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Research Article

Nutritional Quality, Functional Property and Storage Potential of Malted Ragi Flour

Sudha Tiwari[1]*, Nandita Sarkar[1], Alpana Singh[2]

[1]Govt. M. H. College of Home Science & Science for Women, Jabalpur, India
[2]Professor, Department of Food Sci. and Tech. J.N.K.V.V, Jabalpur, India

***CORRESPONDING AUTHOR**
Sudha Tiwari, Research Scholar, Govt. M. H. College of Home Science & Science for Women, Jabalpur, India
Email: sudhatiwari88@gmail.com

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ABSTRACT
Ragi was malted and effect of malting was analyzed for proximate composition, micro-nutrient content, anti-nutritional chemicals and functional properties. Storage potential was assessed on the basis of microbial load, moisture and peroxide value of the malted flour for the period of three months with an interval of 10 days. On malting there was increase in the moisture (28%), protein (21%), carbohydrate (8%), mineral contents (3-16%). anti-oxidative capacity(15%) and poly-phenolic content(36%) whereas fat(2.6%), fibre(0.3%), water soluble vitamins(1-12%), and anti-nutrient contents(15-40%) were decreased. The microbial analysis shows that there was gradual increase in the number of total viable count and yeast and mould count. The moisture and peroxide value were also found to be gradually increasing and within the acceptable limit during storage period. It can be concluded that malted ragi flour has higher nutritional content than raw ragi flour and could be stored upto 3 months under aseptic condition.

Keywords- Ragi, Malting, Storage potential, Anti-nutritional factor, Functional property

INTRODUCTION

Finger millet (*Eleusine coracana*) is a staple crop of Asian and African countries (mainly in India and Nigeria). Finger millet is short growing crop which matures within 3-6 month and can withstand cooler to hotter condition [1]. It is a help famine crop as it can be stored for lean years [2]. It is an underutilised crop due to lack of awareness of its nutritional quality, health benefits. Finger millet can be used as porridge, base material for cake and cooked as rice [3]. Finger millet has dark red brick coloured seed coat and equally nutritious as other cereals with good amount of protein and micronutrient with highest calcium 300-350mg/100gm. Rich phytochemical profile of finger millet ensures rendering health effect due to their anti-oxidant and immune-modulatory nature. Various processing technique viz. soaking, germination, malting, fermentation and cooking have known to affect anti-oxidant content and anti-radical activity [4]. Malting is low cost simple processing technique that improves nutritive value, reduces anti-nutritional factors and enhances digestibility. Reduction of anti-nutrient in turns makes some minerals more bioavailable to the body. Therefore, present study was undertaken

to assess the changes in nutritional and functional property of finger millet during malting.

MATERIAL AND METHODS

Sample Collection

Ragi (variety GPU-40) was made available from Rewa Agriculture College Rewa (MP), India.

Malting of Ragi

Ragi was malted according to the method of Malleshi (1995) with minor alteration.

Proximate Analysis of the Food Ingredient

The proximate analysis (total fat, crude fiber, moisture and ash content) of the food ingredients were determined by (AOAC, 1990) whereas, protein content (Lowry's method) and carbohydrate content was assessed by the method of Sadasivam.

Mineral Estimation of the Food Ingredients

The mineral such as sodium and potassium was quantified by flame photometer (130-systronic). Magnesium and calcium was assessed by titration method while phosphorus and iron content of the samples were determined by spectrophotometer (UV-Visible 2450-Shimadzu spectrophotometer).

Micronutrient Analysis and Functional Properties

The beta–carotene, thiamine and riboflavin were estimated by spectrophotometry according to the method given by Howe and Sherry (2006). Ascorbic acid by titration method (1984). The total polyphenolic content and anti-oxidative capacity was estimated by Folin-Ciocalteau and DPPH method respectively.

Analysis of Anti-Nutritional Factors

The estimation of phytate and cyanogens was carried out by AOAC, 2004, tannin content by Folin-dennis method and trypsin inhibitors was measured by Kakade *et al.* (1969) using benzoyl-DL-arginine-*p*-nitroanilide (BAPNA) as a substrate from Sigma chemicals, USA.

Shelf- life Evaluation of the malted flour

The prepared feeds packed in air tight jars analysed for microbial load according to the methods described by IS i.e. total viable count (IS 5402:2002), yeast and mould count (IS 5403:1999) and total coliforms (FSSAI, 2012) at 15 day interval over 90 days of storage to ensure its edibility and over all food quality. Moisture and peroxide value were estimated using AOAC methods (AOAC, 2000).

Statistical Analysis

All the collected data was analysed by using SPSS version 16 for significance difference between mean by independent T-Test. Significance was shown at $p \geq 0.05$ level. Each experiment was conducted in triplicate and values were presented as mean± standard deviation.

RESULTS AND DISCUSSION

Proximate Composition of raw and Malted Ragi

The effect of malting on proximate composition of ragi presented in Table 1. Malting induce favorable biochemical changes in ragi. The higher moisture content (11.6%) of malted ragi than that raw ragi (9.8%) indicates water uptake during steeping due to the increasing number of cells within the seed as suggested by other worker [18].

The protein content of malted ragi was higher when compared with the un-treated ragi samples which might be due to micro-organisms utilized the carbohydrate to synthesis amino acid in the food needed for their growth and development with simultaneous production of simple sugar by amylolytic enzymes [19]. Also, during malting protease enzymes were produced which hydrolyze protein to produce peptides and amino acids [20].Some worker suggested that fatty acids are oxidized to carbon dioxide and water to generate energy for germination and lipase enzyme acted on fat to produce fatty acid in malted food [21] The minor increment in fibre could be due to increased bran matter and the building of dry matter during the growth and development (germination) of the plant. Reduction in ash content during processing may be due to the leaching of both micro and macro elements into the extracting medium.

Table 1: Proximate Composition of Raw and Malted Ragi

S.N	Nutrient	Raw Ragi (mean±SD)	Malted Ragi (mean±SD)	Significance
1	Moisture (%)	9.8 ±0.42	12.6±0.10	Significant
2	Protein (%)	10.12±0.19	12.3±0.90	Significant
3	Fat (%)	1.22 ± 0.01	1.08 ± 0.04	Non-significant
4	Fibre (%)	2.5±0.15	2.8±0.15	Non-significant
5	CHO (%)	68±0.13	61± 0.10	Significant
6	Ash (%)	1.93 ± 0.01	1.56 ± 0.0	Non-significant
7	Energy(Kcal)	321±0.50	327± 0.34	Non-significant

**Values are the mean of three determination ± standard deviation, (p≥0.05)*

Mineral Estimation of Raw and Malted Ragi-

The mineral composition of raw and malted ragi flour is shown in Table 2. The mineral composition of the malted samples increased above the values of the control. Maximum rise was noted in calcium and phosphorus by 16.2 and 12.0% respectively. Other minerals value were also found to be increased by 3-7% compared to controlled value. Increased bio-availability of minerals has favourable effect for human consumption in more digestible form for infant and old persons. Thus, malting improved the availability of iron, calcium and other minerals. This observation may be possibly as a result of enzyme solubilisation and leaching of the anti-nutritional factors [22].

Table 2: Mineral composition of raw and malted ragi flour

S.NO.	Mineral (mg/100gm)	Raw Ragi (mean±SD)	Malted Ragi (mean±SD)	Significance
1	Calcium	302±0.2	336±0.10	Significant
2	Iron	3.3±0.99	3.4±0.00	Non-Significant
3	Sodium	9.3±0.02	9.8±0.22	Significant
4	Potassium	383±0.08	391±0.01	Non-significant
5	Magnesium	129±0.11	133±0.01	Significant
6	Phosphorus	278±.015	230±.05	Significant

** Values are the mean of three determination ± standard deviation,(p≥0.05)*

Vitamin Content and Functional Properties

Table 3 illustrates that during malting, the vitamin content of the ragi flour samples was reduced due to their predominance in seed coats which are water soluble (thiamine, riboflavin and ascorbic acid) consequently leach into the liquid medium [23]. This decrease could also be related to the fact that these compounds are heat labile and degrade upon heat treatment [24]. Ascorbic acid in ragi was found in good amount approximate 30.40mg/100g. Greater loss of vitamin C was also reported in other studies possibly because of effect of oxygen and light. The increase in antioxidant activity was observed in processed ragi flour upto 30%. These results suggested that malted ragi has more antioxidant concentrations. The total poly-phenolic content in raw ragi samples was 6.1mg/100g which decreased on malting upto 5.2 mg/100g due to physical leaching off the phenolic compounds into the soaking water and the polyphenol oxidase based enzymatic hydrolysis.

Table 3: Vitamin Content and Functional Properties of Raw and Malted Ragi

Nutrient/100gm	Raw Ragi (mean±SD)	Malted Ragi (mean±SD)	Significance
B-Carotene(ug)	35.76±0.30	23.21±0.51	Significant
Thiamine(mg)	0.50±0.12	0.27±0.01	Significant
Riboflavin(	0.15±0.51	0.09±1.12	Significant
Ascorbic Acid(mg)	30.40±0.12	24.0±0.08	Non-significant

TPC(mg)	6.12±0.9	5.26±0.03	Non-Significant
Anti-oxidative Capacity (%)	38.40±0.51	50.30±0.2	Significant

**TPC-Total Polyphenolic Content, Values are the mean of three determination ± standard deviation,(p≥0.05)*

Anti-Nutritional Factors analysis

Table 4 reflects the levels of the anti-nutritional factors in control and malted ragi samples. The levels of the anti-nutritional factors in the processed ragi samples decreased significantly indicating the occurrence of some form of changes during the malting process. The loss of phytic acid (20%) may be caused by hydrolytic activity of the enzyme phytase. A decrease in Trypsin Inhibitor Activity (17%) could be due to mobilization from seeds to the soaking medium and breakdown of trypsin inhibitor. The reduction of tannins was found 12% due to its heat labile nature which degrade upon heat treatment. Also enzymatic hydrolysis of tannase occurs[25].The raw samples contain 0.11 ug/100 of cyanogen while malted ragi samples contain upto 0.10ug/100 which indicates the elimination of cyanide from the raw sample during processing.

Table 4: Anti-Nutritional Factors of Raw and Malted Ragi

S.N.	Anti-Nutrient (mg/100gm)	Raw Ragi (mean±SD)	Malted Ragi (mean±SD)	Significance
1	Phytic Acid	600±2.0	475±1.2	Significant
2	Tannin	350±0.7	306±1.0	Significant
3	Trypsin Inhibitor	28.3±1.0	18.9±0.5	Significant
4	Cyanogen(ug)	0.11±0.1	0.10±0.3	Significant

** Values are the mean of three determination ± standard deviation (p≥0.05)*

Shelf- life Evaluation of the Malted Ragi Flour

Results of microbial analysis given in table no.5 indicated that during 90 day of the storage study of malted ragi flour there was gradual increase in the total viable count and noted to be 5×10^3 cfu/gm but it was less than upper limit as recommended by [26]. i.e. 10,000 per gram of food sample. Total fungal count was in the range of 2×10^{-3} cfu/gm. According to FSSAI guideline, there should be no yeast and mould count in 1 gm sample. The coliform was not detected in malted ragi flour upto the study period of 3 months. The moisture content and peroxide value increased during storage. At the end of third month the peroxide value was 6.23 mEq/kg which was below the upper limit as per FSSAI (2012) while the moisture level was 10.20(%) which guarantees its suitability upto three months under hygienic condition.

Table 5: Shelf- life Evaluation of the Malted Ragi Flour

Day	Moisture (%)	Peroxide (mEq/kg)	Total Viable Count(cfu/gm)	Total Coliform count (cfu/gm)	Total Fungal Count (cfu/gm)
0	9.8	2.1	1×10^3	ND	ND
15	12.9	2.7	1×10^3	ND	ND
30	13.4	3.4	2×10^3	ND	ND
45	13.7	3.6	3×10^3	ND	ND
60	14.1	4.1	4×10^3	ND	1×10^3
75	14.5	4.8	5×10^3	ND	1×10^3
90	15.2	5.6	5×10^3	ND	2×10^3

**ND-Not detected*

CONCLUSION

Ragi crop withstand cooler to hotter cultivation condition has magnificent nutritional quality which further improves upon malting with respect to bioavailability of calcium phosphorus and anti-oxidative property. Malted ragi will be beneficial to all age group as it is more digestible with rich fibre content. It is an inexpensive and traditional way to reduce bulk density and increase nutrient density in food, hence appropriate for infant. Therefore, it could be employed to formulate supplementary food products with increased shelf-life under hygienic condition.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in this research article.

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