AATCC Review

26 September 2024: Received
29 October 2024: Revised
19 November 2024: Accepted
05 December 2024: Available Online

https://aatcc.peerjournals.net/

Original Research Article

Open Access

Standardization and quality evaluation of value-added cookies and pizza base

Devadarshini C.[1], Satapathy P.[1], Parida P.[1] and Sahoo S. S.*[2]

[1]Department of Food and Nutrition, College of Community Science, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India
[2]Department of Food Science and Nutrition, ASPEE College of Nutrition and Community Science, SDAU, Sardarkrushinagar, Gujarat, India

ABSTRACT

The trend of consuming market-based processed products like cookies, pizza due to changes in income and social status of people has led to numerous attempts of value addition of it to optimize the nutritional benefits. The present study was conducted to develop cookies and pizza bases by using non-conventional raw ingredients. Cookies (C_1, C_2, C_3 and C_4) were prepared from refined wheat flour, finger millet, and barnyard millet flours in proportions 80:10:10, 70:15:15, 60:20:20 and 50:25:25, respectively. Pizza base was prepared by using whole wheat flour, finger millet flour and little millet flour such as (P_1) 80:10:10, (P_2) 70:15:15, (P_3) 60:20:20 and (P_4) 50:25:25 with addition of peanuts (5%) and flax seeds (5%) in all. All the developed products were analyzed for nutritional quality and sensory properties using standard procedures. The flavours of the millet-based treatments during the storage period were found to be altered and it was found difficult to maintain the flavour intact as compared to the control treatments for both cookies and pizza base.All the products were found to contain higher nutrients such as calcium, phosphorous, iron, dietary fibre, and ash as compared to the control products (C_0 and P_0) prepared from refined wheat flour only. Shelf-life evaluation of the products showed their safe consumption in between 60 days and 3 days for the cookies and pizza base, respectively.

Keywords: *Millet, Cookies, Pizza base, Sensory properties, Nutritional quality, Nutrients, Shelf-life*

1. INTRODUCTION

Bakery products are ready-to-eat and instant food items preferred by almost all age group people. Biscuit or cookies are the most highly consumed baked items. Not only cookies but also pizza is one of the most liked food products of youngsters, especially in urban area. Both cookies and pizza are made up of refined wheat flour which is rich in starch and devoid of dietary fibre and many other essential vitamins and minerals. Besides, the urban people are more prone to life-style diseases like diabetes mellitus, obesity, hypertension and cardiovascular diseases which prohibit the consumption of refined wheat flour due to its high glycaemic index. Hence, to get optimum and quality nutrition, there is a need to replace or supplement these products i.e. cookies and pizza base with the gluten-free, nutritious millet flours, nuts and oilseeds. Previously, many attempts have been noticed to develop biscuits, cookies, cake and other bakery food items by incorporating various millets to improve the overall nutritive as well as functional value of the products. [2,10,12-13,16,22,24,27,30]

Nowadays, millets are on the central point of value addition and nutrient enrichment of various processed foods like biscuits, cookies and extruded products. Due to its valuable benefits for human health, people are shifting their preference towards millet-based foods.[19] Being rich in calcium, iron and potassium, ragi is most beneficial for pregnant women, growing children and the elderly persons.[28]

*Corresponding Author: ***Sahoo S. S.***

DOI: https://doi.org/10.21276/AATCCReview.2024.12.04.580

Owing to its low glycaemic index and high fibre content, ragi can help in the management of diabetes, obesity and other cardiovascular diseases.[4] 100g of finger millet provides 305kcal energy, 72g carbohydrates, 11.5g dietary fibre, 7.3g protein, 1.3g fat, 344mg calcium, 3.9mg iron, 137mg magnesium, 283mg of phosphorous, 408mg potassium, 14mg sodium and 2.3mg zinc and 13.1% water.[7] Finger millet is considered as "Poor man's milk" due to its highest calcium and iodine contents. Barnyard millet contains 51.5-62% carbohydrate, 11.2-12.7% protein, 8.1-16.3% dietary fibre, 15.6-18.6% iron, and 3.30-3.70% phytate.[23,26] Barnyard millet contains polyphenols and carotenoids twice that of finger millet.[17] Little millet is a minor millet rich in phosphorous, dietary fibre, and bio-active compounds e.g. tocopherols, carotenoids etc. The anti-oxidant and low-calorie content of little millet helps to maintain a balanced diet and proper body weight.

Flaxseed is rich in fibre, protein, polyunsaturated fatty acids such linoleic and linolenic acids, thiamine, magnesium and phosphorus; several plant compounds, including *p*-Coumaric acid, ferulic acid, phytosterols and lignans that lower total cholesterol levels and LDL, raise HDL in blood, prevents cancer and metabolic syndrome. Peanuts are packed with oleic acid, PUFA and protein and its low carbohydrate content makes it a good choice for diabetic people.

Thus, the present study was planned to formulate value-added cookies and pizza base by using refined wheat flour (RWF), finger millet flour (FMF), barnyard millet flour (BMF), little millet (LMF), flax seed and peanuts with the following objectives.

- To formulate cookies by incorporating finger millet and barnyard millet

• To formulate pizza base by incorporating finger millet, little millet, flax seed, and peanuts
• To assess sensory characteristics, nutrient composition, and shelf life of cookies and pizza base

2. MATERIALS AND METHODS

2.1. Procurement of raw materials

The raw materials like refined wheat flour (RWF), finger millet (FM), barnyard millet (BM), little millet (LM), flaxseeds, peanuts, sugar and butter were all purchased from local market, Bhubaneswar, Odisha.

2.2. Preparation of finger millet, barnyard millet and little millet flour

The purchased FM, BM and LM grains were cleaned and washed properly in tap water to remove the dirt, soil and other contaminants. Then the cleaned FM, BM and LM grains were sundried and ground with the help of a pulveriser and sieved using 60 mesh size sieve to obtain fine flour. The FM and BM flours were stored in air-tight glass jars for further research work.

2.3. Formulation of cookies and pizza base

Different proportions of refined wheat flour (RWF), finger millet flour (FMF), barnyard millet flour (BMF) was mixed with fixed amount of icing sugar i.e., 25g and butter i.e., 50g. The cookies were developed by creaming method. One control (C_0) treatment of cookies was prepared by using 100% RWF. Four treatments of cookies were prepared by incorporating RWF and flour mix of FMF and BMF in different proportions such as 80:10:10, 70:15:15, 60:20:20 and 50:25:25 named C_1, C_2, C_3 and C_4, respectively.

One control (P_0) treatment of pizza base was prepared by using 100% RWF only. Four treatments of cookies were prepared by incorporating RWF and flour mix of FMF and LMF in different proportions such as 80:10:10, 70:15:15, 60:20:20 and 50:25:25 named P_1, P_2, P_3 and P_4, respectively. The amounts of flax seeds and peanuts were 5% for each in all millet incorporated treatments.

Fig. 3. Developed millet cookies

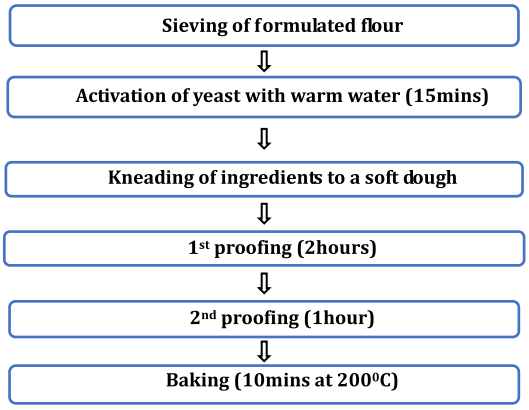

Fig. 1. Flowchart for preparation of pizza base

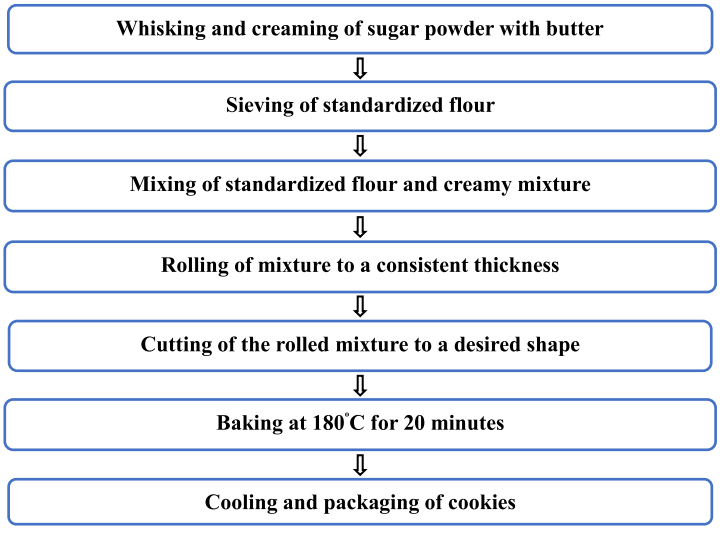

Fig. 2. Flowchart for preparation of cookies

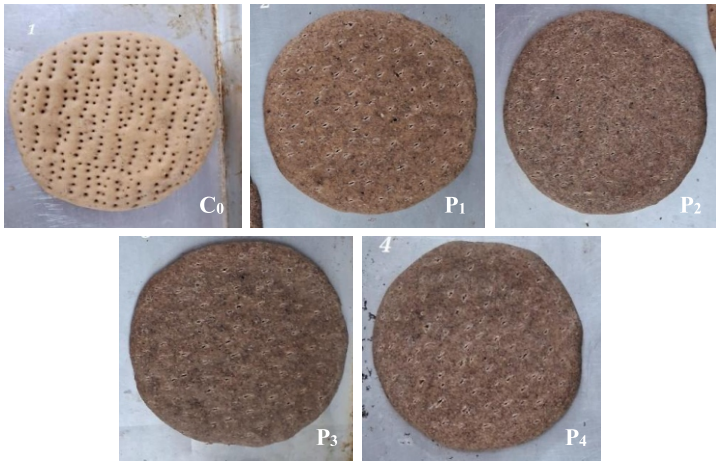

Fig. 4. Developed millet pizza base

2.4. Sensory evaluation of the developed cookies and pizza base

All the treatments of cookies and pizza base were evaluated by thirty semi-trained panel members for their sensory parameters such as colour, texture, flavour, taste, and overall acceptability by using a nine-point Hedonic rating scale.[18]

2.5. Nutrient analysis of the developed cookies and pizza base

The proximate analysis of moisture, fat, protein, minerals, and crude fibre was estimated by AOAC method (2007).[3] Moisture content of the developed products was determined by using hot air oven drying methods of AOAC.[3] The carbohydrate content was calculated by using the difference method.

Kjeldahl method was used to determine the crude protein content of the developed cookies and pizza base in KELPLUS Automatic Nitrogen estimator system by following the digestion, distillation and titration processes. The fat content of the developed products was estimated by the Soxhlet method of AOAC.[3] The concentration of minerals such as calcium, iron and phosphorous was determined by using the Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method.

2.6. Shelf-life evaluation of the developed cookies and pizza base

All the treatments of cookies and pizza base were kept in LDPE zip lock pouches at room temperature. The shelf life was assessed through sensory evaluation by using a nine-point hedonic rating scale in 15 days intervals for 4 months for cookies and in each day for 1 week for pizza base.

2.7. Statistical analysis of data

The collected data was organized, tabulated and analysed statistically. The analysis of variance (ANOVA) and paired t-test was used for interpreting the differences between variations for individual sensory parameter and nutrient content.[8]

3. RESULTS

3.1. Sensory evaluation of the developed cookies and pizza base

Fig. 5 represents the sensory acceptability of mixed millet cookies by the panellists. All 4 formulations of mixed millet cookies and control were represented to panellists to identify which formulation of mixed millet cookies was highly acceptable. Mean score of colours of the developed cookies C_0, C_1, C_2, C_3 and C_4 were 7.9, 7.1, 7.2, 7.5 and 6.3, respectively. C_0 received the highest score w.r.t colour i.e., 7.9 and C_4 received lowest score i.e., 6.3. Mean score of texture of the cookies C_0, C_1, C_2, C_3 and C_4 were 8.0, 7.2, 7.3, 7.4 and 6.8, respectively. C_0 received the highest score w.r.t texture i.e., 8.0 and C_4 received lowest score i.e., 6.9. Mean score of flavour of the cookies C_0, C_1, C_2, C_3 and C_4 were 8, 7.2, 7.3, 7.4 and 6.8 respectively. C_0 and C_1 received the highest score w.r.t flavour i.e., 8 and C_4 received lowest score i.e., 6.8. Mean score of taste of the cookies C_0, C_1, C_2, C_3 and C_4 were 7.9, 7.0, 7.2, 7.4 and 6.9, respectively. C_0 received the highest score w.r.t taste i.e., 7.8 and C_4 received lowest score i.e., 6.3. Mean score of overall acceptability of the cookies C_0, C_1, C_2, C_3 and C_4 were 8, 6.9, 7.1, 7.4 and 6.6 respectively. C_0 received the highest score w.r.t overall acceptability i.e., 8 and C_4 received lowest score i.e., 6.6. Overall, it can be shown that cookies made with RWF (control- C_0) had highest score and C_4 had lowest with respect to all the parameters of sensory evaluation. The 20% and 30% formulation of millet cookies are highly acceptable by panellists with scores 7.1 and 7.4, respectively.

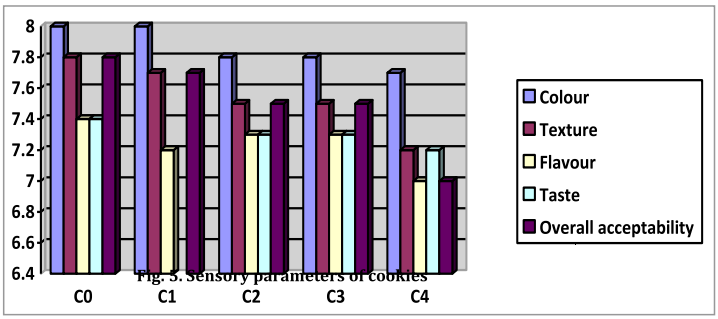

Fig. 5. Sensory parameters of cookies

Fig. 5. Sensory parameters of cookies

Fig. 6 shows the sensory evaluation and acceptability of developed pizza base. Pizza bases with formulations P_1, P_2, P_3 and P_4 had mean colour values 7.4, 7.1, 6.9 and 6.1 respectively. P_1 got highest score i.e., 7.4 and P_4 got lowest score i.e., 6.1 among all the treatments. Mean texture values of P_1, P_2, P_3 and P_4 were 7.6, 7.3, 7.0 and 6.5 respectively. P_1 got highest score i.e., 7.6 and P_4 got lowest score i.e., 6.5 among all the treatments. Pizza bases with formulations P_1, P_2, P_3 and P_4 had mean flavour values 7.2, 7.6, 7.4 and 6.6 respectively. P_2 got highest score i.e., 7.6 and P_4 got lowest score i.e., 6.6 among all the treatments. The mean taste values of P_1, P_2, P_3 and P_4 were 7.0, 7.4, 7.2 and 6.2, respectively. P_2 got highest score i.e., 7.4 and P_4 got lowest score i.e., 6.2 among all the developed mixed millet pizza bases. Pizza bases with formulations P_1, P_2, P_3 and P_4 had mean overall acceptability values 7.1, 7.7, 7.4 and 6.5 respectively. P_2 got highest score i.e., 7.7 and P_4 got lowest score i.e., 6.5 among all the treatments. The scores for all sensory parameters taken were higher in control. However, after comparing with control and according to their overall acceptability, substitution level 20% (P_2) and 30% (P_3) were found to be acceptable among the developed pizza bases.

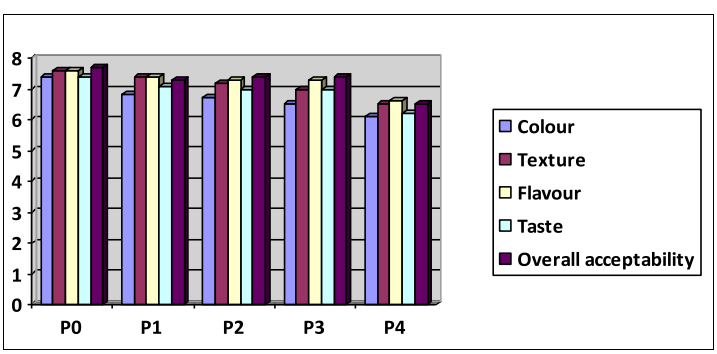

Fig. 6. Sensory parameters of pizza base

3.2. Nutrient analysis of the developed cookies and pizza base

Table 3.1. Nutrient composition of control and highly accepted mixed millet cookies (per 100g on dry matter basis)

Nutrients (per 100g)	C_0	C_2	C_3	CD@5%
Moisture (%)	5.23^{a}±0.02	4.84^{c}±0.01	4.25^{e}±0.008	0.05
Crude protein (g)	11.3^{a}±0.11	10.35^{c}±0.01	10.18^{d}±0.01	0.16
Crude fat (g)	13.36^{bc}±0.14	13.45^{b}±0.01	13.85^{a}±0.01	0.2
Crude fibre (g)	0.36^{e}±0.01	1.87^{c}±0.01	2.43^{c}±0.01	0.04
Carbohydrate (g)	68.25^{a}±0.23	67.41^{b}±0.03	67.04^{c}±0.01	0.33
Total Ash (g)	1.48^{e}±0.01	2.06^{c}±0.01	2.23^{b}±0.01	0.04
Calcium (mg)	23^{a}±0.43	69.3^{b}±0.23	84.8^{c}±0.17	0.88
Phosphorous (mg)	121^{a} ±1.76	169.3^{b}±0.34	185.4^{c}±0.44	3.22
Iron (mg)	2.7^{a}±0.11	4.75^{c}±0.08	5.44^{b}±0.12	0.42
Energy (Kcal)	438.44^{a} ±0.26	432.09^{c}±0.09	433.53^{b} ±0.05	0.38

Note- *Values are mean ± SE of three replications. Means with same superscript (a, b, c, d and e) in the same row differ significantly (P <0.05).*

In Table 3.1 it was observed that control (C_0) cookies contained 5.23% moisture, 1.48% ash content, 11.3% crude protein, 13.36% crude fat, 0.36% crude fibre and 68.25% carbohydrate. The moisture content of both the millet incorporated treatments decreased gradually as 4.84% and 4.25% for C_2 and C_3, respectively. The decreased moisture content might be due to increase in total fibre content with addition of mixed millet flour. The ash content of C_2 and C_3 were found to be 2.06% and 2.23%, respectively. The ash content increased with increasing incorporation of mixed millet flour due to high mineral contents of finger and barnyard millet. The protein, fat, crude fibre and carbohydrate content of mixed millet cookies were observed to be 10.35% and 10.18%, 13.45% and 13.85%, 1.87% and 2.43% and 67.41% and 67.04%, respectively. It was noticed that control (C_0) cookies had 23, 121 and 2.7 mg of calcium, phosphorous and iron content per 100g of sample. The most highly accepted C_2 and C_3 cookies contained higher content of calcium, phosphorous and iron i.e. 69.3 and 84.8, 169.3 and 185.4 and 4.75 and 5.44mg per 100g, respectively.

Table 3.2. Nutrient composition of control and highly accepted millet-based pizza base (per 100g on dry matter basis)

Nutrients (per 100g)	P_0	P_2	P_3	CD@5%
Moisture (%)	18.08^{b}±0.67	21.68^{a}±0.09	22.68^{a}±0.54	2.64
Crude protein (g)	11.16^{b}±0.32	12.43^{a}±0.35	12.29^{a}±0.30	1.00
Crude fat (g)	3.50^{b}±0.41	4.83^{a}±0.15	5.24^{a}±0.37	0.98
Crude fibre (g)	2.99^{b}±0.14	4.60^{a}±0.32	4.90^{a}±0.26	0.84
Carbohydrate (g)	62.29^{a}±0.58	54.95^{b}±0.68	53.09^{b}±0.08	3.63
Total Ash (g)	1.56^{ab}±0.12	1.69^{b}±0.05	1.78^{b}±0.10	0.34
Calcium (mg)	46.80^{e} ± 0.76	102.32^{c}±0.41	109.67^{b}±0.42	1.40
Phosphorous (mg)	325.44^{e}±0.28	352.81^{b}±0.08	350.29^{c}±0.15	0.89
Iron (mg)	4.24^{d} ± 0.05	5.08^{b} ± 0.04	5.22^{bc} ± 0.02	0.24
Energy (Kcal)	325.3^{a} ± 0.41	312.99^{b}±0.36	308.68^{c}±0.25	0.92

Note- *Values are mean ± SE of three replications. Means with same superscript (a, b, c, d and e) in the same row differ significantly (P <0.05).*

From Table 3.2 The control pizza base contains 1.96% ash, 18.08% moisture, 11.16% protein, 3.50% fat, 2.99% fibre and 62.29% carbohydrate. In mixed millet pizza base, except P_4 other three formulations i.e., P_1, P_2 and P_3 had ash values significantly higher ($p<0.05$) than the control ranging 1.58-2.15%. Moisture ranging 21.09-23.13%, protein ranging 11.89-12.82%, fat ranging 4.54-5.33% and fibre ranging 4.46-5.01% were significantly ($p<0.05$) higher than the control sample. Carbohydrate values of all millet-based treatments were significantly ($p<0.05$) lower than the control which ranges 52.48-55.49%. Mixed millet pizza bases had calcium content for P_2 (102.37mg/100g) and P_3 (109.67mg/100g), iron content for P_2 (5.08mg/100g) and P_3 (5.24mg/100g) and phosphorus content for P_2 (352.81mg/100g) and P_3 (350.29mg/100g).

3.4. Shelf-life evaluation of the developed cookies and pizza base

From the sensory scores of the cookies and pizza base, it was observed that the taste, flavour and overall acceptability of the cookies obtained good scores up to 60 days i.e. 2 months and afterwards the flavour got less scores due to the development of rancidity in room temperature due to absence of any artificial preservatives. The pizza base had its taste, flavour, texture, and overall acceptability good and stable up to 3 days and afterward it develops off-flavour.

Both control and highly accepted treatments of cookies and pizza base were not acceptable by the panel members after 60 days and 3 days, respectively.

4. DISCUSSION

4.1. Sensory evaluation of the developed cookies and pizza base

In the cookies increasing proportion of finger millet and barnyard millet significantly affected the sensory score of colour (8.0-7.7), texture (7.8–7.2), flavour (7.4-7.0), taste (7.4-7.2) and overall acceptability (7.8-7.0) as depicted in figure 3.1. All the treatments of cookies made with mixed flours of barnyard millet and finger millet showed comparatively similar scores for colour, texture, flavour, taste, and overall acceptability as that of the control cookies. Treatments C_2 (20%) and C_3 (30%) were considered more accepted than the other two treatments as per the overall acceptability score.

In the pizza base, increasing proportion of little millet and finger millet significantly affected the sensory score of colour (7.4-6.1), texture (7.6–6.5), flavour (7.6-6.6), taste (7.4-6.2) and overall acceptability (7.7-6.5) as depicted in figure 3.2. The difference in score for colour may be the increment of finger millet proportion which darkened the pizza base. The score for texture decreased as millet concentration increased may be due to breads or bakery items formulated with gluten-free flour are

denser and harder than regular gluten-containing flour bread.[20] Treatments P_2 (20%) and P_3 (30%) were considered more accepted than the other two treatments as per the overall acceptability score.

4.2. Nutrient analysis of the developed cookies and pizza base

From Table 3.1 was noticed that C_0 contained the highest moisture, protein, and carbohydrate and lowest fibre and fat. C_3 contained maximum fibre and ash and minimum protein. Control and all two treatments of mixed millet cookies differ significantly ($P < 0.05$) on their proximate value. The most highly accepted C_2 and C_3 contained higher amounts of fat, fibre and ash contents with lower protein, carbohydrate and energy values as compared to the control cookies. Similar results were observed by Krishnan *et al.*, (2011), Saha *et al.*, (2011), Kishorgoliya *et al.*, (2018) and Kaur *et al.*, (2020).[10,12,13,22] The increase in calcium, phosphorous and iron content might be due to higher mineral contents present in both finger and barnyard millets. Similar results were obtained by Desai *et al.*, (2010), Kulkarni *et al.*, (2012), Lande *et al.*, (2017) and Dangal *et al.*, (2021) during their own studies.[5,6,14,15]

The result in Table 3.2 showed increased value of ash (1.56-1.78%), moisture (18.08-22.68%), fat (3.50-5.24%), fibre (2.99-4.90%), protein (11.16-12.29%) and decrease in carbohydrate (55.49-52.48%) with the addition of millet flours. Similar results were observed by Singh *et al*. (2012) in his research on bread prepared from composite flour incorporating wheat flour, barnyard millet, proso millet and finger millet flour.[25] All the proximate values were higher than the control sample except the carbohydrate content which decreased significantly ($p<0.05$). Increased fibre content was due to a good crude fibre ratio in finger millet, little millet and flaxseed.[11] Except protein, carbohydrate and phosphorus all the other values increased significantly ($p<0.05$) as the millet proportion increased. In the pizza bases the range of values of developed treatments were calcium (46.80-102.32mg), iron (4.24-5.22mg) and phosphorous (325.44-350.29mg) per 100g sample. All the millet-based treatments were found to contain higher amount of calcium, iron and phosphorous. Similar results were reported during the development of a multigrain pizza base by Agarwal and Verma (2016).[1]

4.3. Shelf-life evaluation of the developed cookies and pizza base

For cookies, initially LDPE pouch container demonstrated visually appealing cookies with high colour scores. However, as the storage duration increased, a substantial decline in colour was evident for all cookie types. This suggests that colour stability is compromised over time, indicating a potential challenge in maintaining the visual appeal of the cookies. Similarly, the initial texture scores indicated desirable textural qualities for all cookie types, regardless of the packaging material. However, as the storage period progressed, a consistent decline in texture scores was observed. By day-60, all cookies exhibited a significant decrease in texture, implying a potential loss in crispness or crunchiness. Flavour profiles of the cookies were initially satisfactory, but a notable decline occurred as storage time increased. This suggests that the flavour characteristics are susceptible to deterioration over the storage period, emphasizing the need for strategies to maintain flavour stability. Taste acceptability was high initially for all cookie types, yet a consistent decline in taste scores was observed over the storage period Overall acceptability scores reflected a similar trend, with high initial scores diminishing over the 60-day storage period for both PP pouch and PET container. This suggests that the overall likability of the cookies experienced a decline, emphasizing the challenge of maintaining consumer acceptance during extended storage.

For pizza base, it was found that along with control the scores for all the sensory parameters decreased with increase in storage intervals. It was evident from the current investigation that at 4th day of storage change in taste was observed. so, the pizza bases were acceptable up to 3rd day which was similar to the results given by Reddy *et al.*, (2017) and Kakade *et al.*, (2023).[9,21] The shelf-life of developed pizza base were found to be 3 days and further it could be stored 2-3 days more if stored in refrigerator.

5. CONCLUSION

From the above study, it has been concluded that the addition of finger millet and barnyard millet during the preparation of cookies and finger millet, little millet, flaxseed and peanuts in pizza base helped in increasing their nutritional value in terms of dietary fibre, total ash, moisture and minerals such as calcium, phosphorous and iron. Thus, value addition of bakery products such as cookies and pizza base can be beneficial for infants, school-going children, adolescents, pregnant and lactating women as well as the elderly people for their growth and maintenance. Also being of low glycaemic index and dense in dietary fibre, micronutrients and antioxidants millet incorporated bakery products can be safer options for people suffering from diabetes, obesity, cardiovascular diseases, osteoporosis, anemia etc. Millet-incorporated bakery products can be effective in managing micronutrient deficiency disorders in the community level.

FUTURE SCOPE OF THE STUDY

The present study facilitates the development and commercialization of low GI based, millet-incorporated functional cookies, pizza base and other bakery products as well as ready-to-eat products among the consumers, especially those who suffers from diabetes mellitus, cardiovascular diseases, obesity and other life-style related disorders.

CONFLICT OF INTEREST

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

ACKNOWLEDGEMENT

The authors express their heartfelt gratitude to Indian Council of Agricultural Research (ICAR) and Odisha University of Agriculture and Technology for providing the financial assistance during the research work and the Central Laboratory Facilities of OUAT, Bhubaneswar for the timely provision of nutrient analysis.

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