DR-2198
[1-7]

RESEARCH ARTICLE Asian Journal of Dairy and Food Research

Impact of Malting and Moist-steaming on Carbohydrate and Dietary Fibre Quotient of Millets and its Utilization in the Preparation of Low Estimated Glycemic Index and High Fibre Pizza Base

A.C. Dagadkhair[1], P.D. Shere[1], R.B. Kshirsagar[2]

10.18805/ajdfr.DR-2198

ABSTRACT

Background: The Carbohydrate and dietary fibre quotients (CQ and DFQ) are an indication of total carbohydrate, dietary fibre and its fractions *viz*. soluble and insoluble. Malting is a nutrition transition natural method having many benefits. Further, a resistant starch (RS) is called a fraction of dietary fibre which forms on heating starch rich foods. Millets were malted and moist steamed in order to improve CQ and DFQ and used in preparation of pizza base.

Methods: The moist steamed millets (MSM) malt was analyzed under Scanned Electronic Microscopic (SEM) to detect RS. The developed pizza base was analyzed for proximate composition, in-vitro digestibility and Estimated Glycemic Index (EGI) *etc.*

Result: The SEM of moist steamed malt showed the retrograded starch molecules as an effect of moist steaming and cooling process. The proximate composition of pizza base showed a significant change in all parameter on fortification. The microbial parameters were slightly affected on fortification. The total starch, rapidly digestible starch (RDS), slowly digestible starch (SDS) and resistant starch (RS) content were too reduced on fortification. The Hydrolysis Index (HI) and Estimated Glycemic Index (EGI) were too decreased from 45.06 to 31.74 and 64.45 to 53.14 respectively on fortification. Hence, it is concluded that the MSM malt utilization in pizza base has impact on overall quality of pizza base including physico-chemical properties, microbial and EGI. The high fibre and RS millets malt could be utilized in the preparation of high fibre and low EGI pizza base.

Key words: Malting, Moist-steaming, Pizza base.

INTRODUCTION

The rising health complications are igniting the minds of food technologist to shift the product development paradigm towards fulfilling the consumer aspirations with respect to prevention of disease or disorder. The millets are a known source of dietary fiber and well known for minerals. The millets are processed by different ways *viz*. milling, soaking, germination, roasting, fermentation, popping, cooking, extrusion and radiation (Anonymous, 2023). Millets are also a great source of phytochemicals that serve as immune system regulators, detoxifying agents, antioxidantsand other roles, preventing age-related degenerative illnesses like cancer, diabetesand cardiovascular diseases. The millets are also reported to have anti-inflammatory, hypolipidemic and low-glycemic index qualities (Rao *et al*., 2017; Nitya and Keshavan, 2018; Chaturvedi, 2018).

Malting involves carefully regulating soaking and germination under circumstances that produce the desired chemical, biochemical and physical changes related to the germination process. Additionally, malting has been shown to enhance the amount of soluble sugars, lysine, methionine, water-soluble proteinsand diastatic activity in the malt (Kundai *et al*., 2023).

RS is a linear a 1,4-D-glucan molecule that primarily comes from retrograded amylose in cooked starchy foods. It was discovered that resistant starch (RS) produced when rice and ragi were parboiled, expanded, popped, flaked, dried on rollers, cooked in extrusions, maltedand autoclaved. The RS has low calorie content (1.6-2.8 Kcal/g), it can complement low-fat and low-sugar food formulations and add distinctive qualities in addition to dietary fiber fortification in high-fiber foods (Admajith *et al*., 2021).

The millets could be explored for the development of low GI food products and many of scientists have produced

[1]Department of Food Process and Product Technology, MIT School of Food Technology, MIT Art, Design and Technology University, Pune-412 201, Maharashtra, India.
[2]College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431 402, Maharashtra, India.

Corresponding Author: A.C. Dagadkhair, Department of Food Process and Product Technology, MIT School of Food Technology, MIT Art, Design and Technology University, Pune-412 201, Maharashtra, India. Email: amoldagadkhair007@gmail.com

How to cite this article: Dagadkhair, A.C., Shere, P.D. and Kshirsagar, R.B. (2024). Impact of Malting and Moist-steaming on Carbohydrate and Dietary Fibre Quotient of Millets and its Utilization in the Preparation of Low Estimated Glycemic Index and High Fibre Pizza Base. Asian Journal of Dairy and Food Research. DOI: 10.18805/ajdfr.DR-2198.

Submitted: 24-01-2024 **Accepted:** 20-06-2024 **Online:** 23-07-2024

various products including roti, dosa and dumpling (mudde) from millets mix (Geetha *et al*., 2020; Narayanan *et al*., 2016), Foxtail and Barnyard based biscuitsand many more. Thus new products high in fibre and low GI pizza base are apt for the present situation as the pizzas are popular among all the groups. Malting is a nutrition transition natural method having many benefits. Millets when malted and moist steamed improves Carbohydrate and Dietary fibre and can be used in preparation of pizza base.

MATERIALS AND METHODS

Materials

Raw ingredients including millets, refined wheat flour, salt, sugar, yeast and others were accessible at the Bakery Plant of the MIT Art, Design and Technology University, Pune.

The presented research is a part of PhD research work conducted during the year 2022 to 2023 at the School of Food Technology, MIT Art, Design and Technology University, Pune.

Preparation of moist steamed millets (MSM) malt

The selected millets namely finger, foxtail and barnyard millets were initially malted and later on moist steamed followed by cooling.

Scanning electronic microscopy (SEM) of raw, malted millets and moist steamed millets malt

The SEM of samples was done by using model FEI Nova NanoSEM NPEP303. The samples were observed at 3 to 10 kV at differential pressure and magnification up to 1000.

Carbohydrate quotient (CQ)

The CQ is a new term that was created and quantified as a ratio of non-digestible (includes dietary fibers and RS) to digestible carbohydrates (includes RDS and SDS). It was determined using the equation (1).

$$CQ= \frac{\text{Non digestible carbohydrate}}{\text{digestible carbohydrate}} \quad \text{...(eq 1)}$$

Dietary fibre quotient (DFQ)

The DFQ is a ratio soluble dietary fibres (including RS) to insoluble dietary fibres and calculated by following equation (2).

$$CQ= \frac{\text{Soluble dietary fibres}}{\text{Insoluble dietary fibres}} \quad \text{...(eq 2)}$$

Preparation of moist steamed millets (MSM) malt fortified pizza base

The MSM malt fortified pizza base was made in accordance with the Table 1 formulas and Flowsheet 1 (NIIR, 2014).

Proximate composition of prepared products

According to the standard procedures, the proximate composition of prepared pizza base were examined for moisture, total carbohydrate, protein, crude fiber, crude fat, ash contentand minerals content (AOAC, 2005a; AOAC, 2005b).

Starch digestibility (*In vitro*) and estimated glycemic index (EGI) of moist steamed millets (MSM) malt pizza base

The standards technique and framework were employed to evaluate the *in vitro* hydrolysis of starch. The starch hydrolysis kinetics was characterized by using a nonlinear equation which was adjusted to the digestion curves by using a methodology given by (Mohamed *et al*., 2017).

Microbial quality of moist steamed millets (MSM) malt fortified pizza base

The pizza base was fetched for microbial examinations like total plate count (TPC) and yeast and mold count (YMC) after manufacturing for 4 days storage period to determine its shelf life (Aneja, 2007).

Sensory evaluation

The sensory assessment of the developed pizza base was carried using nine point hedonic scale (from dislike extremely to like extremely in merit order) method (Sukanya and Michael, 2014).

Statistical analysis

A triplicate of each measurement was made to determine the level of significance (p<0.05), the findings were examined using one-way analysis of variance (ANOVA). Microsoft Excel 2016 and IBM SPSS Statistics version 29.0.0.0 were used to conduct the statistical analyses.

Table 1: Formulation for moist steamed millets (MSM) malt fortified pizza base.

Ingredients (g)	Maida (g)	Foxtail millet (g)	Finger millet (g)	Barnyard millet (g)	Sugar	Salt	Soybean oil	Yeast	CP
Control	100	-	-	-					
FPB1	94	2	2	2					
FPB2	91	3	3	3					
FPB3	88	4	4	4					
FPB4	85	5	5	5	3 g	2 g	2 ml	4 g	1 g
FPB5	82	6	6	6					
FPB6	79	7	7	7					
FPB7	76	8	8	8					
FPB8	73	9	9	9					
FPB9	70	10	10	10					

RESULTS AND DISCUSSION

The impact of malting and moist steaming on the microstructural characteristics of millets

Fig 1, 2 and 3 namely raw, malted and moist steamed millets were examined at 2500X magnification. Fig 1 showed the compact starch molecules without any distortion. In the Fig 2, malted millets starch molecules were observed to be distorted which could be due to the enzymatic (amylases) action on starch molecules. Fig 3 of moist steamed malted millet flour recorded presence of retrograded starch molecules due to the cycles of moist steaming and cooling process.

Effect of malting and moist steaming on CQ and DFQ of millets

The malting and moist steaming process alters the total carbohydrates, dietary fibers and RS content which reflects on CQ and DFQ of malted millets flour as shown in Table 2. The CQ of millets (raw, malted and moist steamed) ranged from 0.08 to 0.50. Amongst the various samples listed in Table 2, the moist steamed millet samples showed significantly improved CQ (0.19, 0.21 and 0.50) than raw (0.08, 0.15 and 0.29) and in the same context moist steamed BM showed highest 0.50 and raw FM showed lowest 0.08 CQ.

Sensory profile of moist steamed millets (MSM) malt fortified pizza base

The sensory profile analysis results are as per Graph 1. The sensory characteristics including overall acceptability of pizza base was recorded in decreasing manner as previous trend. On considering the scores of panelist it was decided to take up the FPB8 sample for further study.

Proximate composition of moist steamed millets (MSM) malt fortified pizza base

The proximate composition of pizza base was analyzed and the results are depicted in Table 3. A significant difference in moisture content ($p<0.05$), was recorded. Protein and carbohydrates were found to be significantly decreasing from 9.21% to 8.73% and 57.37% to 52.20% in control and FPB8 respectively. The fat content of FPB8 (1.07%) significantly reduced than control (1.30%). The similar effect was observed in fiber (0.34% to 3.13%) and crude ash content (0.81% to 2.26%) in control and FPB8 respectively. The superior mineral composition of millet malt resulted in significant increase in minerals *viz*. calcium (151 to 164 mg/100g), phosphorous (183 to 199 mg/100 g), magnesium (24.0 to 76.6 mg/100 g) and iron (2.42 to 4.28 mg/100g) in FPB8 in comparison with control. The theoretical energy value of pizza base was noted to be decreased with fortification.

In-vitro digestibility and EGI of moist steamed millets (MSM) malt fortified pizza base

The starch hydrolysis values for control and fortified pizza base shows (Table 4 and Graph 2) that the starch hydrolysis was consistently less in fortified samples from the beginning to the end of hydrolysis process, *i.e.* control (64.66 to 83.80) and fortified pizza base (61.89 to 78.10) 30 min and at 180 min respectively. The total starch content was reduced from 73.25% (control) to 71.35% (FPB8). The RDS was decreased from 47.90% (control) to 44.27% (FPB8). The SDS and RS were found to be in an increasing

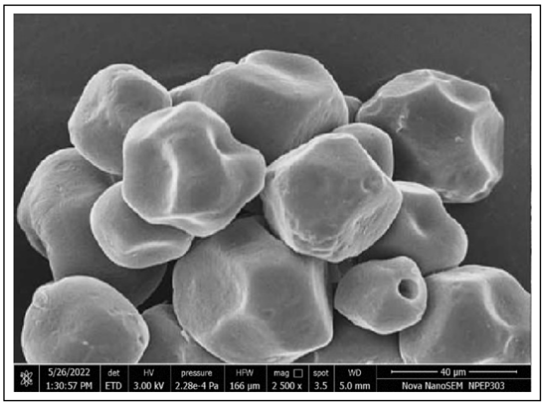


Fig 1: Microstructure of native starch molecules in millet.

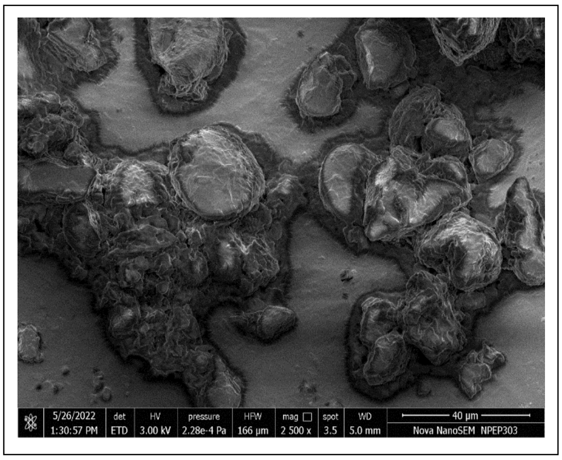


Fig 2: Microstructure of starch molecules in malted millets.

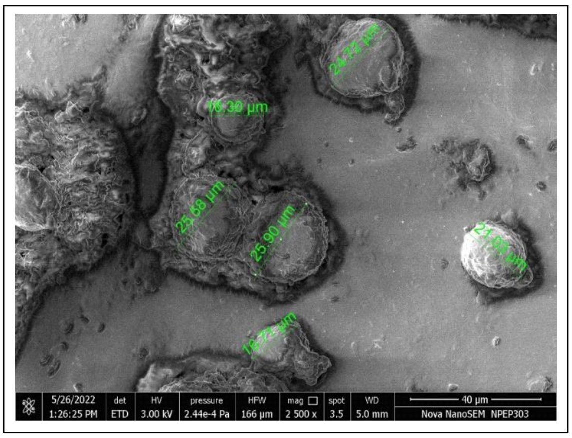


Fig 3: Microstructure of starch molecules after steaming and cooling cycles.

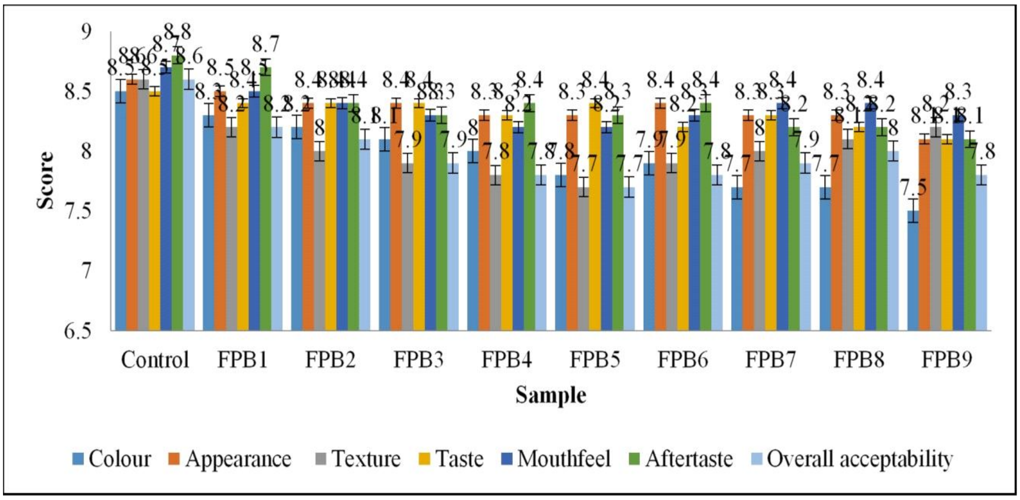
order on fortification. The SDS and RS in pizza base were found to be as from 23.22% (control) to 24.24% (FBP8) and from 2.41% (control) to 4.34% (FPB8) respectively.

The HI for control and fortified (FPB8) were recorded as 45.06 and 31.74, which clearly shows that CQ and DFQ enhanced millets malt have significantly impacted HI of pizza base. Simultaneously, the EGI of prepared products shows the similar effect like HI. The EGI of prepared pizza base was significantly affected as 64.45 and 54.14 for control and FPB8 respectively.

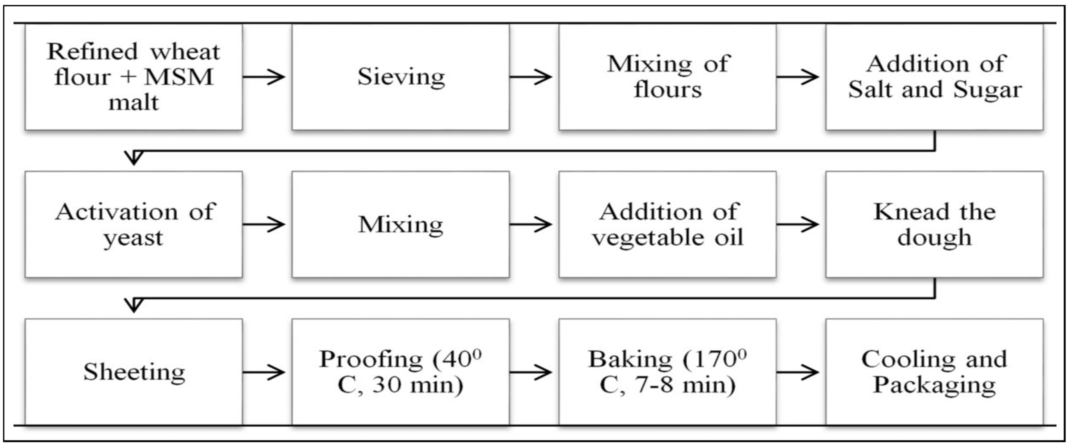
Table 2: Effect of malting and moist steaming on CQ and DFQ of millets.

Sample		CQ	DFQ
	Raw	0.08±0.00^{g}	0.61±0.00^{b}
Finger millet	Malted	0.15±0.01^{f}	0.51±0.01^{c}
	MS	0.19±0.01^{e}	0.85±0.01^{a}
	Raw	0.15±0.01^{f}	0.23±0.01^{h}
Foxtail millet	Malted	0.18±0.01^{e}	0.26±0.02^{g}
	MS	0.21±0.01^{d}	0.48±0.02^{d}
	Raw	0.29±0.01^{c}	0.43±0.01^{e}
Barnyard millet	Malted	0.41±0.00^{b}	0.39±0.01^{f}
	MS	0.50±0.00^{a}	0.63±0.01^{b}

Values followed by the different letters in the same column are significantly different ($p<0.05$).
*each value is a determination of 3 values.



Graph 1: Sensory Evaluation of moist steamed millets malt fortified pizza base.



Flowsheet 1: Preparation of moist steamed millets (MSM) malt fortified pizza base.

Microbial quality of moist steamed millets (MSM) malt fortified pizza base

The microbial quality evaluation results are recoded in the following Table 5. The zero days recorded no bacterial and fungal growth however, on subsequent storage days from day 1 to 4 TPC and yeast and mold ranged from 0.35×10^{2} to 2.23×10^{3} and 0.54×10^{2} to 2.82×10^{3} for control sample respectively. Similarly, for FPB8 sample, TPC and yeast

Table 3: Proximate composition of moist steamed millets (MSM) malt fortified pizza base.

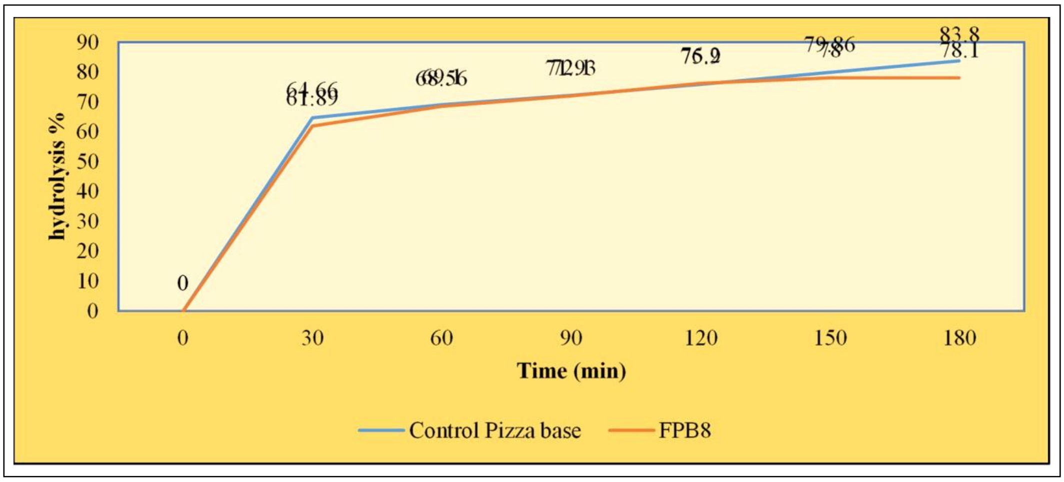
Parameter (%)	Control	FPB8
Moisture	30.54±0.01^{b}	32.12±0.02^{a}
Carbohydrate	57.37±0.02^{a}	52.20±0.05^{b}
Protein	9.21±0.01^{a}	8.73±0.05^{b}
Fat	1.30±0.01^{a}	1.07±0.02^{b}
Dietary fiber	0.34±0.01^{b}	3.13±0.05^{a}
Ash	0.81±0.01^{b}	2.26±0.15^{a}
Energy (Kcal)	278.12±0.19^{a}	255.22±0.49^{b}
Minerals (mg/100g)		
Ca	151±1.00^{b}	164±1.00^{a}
P	183±1.00^{b}	199±1.00^{a}
Mg	24.0±2.00^{b}	76.6±1.52^{a}
Fe	2.42±0.03^{b}	4.28±0.01^{a}

Values followed by the different letters in the same row are significantly different (p<0.05).
*each value is a determination of 3 values.

Table 4: Starch fraction of moist steamed millets (MSM) malt fortified pizza base.

Sample	Control	FPB8
Total starch	73.25±0.04^{a}	71.35±0.15^{b}
Rapidly digestible starch (RDS)	47.90±0.15^{c}	44.27±0.12^{d}
Slowly digestible starch (SDS)	23.22±0.05^{b}	24.24±0.03^{a}
Resistant starch (RS)	2.41±0.01^{c}	4.34±0.01^{a}
C"	36.10±0.10^{c}	34.60±0.02^{d}
K	0.02±0.00^{a}	0.01±0.00^{b}
AUC	4742.32±3.14^{c}	3339.93±2.00^{d}
HI	45.06±0.12^{c}	31.74±0.02^{d}
EGI	64.45±0.07^{c}	54.14±0.01^{d}

Values followed by the same letters in the same row are not significantly different (p<0.05).
*each value is a determination of 3 values.



Graph 2: Starch digestibility (In vitro)/ Hydrolysis curve.

Table 5: Microbial quality of moist steamed millets (MSM) malt fortified Pizza base.

Storage period (Days)	Total plate count(cfu/g)		Yeast and mold count(cfu/g)	
	Control	FC3	Control	FC3
Fresh	Not detected	Not detected	Not detected	Not detected
15	0.5 ± 0.00^{d}	0.53 ± 0.01^{d}	0.22 ± 0.01^{d}	0.24 ± 0.01^{d}
30	1.5 ± 0.02^{c}	1.62 ± 0.01^{c}	0.41 ± 0.01^{c}	0.44 ± 0.01^{c}
45	$1.31\times10^{2}\pm0.01^{b}$	$1.34\times10^{2}\pm0.00^{b}$	$0.63\times10^{2}\pm0.00^{b}$	$0.67\times10^{2}\pm0.00^{b}$
60	$2.47\times10^{2}\pm0.01^{a}$	$2.54\times10^{2}\pm0.01^{a}$	$0.89\times10^{2}\pm0.01^{a}$	$0.92\times10^{2}\pm0.01^{a}$

Values followed by the different letters in the same row are significantly different ($p<0.05$).

*each value is a determination of 3 values.

and mold count was increased from 0.36×10^{2} to 2.28×10^{3} and 0.58×10^{2} to 2.84×10^{3} respectively.

Microstructural characterization of raw and malted millet flour

The repeated heating and cooling cycle dissolved and recrystallized the amylose molecules as well as made the surface rough. Thus, hypothesized that the distortion during malting process split the amylopectin molecules into amylose fraction which got retrograded (turned to RS3) on moist steaming and cooling cycle. A similar effect on starch molecules was reported by group of scientist (Yunzhan *et al*., 2020).

Effect of malting and moist steaming on CQ and DFQ of millets

It was observed from the present study that the malting and moist steaming process altered the total carbohydrates, dietary fibers and RS content which reflects on CQ and DFQ of malted millets flour, the moist steamed millet samples showed significantly improved CQ than raw and in the same context moist steamed BM showed highest and raw FM showed lowest CQ. The moist steaming process shows a significant influence to alter the CQ. The increased dietary fibre and RS content on malting and moist steaming are the prime factors in increasing the CQ and DFQ. The improved CQ in millets showed its probable utilization as a source of dietary fibres in human diet (Banusha *et al*., 2013).

Sensory profile of moist steamed millets (MSM) malt fortified pizza base

The fall in sensory score for fortified millets pizza base was due to increased content of millets (which has a dark colour and makes the product less appealing) in the formulation. The similar effects were noted in foxtail millet millets fortified pizza base. The taste was changed due to the fortification of millet malt which imparts slightly malty and sweet taste in the product. This shift in texture parameter could be attributed to increased soluble dietary fibre content that holds more moisture causing softness in pizza base texture (Veena *et al*., 2020).

Proximate composition of moist steamed millets (MSM) malt fortified pizza base

The rise in moisture attributed to the tendency of increased dietary fibers to absorb and retain water in the malt fortified pizza base. The fortified pizza base recorded lower carbohydrates and fat content than control and it was due to utilization multi-millets malt which depicts lower carbohydrates and fat content than refined wheat flour (Takawale *et al*., 2021; Samson *et al*., 2023). The reason behind elevated contents in said minerals was solely due to fortification of mineral rich millets malt. The equivalent results pertaining enhancement in above nutrients were noted by (Priyadarshana *et al*., 2021; Samson *et al*., 2023).

***In vitro* digestibility and EGI of moist moist steamed millets (MSM) malt fortified pizza base**

The fortification of MSM malt significantly impacted the starch hydrolysis and it was due to enhanced dietary fibre content especially RS3 in the pizza base. The clear change in total starch, SDS and RS was due to fortification of moist steamed millets malt. There was a strong correlation between the HI of the pizza base and the starch fractions. The index of starch hydrolysis and ultimately the EGI was observed to be affected by amylose/amylopectin ratio, the kind of starch, the physical entrapment of starch molecules within food, food processingand other food matrix elements such as sugars, fat, protein, dietary fiberand anti-nutrient content (Ferrer *et al*., 2012; Faviola *et al*., 2013; Edith *et al*., 2012; Jan *et al*., 2011).

Microbial quality of moist steamed millets (MSM) malt fortified pizza base

The rate of microbial deterioration was found to be significantly more in FPB8 sample compared to the sample prepared from refined wheat flourand this might be due to more moisture content held by fortified pizza base and the packaging material used. The microbial count is within the safe limit of specifications laid down by FSSAI and Codex (Sagar and Pareek, 2020).

CONCLUSION

The low calorie and high dietary fibre pizza base was made by using thermally treated millets malt. The moist steamed millets malt was analysed for SEM, CQ and DFQ and the product was evaluated for proximate composition, *in-vitro* digestibility and Estimated Glycemic Index (EGI) *etc.* Based on the net outcome of the above analysis, it has noted that the good quality pizza base could be made with such a moist millets malt with minimum effect on quality.

ACKNOWLEDGEMENT

We the authors of this article would like to acknowledge the MIT Art, Design and Technology University, Pune for providing us a state of art facilities to conduct the research and providing the facilities for analysis and statistical tools to conduct statistical analysis.

Conflict of interest

The authors of this article have no conflict of interest.

REFERENCES

Admajith, M., Kaimal, A., Mujumdar, S. and Bhaskar, N.T. (2021). Resistant starch from millets: Recent developments and applications in food industries. Trends in Food Science and Technology 111: 563-580.

Aneja, K.R. (2007). Experiments in microbiology, plant pathology and biotechnology. New age international, pages 9-55.

Anonymous, (2023). India millets production. Agricultural and processed food products export development authority (APEDA). https://apeda.gov.in/milletportal/Production.html. Accessed on 19.09.2023.

AOAC. (2005a). Official Methods of Analysis of Association of Official Analytical Chemists, 20th Edn. AOAC, Washington. D.C.

AOAC. (2005b). Official methods of analysis of Association of Official Analytical Chemists, 17th Edn, Vol. 2. AOAC, Washington. D.C.

Banusha, S. and Vasantharuba, S. (2013). Effect of malting on nutritional contents of fingermillet and mungbean. American-Eurasian Journal of Agricultural and Environmental 13: 1642-1646.

Chaturvedi, N. (2018). Quality evaluation of malted barnyard millet flour and development of value added rusk. international journal for research in applied science and engineering technology 6: 631-636.

Edith, A.A., José, J.I.H., Glenda, P.V., Perla, O.D. and Luis, A.B.P. (2012). Starch digestibility and glycemic index of cookies partially substituted with unripe banana fiour. LWT - Food Science and Technology. 46: 177-182.

Faviola, R.P., María, G.S., Ana, L.R.B., Alma, R.I.R. and Benjamín, R.W. (2013). Estimated glycemic index and dietary fiber content of cookies elaborated with extruded wheat bran. Plant Foods for Human Nutrition. 68: 52-56.

Ferrer, M.A., Penalva, L.C., Iglesia, I., Urtasun, L., De Miguel, Etayo, P., Remon, S., Corte's, E. and Moreno, L.A. (2012). *In vitro* and *in vivo* assessment of the glycemic index of bakery products: infiuence of the reformulation of ingredients. European Journal of Nutrition 51: 947-954.

Geetha, K., Geetha, M.Y., Savita, H. and Netravati, H. (2020). Glycemic index of millet based food mix and its effect on pre diabetic subjects. Journal of Food Science and Technology. 57: 2732-2738.

Jan, P.S., Jasmin, W., Ute, B., Michaela, H., Heike, K., Inga, S., Katharina, M. and Andreas, H. (2011). Glycemic index and microstructure analysis of a newly developed ûber enriched cookies. Food Function 7: 464-474.

Kundai, T.M., Shonisani, E.R., Mpho, E.M. (2023). Effect of malting on physicochemical, antioxidantand microstructural properties of finger millet (*Eleusine coracana*) flours. Food Science and Nutrition 00: 1-17.

Mohamed, L., Rachid, S., Badreddine, B., Ladjel, T., Djaffar, D., Boubekeur, N. (2017). Starch digestion in pearl millet [*Pennisetum glaucum* (L.) R. Br.] flour from arid area of Algeria. Journal of Applied Botany and Food Quality 90: 126-131.

Narayanan, J., Sanjeevi, V., Rohini, U., Trueman, P., Viswanathan, V. (2016). Postprandial glycaemic response of foxtail millet dosa in comparison to a rice dosa in patients with type 2 diabetes. Indian Journal of Medical Research. 144: 712-717.

NIIR, (Board of Consultant and Engineers'), (2014). The Complete Technology Book on Bakery Products (Baking Science with Formulation and Production) 4th Edition, NIIR Project Consultancy Services. pages 560-578.

Nitya, S. and Keshavan N. (2018). Foxtail millet: Properties, processing, health benefitsand uses. Food Research International. 34: 329-363.

Priyadarshana, D.B., Nallani, V.N., Chowdary, K.G.and Periyar, R.D. (2021). Evaluation of sensory attributes of millet based pizza base. International Journal of Chemical Studies. 9: 221-223.

Rao, B.D., Bhaskarachary, K., Christina, G.D.A., Devi, G.S., Tonapi, V.A. (2017). National and Health benefits of Millets. ICAR-Indian Institute of Millets Research (IIMR), Hyderabad, India. pp.10-38.

Sagar, N.A., Pareek, S. (2020). Dough rheology, antioxidants, textural, physicochemical characteristicsand sensory quality of pizza base enriched with onion (*Allium cepa* L.) skin powder. Scientific Reports 29: 10: 18669.

Samson, A.O., Ini-Abasy, V.B. (2023). Composition, functionality and baking quality of flour from four brands of wheat flour. Journal of Culinary Science and Technology. 1-7.

Sukanya, W., Michael, O.M. (2014). The 9-point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives. Journal of the Science of Food and Agriculture 95: 2167-2178.

Takawale, D.P., Mhalaskar, S.R., Kulthe, A. (2021). Studies on development of gluten free malted multi-millet cookies. Journal of Emerging Technologies and Innovative Research, 8: 1609-1618.

Veena, T., Udaykumar, N.and Sudha Devi, G. (2020). Millet incorporated pizza base. International Journal of Current Microbiology and Applied Science. 9: 2830-2837.

Yunzhan, Z., Zhencheng, W., Ruifen, Z., Yuanyuan, D., Xiaojun, T., Yan Z., Guang, L., Lei, L., Jiajia, W., Na L., Mingwei, Z. (2020). Optimization of the autoclave preparation process for improving resistant starch content in rice grains. Food Science and Nutrition 8: 2383-2394.