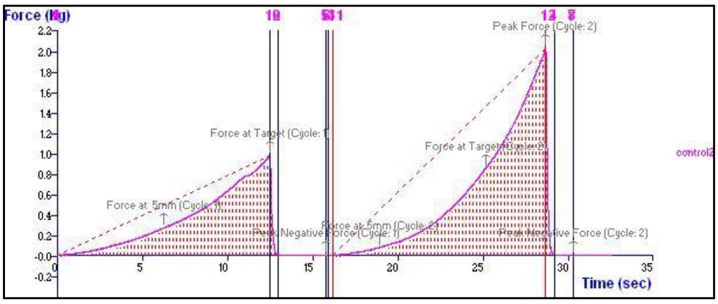

Fig. 4. Textural parameters of control and accepted treatments

The Co momos were having less cohesiveness than M_3. The control scored less for hardness than M_3. There was no significant difference in adhesiveness of both the treatments. M_3 was found to have more gumminess than that of Co momos. The springiness of control momos was observed to be more than that of M_3. There was a statistically non-significant decrease in chewiness of M_3 than that of the control momos. M_3 momos showed greater resilience as compared to the control treatment of momos (Fig. 4 and table 1).

3.3 Nutritional composition of developed momos

Table 2. Comparative analysis of nutritional composition

Sr. No	Nutrients per 100 g	Nutrient Content	
		Control (Mean ± SD)	M_3 (Mean ± SD)
1	Moisture (g)	69.43±0.05	74.36±0.07
2	Energy (Kcal)	119.24±4.01	114.62±3.14
3	Carbohydrate (g)	20.54±1.16	19.06±1.02
4	Crude protein (g)	4.18±0.17	4.07±0.12
5	Crude fat (g)	0.72±0.04	0.79±0.01
6	Crude fibre (g)	4.11±1.10	5.84±1.03
7	Total Ash (g)	1.58±0.12	2.46±0.09
8	Calcium (mg)	48.52±1.21	90.27±2.31
9	Phosphorous (mg)	69.71±2.01	86.24±1.32
10	Iron (mg)	1.08±0.04	1.43±0.06
11	Zinc (mg)	0.38±0.03	0.51±0.02
12	Magnesium (mg)	28.16±0.25	37.24±0.42
13	Sodium (mg)	29.04±0.12	34.18±0.08
14	Potassium (mg)	290.49±2.06	326.11±2.34

The moisture content of control (Co) momos (69.43%) was found to be non-significantly lower than that of M_3 momos (74.36%). This increase in moisture content might be due to enhanced water absorption by the higher fibre content of malted finger millet flour during kneading. Similar results were reported by Anju and Sarita (2010) and Pathak *et al*. (2018) in their research studies [10, 23].

The M_3 momos was estimated to provide 114.62 kcal which was lower than that of the control momos which was 119.24 kcal per 100 g of sample. This net decrease in the calorific value of M_3 momos might be the result of a decrease in total carbohydrate content due to use of malted finger millet flour in place of refined wheat flour. The M_3 momos contained 19.06 g carbohydrate which was lower than that of Co momos i.e. 19.06 g per 100 g. similar findings were highlighted by Kudake *et al*. (2019) during the preparation of finger millet noodles. The decrease in net quantity of carbohydrates might be due to the substitution of malted finger millet flour in place of refined wheat flour. The crude fat content of accepted treatment M_3 (0.79 g) was found to be increased non-significantly as compared to control momo (0.72 g) per 100 g [24].

The crude protein content of M_3 momos was estimated to be 4.07 g which was non-significantly lower than that of the Co momos i.e. 4.18 g per 100g. This slight decrease in protein content in M_3 momos might be due to lower quantity of protein of malted FMF. Dangal *et al*. (2021) reported similar results during the preparation of finger millet--based thekua [25].

The crude fibre content of M_3 momos (5.84 g) was noticed to be increased significantly than that of control one (4.11 g) per 100 g. It might be due to the higher crude fibre content of malted FMF as compared to RWF. Similar results were highlighted by Krishnan *et al.*, 2011; Saha *et al.* (2011), Nazni and Karuna (2016), Shrestha and Srivastava (2017), Thejasri *et al.* (2017), Kishorgoliya *et al.* (2018) and Kudake *et al.* (2018) [11-16, 23].

The total ash content of M_3 momos (2.46 g) was observed to be increased significantly as compared to that of Co momos (1.58 g) per 100 g. This increase in ash content might be due to higher content of minerals present in malted FMF than RWF.

Similar results were obtained by Salunke *et al.* (2019), Kaur *et al.* (2020) and Kudake *et al*. (2018). [17, 18, 24].

The calcium content of M_3 and Co momos were estimated to be 90.27 mg and 48.52 mg per 100 g momos, respectively. The calcium content of the momos was observed to increase significantly after the incorporation of malted finger millet flour as it contained the highest amount of calcium [7]. Similar results were reported by Dangal *et al*. (2021), Desai *et al*. (2010), Kulkarni *et al*. (2012) and Lande *et al*. (2017) during the preparation of finger millet-based noodles, thekua, vermicelli, cookies and other RTE products [25-28].

A significant increase in phosphorus content of the M_3 momos had been observed as compared to Co momos. This increase in phosphorus content might be due to more bioavailability of phosphorus of FMF after malting. These results were at par with the results cited by Desai *et al*. (2010), Kulkarni *et al*. (2012) and Lande *et al*. (2017) during the preparation of finger millet incorporated cake, noodles and vermicelli, respectively [26-28].

The iron content of the M_3 momos was found to be increased significantly as compared to that of Co momos. This might be because of a higher amount of iron present in malted FMF. The sodium, potassium, magnesium and zinc content of M_3 increased significantly than that of the control one. This increase might be due to the higher content of these minerals in FMF as compared to RWF. Similar results were reported by Kulkarni *et al*. (2012) and Lande *et al*. (2017) [27-28].

3.4. Shelf-life analysis of developed momos

It was observed that all the organoleptic parameters were found to be diminished after the 15th and 18th day for momos kept in LDPE pouches and pet bottles at super-chilling temperature conditions, respectively. Both the Co and M_3 samples in LDPE pouches at super-chilled conditions were observed to show the growth of yeast and mold after 15th day of the shelf-life study period. The organoleptic characteristics of control and M_3 momos were observed to be decreased after the 18th day kept in LDPE pouches and pet bottles at frozen temperature. Similar results were suggested by Rathod *et al*. (2018) [29].

4. Conclusion

The study concluded that the utilization of malted finger millet flour to develop the momos can increase moisture, crude fibre, total ash, calcium, phosphorous, potassium, sodium, magnesium, iron and zinc content in the outer wrapper. Thus, supplementation of finger millet flour in momos can enhance its overall nutritive value. Incorporation of finger millet and other millets in fast food and street food items like momos can be an effective method to manage micronutrient deficiency and life style-related disorders in consumers of different age groups.

Acknowledgements

The authors express their heartfelt gratitude to the ICAR (Indian Council of Agriculture Research) for generously providing fellowships during the research period.

Conflict of interest

The authors declare no conflicts of interest. They bear sole responsibility for the content and composition of the paper.

Future scope of the study

The research study can be utilized and referred to prepare more millet based steamed and other snack products and its commercialization.

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