The Pharma Innovation Journal 2022; SP-11(8): 195-198

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(8): 195-198
© 2022 TPI
www.thepharmajournal.com
Received: 09-06-2022
Accepted: 12-07-2022

Nupur Selokar
Food Processing Business Incubation Centre, National Institute of Food Technology Entrepreneurship and Management, (NIFTEM-T), Thanjavur, Tamil Nadu, India

R Vidyalakshmi
Food Safety and Quality Testing, National Institute of Food Technology Entrepreneurship and Management, (NIFTEM-T), Thanjavur, Tamil Nadu, India

VR Sinija
Centre of Excellence in Non-Thermal Processing, National Institute of Food Technology Entrepreneurship and Management, (NIFTEM-T), Thanjavur, Tamil Nadu, India

Vincent Hema
Centre of Excellence in Grain Science, National Institute of Food Technology, Entrepreneurship and Management, (NIFTEM-T), Thanjavur, Tamil Nadu, India

Corresponding Author
Vincent Hema
Centre of Excellence in Grain Science, National Institute of Food Technology, Entrepreneurship and Management, (NIFTEM-T), Thanjavur, Tamil Nadu, India

Development and quality evaluation of malted millet flour

Nupur Selokar, R Vidyalakshmi, VR Sinija and Vincent Hema

Abstract
The most important source of food in the world is cereal grains, which also play a large part in the global diet of people. Additionally, millet grain is currently attracting more interest from food scientists, technologists, and nutritionists due to its significant contribution to national food security and possible health advantages. Scientists and nutritionists are challenged by these effects to look into the production, processing, and use of alternative food sources in order to eradicate hunger and poverty. Malting or germination is a suitable pre-treatment that may be used to enhance the nutritional qualities of native cereal grains. As a result, the effects of malting on proximate, water absorption index, water solubility index, and *in vitro* protein digestibility were explored and optimised in this study. When compared to raw millet flour, malted millet flour had greater protein content (M03-11.75 percent, M08-13.96 percent) and protein digestibility (M03-60 percent, M08-64 percent), and the overall results indicated that malted millet flour is healthier with good quality and nutrition.

Keywords: Quality evaluation, malted millet flour, food

1. Introduction
Cereals are key sources of the world's food supply and play a vital role in the worldwide human diet. It's common knowledge that cereals are a fantastic source of calories, protein, dietary fibre, and minerals (Slavin *et al*., 2000) [19]. Millets are cereal grains that are grown all throughout the world, with varying importance depending on continent and area. Millets, or small-seeded grains, are members of the Poaceae (Gramineae) family (Zhu, 2014) [22]. Millets are an important source of nutrition and a staple meal for millions of people in developing countries (Filli *et al*., 2010; Mridula & Sharma, 2015) [9, 13]. Millet is a popular crop among farmers in India, Africa, and China because to its hardiness, natural biodiversity, and very low agricultural input costs. Millets provide much-needed energy and, to a lesser extent, protein to the communities where they grow. Millets are possibly the earliest grains cultivated by man, with early cultivation reports dating back to roughly 5,550 BC (Crawford, 2006). In terms of output, India and China are the top two millet producers in the world. Finger millet (Eleusine coracana), proso millet (*Panicum miliaceum*), foxtail millet (Setaria italica), and pearl millet are the four primary varieties (*Pennisetum glaucum*) (Annor *et al*., 2017) [1]. Millets are ingested whole or hand-pounded, as opposed to rice and wheat, which are milled and polished. As a result, they contribute significantly not only to carbohydrate and protein intake, but also to vitamin and fibre intake (Antony *et al*., 1996) [2]. Millet grains have much more phenolic phytochemical compounds than other cereals (Taylor & Duodu, 2015) [20].
Malting is a metabolic process that results in the formation of a range of hydrolytic enzymes and bioactive substances. Malting is a regulated procedure of limiting germination of cereal grain (Banusha & Vasantharuba, 2013) [4]. When grains are malted, they are hydrated under ambient circumstances, and endogenous enzymes begin to transform the grain's contents, including soluble sugars, protein, and enzyme activity (Nadeem *et al*., 2010) [14]. Thus, malting enhances the nutritive content and digestibility of meals in general, and it may be an ideal easy strategy for obtaining the most iron and other minerals from grains. Locally accessible crops include fingermillet and mungbean (Platel *et al*., 2010) [16]. Numerous studies have demonstrated how germination may greatly enhance the protein content and nutritious profile of grains. Because nitrates are absorbed during germination, which speeds up the metabolism of nitrogenous substances from carbohydrate reserves, the crude protein level may rise (Najdi Hejazi *et al*., 2016) [15]. Additionally, because of an increase in the grain's proteolytic activity during germination, protein quality is enhanced. Because of this improvement, storage proteins, mostly prolamin, are hydrolyzed into albumins and globulins, which causes glutamic

and proline amino acids to be converted into limiting amino acids like lysine (Chavan & Kadam, 1989) [6]. Malted millet is widely used in weaning food, baby food, and supplement food formulations and is an excellent source of α- and β-amylases (Chethan *et al*., 2008) [7].

Millets are an inexpensive native cuisine that are abundantly farmed in India. Millets are also a rich source of nutrients. In order to assess and compare the nutritional changes in raw millet flour and malted millet flour, the current study was conducted.

Method and Material

Raw materials

The raw material such as Foxtail, Barnyard millet, little millet, Kodo millet, Proso millet, Finger millet, Pearl millet, Sorghum was selected and they are procured from a departmental store in Thanjavur, Tamil Nadu. And all the chemical were procured from Hi-Media, Chennai, Tamil Nadu.

Preparation Of millet flour and Malted millet flour

Using the millets, four varieties of flour were developed (germinated and non-germinated flour) namely three millet flour (C1), eight millet flour (C2), three millets malted millet flour (M03) and eight millets malted millet flour (M08). Three millets flour and three millets malted millet flour were developed or processed using finger millet, pearl millet, and sorghum. Eight millet flour and eight millets malted millet flour was processed or developed using Foxtail, Barnyard millet, Little millet, Kodo millet, Proso millet, Finger millet, Pearl millet, Sorghum. The millets were collected and cleaned to remove foreign materials such as mud, dust, and other debris.

Preparation of millet flour

The cleaned millet was roasted for 5min at 60C to remove the astringent flavor and then grind to make a fine powder by using pulverizer and seived.

Preparation of Malted millet flour (Three millets and Eight Millets)

The millets were cleaned and steeped in water for 24 hours at room temperature. Drain the water, germination was continued for 48 hours by keeping millets under wet muslin cloth. Ungerminated millets were removed, and sprouted/germinated grains were placed in a dryer for five hours to minimize the moisture content from the millets and for 5min at 60 ^{0}C, to get rid of the bitter taste, the dried, germinated seed was roasted. Then, the grain was ground in a pulverizer and sieved (Banusha & Vasantharuba, 2013) [4].

Proximate Analysis

Samples were examined for moisture, crude protein, ether extract, crude fibre, and ash using conventional A.O.A.C techniques in duplicate. The Kjeldhal nitrogen was converted to crude protein using a ratio of 6.25. By employing the Soxhlet equipment and the ether extraction technique, crude fat was identified. Acid digestion and the alkali digestion technique were used to measure the crude fibre. Ash concentration was assessed in a muffle furnace for six hours at 550 °C (Arif *et al*., 2011) [3].

Water absorption index (WAI) and water solubility index

WAI and WSI were calculated using a technique developed for cereals. Following thorough mixing, the ground flour blends were suspended in water at room temperature for 30 minutes, gently mixed throughout this time, then centrifuged at 3000 g for 15 minutes. The supernatants were decanted into a known-weight evaporating dish. The WAI was calculated as the weight of gel after supernatant removal per unit weight of original dry particles. The weight of dry solids in the supernatant calculated as a percentage of the original weight of the sample was used to calculate the WSI (Chauhan *et al*., 2015) [5].

In vitro protein digestibility

As per the (Samuel & Peerkhan, 2020) [17] 5 ml each sample were weighed in centrifuge tube, and 15 ml of 1.5 pepsin-pancreatin containing of 0.1 M HCl pancreatin was added. At 37 ^{0}C for 3hr incubate the tube. A phosphate buffer with 0.005 M sodium azide and a pH of 8.0 was used to neutralize the solution. To inhibit microbial development, add 1 mL of toluene, and the mixture was carefully mixed before being incubated for 24 hours at 37 °C. After being incubated, samples were treated with 10ml of 10% trichloroacetic acid (TCA) and spun at 5000rpm at room for 20 minutes at room temperature. The nitrogen content of the TCA-soluble fraction in the supernatant liquid was determined using the micro-Kjeldahl technique. The formula was used to determine the digestibility percentage of proteins (eq.1).

$$\text{Protein Digestibility \%} = \frac{(\text{N in the supernatant} - \text{N in the blank})}{\text{N in the sample}} \times 100 \ldots (\text{eq. 1})$$

Water Activity and Color

As per (Sethupathy *et al*., 2020) [18], the water activity of fresh snack bar assessed by using water activity meter(AQUA LAB Dew point water activity meter 4TE). The colour was determined using a Lovibond spectrocolorimeter (Model LC 100). After calibrating the spectrocolorimeter, unmalted and malted millet flour were deposited in cuvettes and introduced into the colour measuring instrument (Udeh *et al*., 2018) [21].

Statistical Analysis

All of the findings in this study are represented by the mean values of two distinct replication standard deviations (n=2 s.d.). Minitab 16 (Minitab Inc., State College, PA, USA) was used to conduct the statistical analysis. For numerous variables, an analysis of variance (ANOVA) was used, and a Tukey's test was used to discover significant differences. A simple linear correlation analysis was used to identify the relationship between the mean values (Jabeen *et al*., 2021) [11].

Result and Discussion

Proximate Analysis

Table 1 shows the proximate analysis result of Malted millet flour in comparison to raw millet flour. Malted millet flour contained much more protein than raw millet flour. All samples (C1, C2, M03, and M08) showed a significant difference (p<0.05). The higher protein concentration in Malted millet flour might be due to enzyme synthesis during germination, which could have resulted in the generation of certain amino acids during protein synthesis (Marero *et al*., 1989s; Uwaegbute *et al*., 2000). When comparing malted millet flour to raw millet flour, the fat content was reduced. There was a significant difference across all samples (p<0.05), which is due to increased lipolytic enzyme activity during germination, which hydrolyzes lipid components into fatty acids and glycerol. The ash level of M03 and M08

reduced as compared to raw millet flour, which might be owing to solubility in water and subsequent loss on leaching throughout these processing processes, as discovered in Arif *et al*., (2011) [3] research. All samples had a significant difference (p<0.05). As compared to raw millet flour, the malting procedure steadily increased the fibre content of Malted millet flour. Every sample (C1, C2, M03, and M08) had a significant difference (p<0.05). Malting and germination were the causes of the rise in crude fibre. Arif *et al*., (2011) [3], the similar effect was found with malted barley flour. The moisture level of malted flour significantly reduced owing to millet roasting and pre-process drying. Within the sample, there were substantial differences (p<0.05). The carbohydrate content of Malted millet flour decreased as compared to raw millet flour, and there was a significant difference within sample (p<0.05). The drop in carbohydrate content was caused by grain germination, and the increase in alpha amylase activity was discovered in the same research Chauhan *et al*., (2015) [5].

In vitro protein digestibility

Based on their initial and final values following pancreatin digestion in accordance with Eq (1), the tested samples' protein digestibility was assessed. Results are present quantitatively in Table 3. Malted millet flour had a greater *in vitro* protein digestibility than raw flour. Significant difference existed within the sample (p<0.05). While IVPD was estimated to be between 53 and 56 percent for raw millet flour samples (C1 and C2), upon malting, this value improved to between 60 and 64 percent (M03 and M08), indicating an improvement in protein digestibility. Same study were found in Najdi Hejazi *et al*., (2016) [15] where increase in IVPD content after germination/malting.

Water absorption Index (WAI) and Water solubility Index (WSI)

Malted millet flour exhibited a considerably greater WAI than raw millet flour, and there was a significant difference within the sample (p<0.05). It was discovered that malting and germination increase grains' ability to absorb water, Jawad *et al*., (2013) [12], same result were found in current study. As a result of the breakdown of polysaccharide molecules and the increase in protein amount and quality brought on by germination, there are more sites for water interaction and water retention (Gamel *et al*., 2006) [10]. Similarly, the WSI of Malted Millet Flour increased as compared to raw millet flour, and there was no significant difference in Malted millet flour (M03 and M08) and raw millet flour (C1 and C2) (p<0.05). According to Chauhan *et al*., (2015) [5] study he found that as a result of the breakdown of polysaccharide molecules and the increase in protein amount and quality brought on by germination, there are more sites for water interaction and water retention.

Color and Water Activity

The color values for flour, (ungerminated and germinated flour) are displayed in Table 6. Following Raw millet flour, the malted millet flour exhibits a much greater value for lightness (L), but a lower value for redness (a) and yellowness (b).As per Chevallier *et al*., (2000) [8], the Maillard reaction was essential in the evolution of color. As a result, the increase in total protein content may be associated with a decrease in the lightness of germinated amaranth flour. The same study was discovered in the case of Malted millet flour. Malted millet flour's water activity steadily decreased in comparison to Raw millet flour. There was a significant difference between the samples (p<0.05).

Table 1: Proximate Analysis of Raw millet flour and Malted millet flour

Sample	Protein(gm/100gm)	Fat(gm/100gm)	Moisture(gm/100gm)	Fibre(gm/100gm)	Carbohydrate(gm/100gm)	Ash(gm/100gm)
C1	7.69±0.04^{c}	6.4±0.14^{b}	7.82±0.01^{b}	4.055±0.03^{c}	71.08±0.01^{a}	2.95±0.05^{c}
C2	8.23±0.09^{c}	7.2±0.14^{a}	8.08±0.02^{a}	5.3±0.14^{b}	68.04±0.41^{b}	3.15±0.01^{b}
M03	11.79±0.23^{b}	5.3±0.14^{c}	6.46±0.04^{d}	5.8±0.14^{ab}	67.485±0.04^{b}	3.155±0.04^{b}
M08	13.96±0.09^{a}	6.3±0.14^{b}	7.41±0.02^{c}	6.35±0.21^{a}	61.98±0.01^{c}	4±0.01^{a}

Note: When the same letter is not immediately after two mean values in the same row, there is a significant difference (p≤0.05). Mean standard deviation (n=2)

Table 2: Color analysis and water activity of Raw millet flour and Malted millet flour

Sample	Color			Water Activity
	L	a	b	
C1	28.53	7.86	8.96	5.25±0.07^{ab}
C2	29.36	7.33	9.43	5.7±0.14^{a}
M03	31.73	6.35	10.03	4.4±0.28^{bc}
M08	34.63	6.03	11.35	4.85±0.07^{c}

Note: When the same letter is not immediately after two mean values in the same row, there is a significant difference (p≤0.05). Mean standard deviation (n=2)

Table 3: *In vitro* protein digestibility of raw millet flour and Malted millet flour

Sample	*In vitro* digestibility (%)
C1	53.72±0.43^{d}
C2	56.77±0.26^{c}
M03	60.94±0.82^{b}
M08	64.04±0.55^{a}

Note: When the same letter is not immediately after two mean values in the same row, there is a significant difference (p≤0.05). Mean standard deviation (n=2)

Table 4: Water absorption index (WAI) and Water solubility index (WSI) of Raw millet flour and Malted millet flour

Sample	WAI	WSI
C1	3.82±0.01^{d}	5.86±0.02^{d}
C2	3.975±0.02^{c}	6.1±0.01^{c}
M03	4.48±0.05^{b}	11.62±0.04^{b}
M08	4.95±0.042^{a}	13±0.01^{a}

Note: When the same letter is not immediately after two mean values in the same row, there is a significant difference (p≤0.05). Mean standard deviation (n=2)

Conclusion

The current study set out to assess how the malting procedure affected the nutritional composition and *in vitro* protein digestibility of both raw and malted millet flour. The findings of this study shown that millets may be malted or germinated to generate products that are more easily digested and have greater nutritional content. When compared to raw grain, malting produced the most advantageous protein digestibility and nutrient content, according to the ANOVA study that was conducted. According to the study, millet can be efficiently

malted to produce products that are more wholesome and nourishing. It is recommended that more research be done on the bioavailability of minerals in malted millet flour, particularly iron, zinc, and calcium.

Author contribution statement

Nupur Selokar: Research work, Writing – Original Draft and Editing

Vincent Hema: Conceptualization, Reviewing, Editing and Supervision

Declaration of Interest: The Author declares no conflict of interest.

References

1. Annor GA. Tyl C, Marcone M, Ragaee S. Why do millets have slower starch and protein digestibility than other cereals? Trends in Food Science & Technology, 2017. https://doi.org/10.1016/j.tifs.2017.05.012
2. Antony U, Sripriya G, Chandra TS. The effect of fermentation on the primary nutrients in foxtail millet (*Setaria italica*). Food Chemistry. 1996;56(4):381-384. https://doi.org/10.1016/0308-8146(95)00186-7
3. Arif M, Abbas Bangash J, Khan F, Abid H. Effect of soaking and malting on the selected nutrient profile of barley. Journal of Biochemistry and Molecular Biology Research. 2011;44(1):18–21.
4. Banusha S, Vasantharuba S. Effect of Malting on Nutritional Contents of Fingermillet and Mungbean. J. Agric. & Environ. Sci. 2013;13(12):1642–1646. https://doi.org/10.5829/idosi.aejaes.2013.13.12.12285
5. Chauhan A, Saxena DC, Singh S. Total dietary fibre and antioxidant activity of gluten free cookies made from raw and germinated amaranth (*Amaranthus* spp.) flour. Lwt, 2015;63(2):939–945. https://doi.org/10.1016/j.lwt.2015.03.115
6. Chavan JK, Kadam SS. Nutritional improvement of cereals by sprouting. In Critical Reviews in Food Science and Nutrition. 1989;28:5. https://doi.org/10.1080/10408398909527508
7. Chethan S, Sreerama YN, Malleshi NG. Mode of inhibition of finger millet malt amylases by the millet phenolics. Food Chemistry. 2008;111(1):187-191. https://doi.org/10.1016/j.foodchem.2008.03.063
8. Chevallier S, Colonna P, Della Valle G, Lourdin D. Contribution of major ingredients during baking of biscuit dough systems. Journal of Cereal Science. 2000;31(3):241–252. https://doi.org/10.1006/jcrs.2000.0308
9. Filli KB, Abubakar IN, UM, VA J. Influence of extrusion variables on some functional properties of extruded millet soybean for the manufacture of' Fura': A Nigerian Traditional Food. African Journal of Food Science, 2010;4(6):342–352.
10. Gamel TH, Linssen JP, Mesallam AS, Damir AA, Shekib LA. Seed treatments affect functional and antinutritional properties of amaranth flours. Journal of the Science of Food and Agriculture. 2006;86(7):1095–1102. https://doi.org/10.1002/jsfa.2463
11. Jabeen S, Huma N, Sameen A, Zia MA. Formulation and characterization of protein-energy bars prepared by using dates, apricots, cheese and whey protein isolate. Food Science and Technology (Brazil). 2021;41(June):197-207. https://doi.org/10.1590/fst.12220
12. Jawad M, Schoop R, Suter A, Klein P, Eccles R. Perfil de eficacia y seguridad de Echinacea purpurea en la prevención de episodios de resfriado común: Estudio clínico aleatorizado, doble ciego y controlado con placebo. Revista de Fitoterapia. 2013;13(2):125-135. https://doi.org/10.1002/jsfa
13. Mridula D, Sharma M. Development of non-dairy probiotic drink utilizing sprouted cereals, legume and soymilk. Lwt, 2015;62(1):482–487. https://doi.org/10.1016/j.lwt.2014.07.011
14. Nadeem M, Anjum M, Amir RM, Khan R, Hussain S, Javed MS. An overview of anti-nutritional factors in cereal grains with special reference to wheat-A review. Pakistan Journal of Food Sciences. 2010;20(4):2226-5899.
15. Najdi Hejazi S, Orsat V, Azadi B, Kubow S. Improvement of the *in vitro* protein digestibility of amaranth grain through optimization of the malting process. Journal of Cereal Science. 2016;68:59-65. https://doi.org/10.1016/j.jcs.2015.11.007
16. Platel K, Eipeson SW, Srinivasan K. Bioaccessible mineral content of malted finger millet (*Eleusine coracana*), wheat (*Triticum aestivum*), and barley (*Hordeum vulgare*). Journal of Agricultural and Food Chemistry. 2010;58(13):8100–8103. https://doi.org/10.1021/jf100846e
17. Samuel KS, Peerkhan N. Pearl millet protein bar: nutritional, organoleptic, textural characterization, and in-vitro protein and starch digestibility. Journal of Food Science and Technology. 2020;57(9):3467–3473. https://doi.org/10.1007/s13197-020-04381-x
18. Sethupathy P, Suriyamoorthy P, Moses JA, Chinnaswamy A. Physical, sensory, in-vitro starch digestibility and glycaemic index of granola bars prepared using sucrose alternatives. International Journal of Food Science and Technology. 2020;55(1):348–356. https://doi.org/10.1111/ijfs.14312
19. Slavin JL, Jacobs D, Marquart L. Grain processing and nutrition. Critical Reviews in Food Science and Nutrition, 2000;40(4):309–326. https://doi.org/10.1080/10408690091189176
20. Taylor JR, Duodu KG. Effects of processing sorghum and millets on their phenolic phytochemicals and the implications of this to the health-enhancing properties of sorghum and millet food and beverage products. Journal of the Science of Food and Agriculture. 2015;95(2):225–237. https://doi.org/10.1002/jsfa.6713
21. Udeh HO, Duodu KG, Jideani AIO. Effect of malting period on physicochemical properties, minerals, and phytic acid of finger millet (*Eleusine coracana*) flour varieties. Food Science and Nutrition. 2018;6(7):1858–1869. https://doi.org/10.1002/fsn3.696
22. Zhu F. Structure, physicochemical properties, and uses of millet starch. Food Research International. 2014;64:200–211. https://doi.org/10.1016/j.foodres.2014.06.026