The Pharma Innovation Journal 2018; 7(5): 395-401

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(5): 395-401

www.thepharmajournal.com
Received: 16-03-2018
Accepted: 18-04-2018

Sowmya HT
M. Tech (Food Tecnology), Department of Food Science and Technology, Agricultural College Hassan University of Agricultural Sciences, Bangalore, Karnataka, India

Naveen Kumar
Lab-Incharge, Dairy and Food Engineering, Department of Food Engineering, National Institute of Food Technology Entrepreneurship & Management Kundli, Sonepat, Haryana, India

Murlidhar Meghwal
Assistant Professor, Department of Food Science and Technology National Institute of Food Technology Entrepreneurship & Management, Kundli, Sonepat, Haryana, India

Correspondence
Sowmya HT
M. Tech (Food Tecnology), Department of Food Science and Technology, Agricultural College Hassan University of Agricultural Sciences, Bangalore, Karnataka, India

Studies on physicochemical changes in germinated rice malt fortified with foxtail millet and green gram

Sowmya HT, Naveen Kumar and Murlidhar Meghwal

Abstract
Indian diet includes several cereal based items in it in their day to day life. Cereals are not only good source of complex carbohydrates but also provide substantial amount of vitamins, minerals, phytochemicals and antioxidants. The aim of this study was to produce complementary nutritive malt food that will meet the nutritional requirement and increase the digestibility and bioavailability for infants, youths, children and old aged peoples by addition of protein rich green gram and millets. Millets have been called nutri-cereals since they are rich in micronutrients like minerals and B-complex vitamins. Additionally they are also rich in health promoting phytochemicals. Efforts are made to determine nutritional quality and effect of fortification with foxtail millet and green gram on germinated rice malt. Results of germinated rice fortified with different concentrations of foxtail millet and green gram ($T_1$90:05:05, $T_2$80:10:10, T_3 70:15:15 and C100:0:0) has shown that increase in foxtail millet and green gram concentrations had gradually increased moisture content, crude fibre, protein, fat, ash content and minerals like Ca, Mg, Fe, K. Water absorption index (WAI) and water solubility index (WSI) has decreased with increase in concentration of foxtail millet and green gram oil absorption index and bulk density of germinated rice malt

Keywords: Fortification, germinated rice malt, foxtail millet, protein enrichment

Introduction
Rice is a grain belonging to the grass family. Rice refers to two species (*Oryzasativa* and *Oryzaglaberrima*) of grass, native to tropical and subtropical south-eastern Asia and to Africa, which together provide more than one-fifth of the calories consumed by humans is a principal cereal, a leading food crop of the world and a staple food of over approximately half of the world's population (Singh *et al*. 2003) its annual consumption is next to wheat (Razavi and Farahmandfar 2008). Rice is the most important food crop in South-East Asia. Rice is a staple food of the people of this region, with average annual consumption per person in 2007 of 131 kg rice provided 49% of the calories and 39% of the protein in their diet in 2007 (FAOSTAT 2011). It is commonly used either as brown or white rice (Prasad, 2012).

Nutritional value of Rice
Rice provides instant energy as its most important component is carbohydrate (starch).Rice flour is rich in starch and it is used for making various food materials. In husked rice, protein content ranges in between 7% to 12%, the brown rice is rich in some vitamins, especially B1 or thiamine 0.34 mg, B2 or riboflavin 0.05 mg, niacin or nicotinic acid 4.7 mg in contrast, the white rice is poor in vitamins 0.09 mg of vitamin B1, vitamin B2 0.03 mg and 1.4 mg of niacin (*sakunthalamanya*).

Fox tile millet (*Setariaitalica*)
Foxtail millet is commonly known as Italian millet, German millet, Chinese millet, Hungarian millet, Dwarf setaria, giant setaria, liberty millet, and Siberian millet. The seeds are small and measure around 2mm in diameter. They are encased in a thin, papery hull which is easily removed upon threshing. Seed colour can vary greatly between varieties grown and range from a pale yellow, through to orange, red, brown and black. A thousand of these seeds weighs approximately 2 grams. The protein in Foxtail millet is known to be deficient in Lysine, and its amino acid scores are comparable to that of Maize. In different grain varieties, higher the protein content, lower is the Lysine content in the protein. It is relatively high in leucine and methionine. The starch in some foxtail millet varieties contain 100% amylopectin, and the starches contained in foxtail, proso and barnyard millets are more digestible than maize starch.

The total ash content of foxtail millet is good and is much higher than the more commonly consumed cereal grains including sorghum, however de-hulling of the grain, like in other millets, causes considerable nutrient losses (http://shodhganga.inflibnet.ac.in).

Green gram

Green gram (*vignaradiata*) belongs to the family legumineseae green gram is one of the important pulse crop in India it has been reported that green gram has been cultivated in India since ancient times. It is widely cultivated throughout the Asia including India, Pakistan, Bangladesh, Sri Lanka (Chamdrsheakar and Gosh 2002). Green gram is protein rich staple food. It supplies protein requirement of vegetarian population of the country. It is consumed in the form of split pulse as well as whole pulse which is an essential supplement of cereal based diet. Green gram is good source of vitamins, minerals, enzymes, complex carbohydrates and its protein quantity is better than others (Kataria *et al*., 1989; Jood *et al*., 1998) [19] and are low in fat have no cholesterol (Dostalova *et al*. 2007) [11].

Germinated green gram is free of flatulence- causing agents (Dostalova. *et al*., 2007) [11] makes the acceptable food for the convalescents and pleasant weaning food for babies (Sadana and Chabra 2004) [28]. The protein is especially rich in the amino acid, lysine but it somewhat deficient in Sulphur containing amino acids. The seeds rich in calcium, magnesium, phosphorous, potassium, folate, and other B-vitamins. They also contain appreciable amounts of vitamin C. Raw seeds are rich in trypsin inhibitors that block the effects of protein digesting enzymes in the gut. Sprouted green gram has lower amounts of these inhibitors. It is reported that sprouting improved the protein/amino acid digestibility by decreasing the anti-nutritional factors and increasing the true/ apparent protein/amino acids digestibility (Bibi *et al*., 2008). The green gram has good nutritive value and on germination its health effects increased (Reddy *et al*., 1978) [26]. So consumption of germinated can be used to control the several diseases. But since due to the potential microbial contamination of germinated legume seed, germinated green gram has low shelf life, therefore there is need to preserve it in a useful way. Present study was effort to develop malt from the germinated greengram with foxtail millet and germinated dehusked paddy which is protein rich and other health benefits.

Malting

Malting of cereals other than hulled barley has been in research domain in recent years (Dewar *et al*., 1997; Suhasini and Malleshi, 1995; Hammond and Ayernor, 2001) [10, 29, 17]. The reasons being economic considerations and local availabilities. In Ghana, various cereals such as maize, sorghum, rice and millet have been malted for use as sources of enzymes in sugar and brewing industries. Research has shown that malted rice has the potential for achieving high starch conversion rate in sugar production (Hammond and Ayernor, 2000) [16]. Malting is a process involving germination and drying of cereal seeds, the prime objective being to promote the development of hydrolytic enzymes that are not active in raw seeds (Dewar *et al*., 1997) [10]. During malting, the seeds undergo various changes of modification such as increase in the quantities of alpha and beta- amylases present in the grain and partial degradation (hydrolysis, catalyzed by enzymes) of reserve substances (cell wall, gums, protein, starch) in the starchy endosperm (Dewar *et al*., 1997) [10].

Malted rice is, however less commonly used in brewing than the ordinary raw rice. Whereas barley, wheat and rye produce relatively large amounts of both Alpha and beta- amylases during malting, rice essentially produces alpha-amylase during this process (Egwim and Oloyede, 2006) [12] Since the combination of both amylolytic enzymes results in a more rapid and complete degradation of starch to fermentable sugars, malts from other cereals are preferred materials for most users. The important role of alpha amylase in rice seeds stays in the hydrolytic breakdown of reserve starch in endosperm tissues during germination. Since barley, wheat and rye are not usually grown in Ghana, there is a need to explore other locally grown cereals especially rice for the production of malt for local sugar and brewing industries. However the quality of malt for use is greatly influenced by the physical, chemical and enzymes activities within the seeds and those that are produced during germination.

The purpose of this study is to investigate physicochemical changes and diastatic activity associated with germinating of local paddy rice as a source of enzymes in starch conversion and brewing industries.

2.0 Materials and methods

2.1 Raw Materials

Paddy (Thunga variety), green gram, foxtail millet where purchased and collected from local market Hassan and all the seeds are stored in room temperature prior to analysis.

2.2 Germination process

Viable seeds of green gram and paddy were used for the germination process. About 3000g of paddy and green gram was cleaned, washed thoroughly in water and soaked in a volume of water 3 times the weight of seeds for 24 hr the soaked seeds were placed on a jute sack in a basket and kept under ambient temperature (25–35°C) and watered 2 – 3 times a day to enhance the germination process. After germination seeds are spread in thin layers (Ayernor and Ocloo, 2007) [13].

2.2 Roasting processing

Foxtail millet are cleaned and roasted 75^0C/ 20 min the grains and subjected to sun drying for about 2-3hr and finally subjected to milling process and cleaned in 500mesh sieve to get desirable flour other case (Marplle *et al*., 2014) [23] studied roasting of flaxseed.

2.3 Malting

After milled flour sieved in standard mesh size of 500 and packed in Polypropylene pouches and prepare different treatments as mention above and one sample is keeping as control and take 150 ml hot water from water doctor and add the flour with different treatment has prepared stir properly still it dissolves properly don't allow to form clumps.

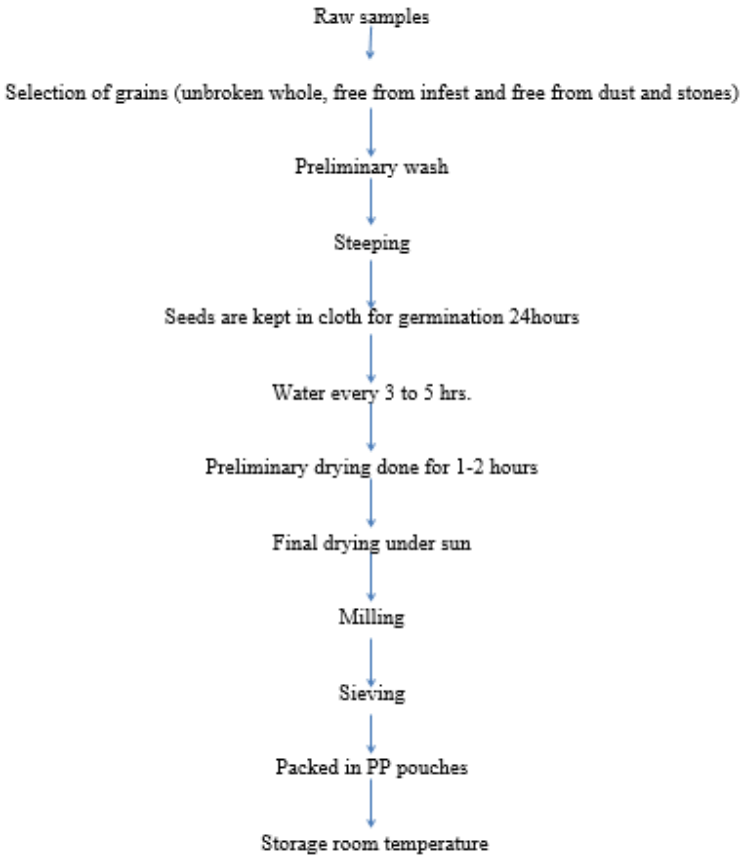
2.4 Sensory evaluation for standardisation of malt

Sensory evaluation of rice fortified with green gram and foxtail millet malt with different sensory parameters like colour, flavour, mouth feel, taste and OAA done by 15 semi trained panel members using 5 point hedonic scale (Prasad *et al*., 2016) [24] standardised the treatment T3 acceptable for all panel member.

2.5 Sample preparation

Samples taken were sun dried at 20-24hr and after drying the samples are subjected to milling using lab scale attrition mill. And samples were packed in polythene pouches and stored in room temperature for further analysis.

2.6 Processing of rice flour fortified with foxtail millet and green gram procedure of malting process



3.0 Results and discussions

Malt prepared using different formulations were subjected for sensory evaluation to a panel of 15 semi trained judges to assess different attributes like colour, flavour, taste, mouth feel, and overall acceptability on a 5 point hedonic scale with 5 as excellent in all respects and 1 as disliked. Based on sensory criteria it was found that with the incorporation green gram and foxtail millet there was an increase in sensory scores from table its clearly indicating malt prepared using green gram and foxtail millet i.e. treatment T3 (T3=70g:15g:15g (Germinated rice: roasted foxtail millet: germinated green gram) were acceptable to the panellists and beyond the level were not acceptable hence 15% incorporation of green gram and 15% foxtail millet to prepare rice malt was taken as optimum. Similar results were reported by Prasad *et al* (2016) [24].

Table 1: Standardisation of fortified rice malt:

Parameters	Control	T1	T2	T3
Colour	4.12±0.35	3.30±0.87	3.71±0.48	3.87±0.44
Flavor	4.06±0.41	3.37±1.18	3.93±0.77	4.06±0.41
Taste	4.06±0.47	3.37±0.91	3.56±0.72	3.87±0.64
Mouth Feel	3.81±0.65	3.25±0.88	3.50±0.92	4.18±0.5
OAA	4.0±0.46	3.12±0.87	3.68±0.70	4.18±0.53

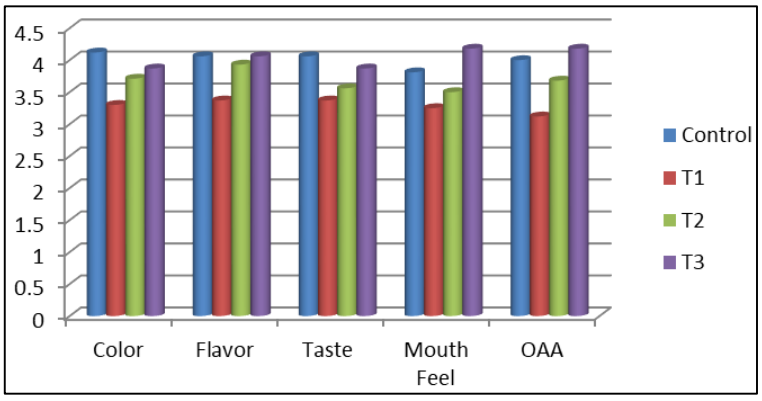


Fig1: Standardisation of fortified rice malt

Malt prepared using different formulations were subjected for sensory evaluation to a panel of 15 semi trained judges to assess different attributes like color, flavor, taste, mouth feel, and overall acceptability on a 5 point hedonic scale with 5 as

excellent in all respects and 1 as disliked. Based on sensory criteria it was found that with the incorporation green gram and foxtail millet there was an increase in sensory scores from table its clearly indicating malt prepared using green gram and foxtail millet i.e. treatment T3 (T3=70g:15g:15g (Germinated rice: roasted foxtail millet: germinated green gram) were acceptable to the panelists and beyond the level were not acceptable hence 15% incorporation of green gram and 15% foxtail millet to prepare rice malt was taken as optimum. (Prasad *et al*., 2016) [24].

3.2 Raw material analysis

Table 2: Raw material analysis of fortified rice malt

S.N.	Constituents	Rice flour	Foxtail millet flour	Green gram
1	Moisture	7.475	10.5	10.0
2	Protein	6.26	11.2	21.89
3	Fat	0.256	4.0	1.2
5	Crude fibre	0.51	7.8	14.9
6	Carbohydrate	83.928	60.1	58.59

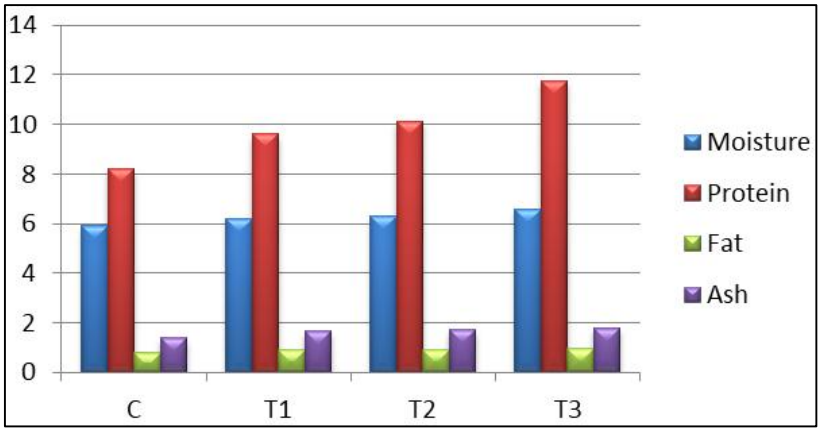


Fig: 2 Comparison of protein, moisture, fat and ash content in germinated rice, roasted foxtail millet and germinated green gram

From the above FIG 2: we clearly indicating that the rice have moisture content of 7.45, protein content of 6.26, fat content of .025, crude fibre 0.51 and carbohydrate of 83.92 and foxtail millet having moisture content 10.5, protein 11.2, fat 4.0, crude fibre 7.8 and carbohydrate 60.1 and Earlier study also clearly indicating the nutritive value of unprocessed foxtail millet flour moisture(11.2), protein (12.5) fat (4.3), crude fibre(8.2), carbohydrate(67.7) (Laxmi *et al*., 2015) [20] and from the table clearly indicating that raw green gram has highest protein of 21.89, and moisture content of 10.0, fat content 1.2, crude fibre content of 14.9 and carbohydrate of 58.59

Table 3: proximate composition of fortified rice malt

S.N	Constituents	C	T1	T2	T3
1	Moisture	5.9	6.2	6.3	6.6
2	Protein	8.2	9.6	10.12	11.76
3	Fat	0.78	0.90	0.92	0.95
4	Ash	1.4	1.65	1.73	1.79

Note:
C=100g (germinated rice).
T1 (90g:5g:05g) = (Germinated rice: roasted foxtail millet: germinated green gram).
T2 (80g:10g:10g) = (Germinated rice: roasted foxtail millet: germinated green gram).
T3 (70g:15g:15g) = (Germinated rice: roasted foxtail millet: germinated green gram).

3.3. Proximate composition

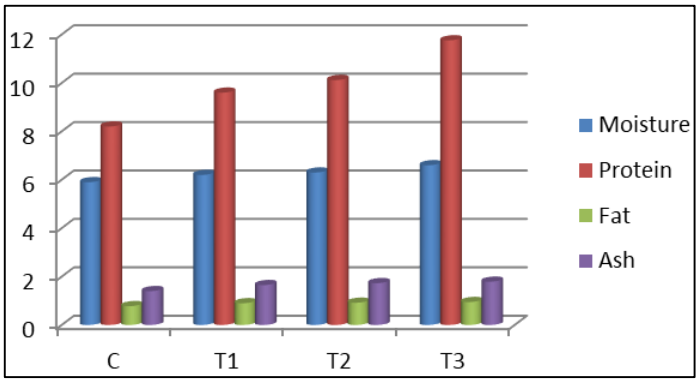


Fig: 3 Comparison of protein, moisture, fat and ash content in germinated rice, roasted foxtail millet and germinated green gram.

From above graph it clearly indicating that treatment T3=70g:15g:15g (Germinated rice: roasted foxtail millet: germinated green gram) has highest protein, moisture, fat and ash content as compare to the control and other two treatments of (T1 and T2)

a

3.4 Mineral composition

Table 4: Mineral composition of fortified malt

Sample	Ca	K	Fe	Mg
Control	0.048	0.306	0.406	0.0776
T1	0.136	0.365	0.452	0.0912
T2	0.136	0.491	0.521	0.1104
T3	0.188	0.521	0.601	0.1150

C=100g (germinated rice).
T1=90g:5g:5g (Germinated rice: roasted foxtail millet: germinated green gram).
T2=80g:10g:10g (Germinated rice: roasted foxtail millet: germinated green gram).
T3=70g:15g:15g (Germinated rice: roasted foxtail millet: germinated green gram).

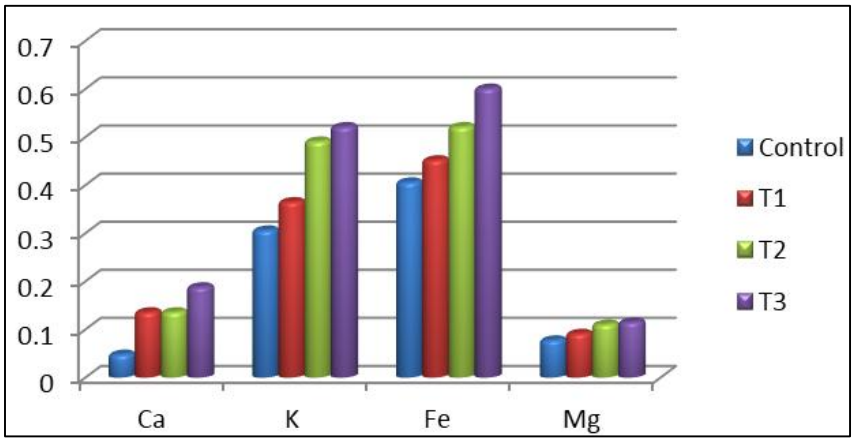


Fig 4: Mineral content in germinated rice, roasted foxtail millet, germinated green gram from the figure it's clear that the treatment T3 (T3=70g: 15g: 15g (Germinated rice: roasted foxtail millet: germinated green gram). has relatively highest content calcium potassium, Iron and magnesium content when compare to the control and treatment T1 &T2.

Note: Formula used to calculate the Ca, Mg, Fe, and K as fallows

1) Ca and Mg = Titre. N. volume of extract/wt. of sample. Aliquot x 100
2) IRON mg per 100g=O.D of the sample x 0.1 x total volume of ash solution x 100/O.D of the sample x 5 x wt. of the sample taken for ashing

Table 5: Water absorption index (WAI) & water soluble index (WSI) of fortified malt

Sample taken	WAI	WSI
Control	6.108	33.2
T1	6.51	30.8
T2	7.361	28.8
T3	8.64	28.4

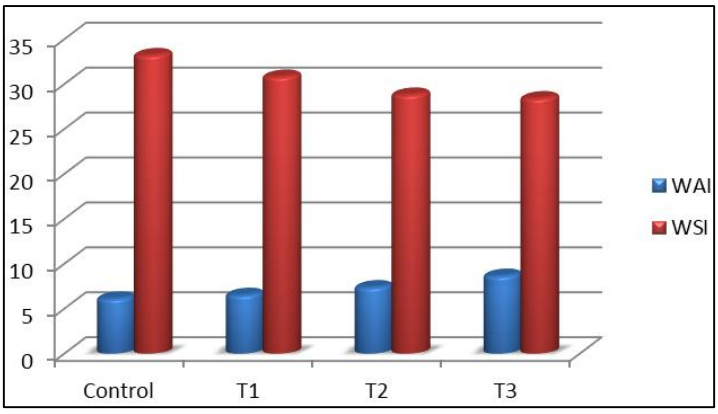


Fig 5: shows that WAI of the treatment T3 is more when compare to remaining treatments hence clear that as increase in the flour content there will be increase in the water abortion capacity of flour and WSI of control sample is more when compare with other treatments of fortified malt hence its shows that as increase the flour content there will be decrease in solubility of flour

Tables 6: Oil absorption index of fortified rice malt

Sample taken	% of oil absorbed
Control	32.5%
T1	30%
T2	31%
T3	31.5%

Note: calculation of OAC= initial wt.-final wt./initial wtx100

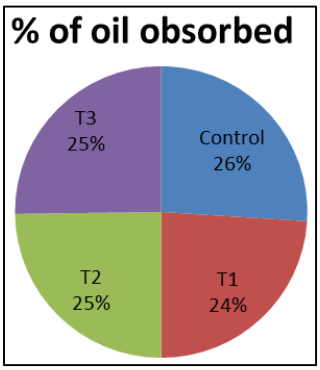


Fig 7: From the above figure its showing the control sample having highest oil absorption capacity fallowed by treatment T3 and minor difference in other 2 samples T2&T1 respectively hence increase the flour percentage in fortification there will change in the oil absorption capacity.

Conclusion

The malt prepared from the different proportion/treatments of rice flour with germinated green gram and foxtail millet it was found that T3 was acceptable (T3=70: 15g:15g (Germinated rice: roasted foxtail millet: germinated green gram). The results are obtained from this study confirmed that malting as a process technique can be used to effectively enhance the nutritional /organoleptic of rice flour green gram, and foxtail millet.

Reference

1. AOAC. official methods of analysis of association of analytical chemists. AOAC, Washington DC., USA, 1990.
2. Bamforth CW, Barclay AHP. Malting technology and the uses of malt. In: Mac Gregor, A.W., Bhatty, R.S. (Eds.), Barley: Chemistry and Technology. American Association of Cereal Chemistry, St. Paul, MN, 1993, 297e354.
3. Bau *et al*. Effect of germination on chemical composition, biochemical constituents and antinutritional factors of soyabean seeds. J. sci. food. agric. 1997; 73:1-9.
4. Bhatty RS. Production of food malt from hull-less barley. Cereal Chemistry. 1996; 73:75e80.
5. Oh CH, Oh SH. Effects of Germinated Brown Rice Extracts with Enhanced Levels of GABA on Cancer Cell Proliferation and Apoptosis. Journal of Medicinal Food. 2004; 7(1):19-23. doi.10.1089/109662004322984653
6. Capanzana MV, Malleshi NG. Studies on malting of rice. Asian Food Journal. 1989; 4:111e115.
7. Chandrashekar CP, Ghosh J. food economy in disarray.indian food industry. 2002; 21:10-14.
8. Chavan JK, Kadam SS. Nutritional improvement of cereals by sprouting. CRFSN 1989; 28:401-408.
9. Cumming JH *et al*. Dietary carbohydrates and health. Do we still need the fibreconcept. Clin. nutr. suppl. 2004; 1:6-17.
10. Dewar J, Taylor JRN, Berjak P. Determination of improved steeping conditions for sorghum malting. J Cereal Sci. 1997; 26:129-136.
11. Dostalova JP, Kadlee Bernaskorva J, Mhouska. application of high pressure processing on legumes preservation. High pressure res. 2007; 27:139-142.
12. Egwim EC, Oloyede OB. Comparison of _-amylase activity in some sprouting Nigerian cereals. Biokemistry. 2006; 18(1):15-20.
13. Ayernor GS, Ocloo FCK. Physico-chemical changes and diastatic activity associated with germinating paddy rice (PSB. Rc 34). African Journal of Food Science. 2007; 1:037-041,
14. Gopalan C, Ramashastri BV, Balasubramanium SC. Nutritive value of India Foods, National Institute of Nutr, ICMR Hyderabad, 1997.
15. Hammond TK. Factors affecting the production of fermentable sugars from cassava flour using a combination of rice malt and commercial enzymes. M. Phil Thesis, University of Ghana, Legon, 2001.
16. Hammond TK, Ayernor GS. Combination of malted cereals and cassava starch in the production of sugar syrup. J. Ghana Sci. Association. 2000; 2(1):87-92.
17. Hammond TK, Ayernor GS. Characteristics of malted rice for the production of sugar syrup. J. Ghana Sci. Association. 2001; 3(3):91-99.
18. Zhang JH, Guo X, Qian H. The impact of germination on the characteristicsof brown rice flour and starch. Journal of the Science of Food and Agriculture. 2012; 92:380e387.
19. Kataria A, Chauhan BM, Punia D. antinutrients and protein digestability (*in vitro*) of mungbean as affected by domestic processing and cooking. food chemistry. 1989; 32:9-17.
20. Laxmi G *et al*. The Impact of Malting on Nutritional Composition of Foxtail Millet, Wheat and Chickpea, J Nutr Food Sci. 2015; 5:5.
21. Gotz ME, Kunig G, Riederer P, Youdim MB. Oxidative Stress: Free Radical Production in Neural De- generation, Pharmacology & Therapeutics. 1994; 63(1):37-122. doi.10.1016/0163-7258(94)90055-8
22. Osman AM. The advantages of using natural substrate-based methods in assessing the roles and synergistic and competitive intractions of barley malt starch-degrading enzymes, J Inst. Brew. 2002; 108(2):204-214.
23. Pandurang Marpalle, Sachin Sonawane K, Shalini Subhash Arya. Effect of flaxseedflour addition on physicochemical and sensory properties of functional bread, LWT-Food Science and Technology. 2014; 58:614-619.
24. Prasad Reddy *et al*. Indian Journal of Science, Preparation of Rice Rotti fortified with flax seed & it's preservation. 2016; 23(79):253-267.
25. Punanik V. American journal of food technology, studies on development of protein rich germinated green gram pickle and its preservation by using class one preservatives, 2011, 742-752.
26. Reddy NR, Balakrishna CV, ksalunkhe D. phytate phosphorous and mineral changes during germination and cooking of black gram (phaseolusmungo) seeds. J

food science. 1978; 43:540-543.
27. Tian S, Nakamura K, Kayahara H. Analysis of Phenolic Compounds in White Rice, Brown Rice, and Germinated Brown Rice. Journal Agricultural and Food Chemistry. 2004; 52(15):4808-4813. doi.10.1021/jf049446f
28. Sadana BA, Chabra C. Development and sensoty evaluation of low cost weaning food formulations J human ecol. 2004; 16:133-136.
29. Suhasini AW, Malleshi NG. Influence of malting conditions on amylase activity, physical characteristics and nutrient composition of wheat malt. J Food Sci. Technol. 1995; 32(2):98.
30. Tian B, Xie B, Shi J, Wu J, Cai Y, Xu T *et al*. Physicochemicalchanges of oat seeds during germination. Food Chemistry. 2010; 119:1195e1200.
31. Tian S, Nakamura Kayahara H. Analysis of phenolic compounds in whiteRice, brown rice, and germinated brown rice. Journal of Agricultural and Food Chemistry. 2004; 52:4808e4813.