STANDARDISATION AND EVALUATION OF FOXTAIL MILLET BASED MALT MIX

ABSTRACT:

Foxtail millet has been consumed similar to rice from times immemorial and many products like soups, vermicelli, pasta and malt mixes were done in recent times to increase the nutrient content of various food products. Due to climate changes, millet usage is increasing nowadays as they require less irrigation and can grow in arid and semi-arid region to achieve nutrition security. In this present research, malted foxtail millet was used to increase the carbohydrates, energy, vitamin C, bioavailability of protein and other nutrients. Malt mix were prepared from germinated malt foxtail millet, roasted bengal gram and milk powder in different five formulation. Sensory evaluation was done for selection of best accepted and it was found that germinated foxtail to roasted bengal gram dal in the ratio of 2:1 was best accepted. This malt mix along with control germinated foxtail was further analysed for proximate composition and vitamin C content. The selected composite's moisture, ash, fat, protein and crude fibre content were higher for test foxtail millet mix whereas carbohydrates, energy and vitamin C were high for control foxtail millet mix. The lower carbohydrate and energy content as well as higher protein and crude fiber level in the test foxtail millet mix makes it an ideal supplementary food for children between 1 – 3 years of age.

Comment [J1]: Abstract should consist of short background, aims of the study, methods, and result

KEY WORDS:Malt mix, germinated foxtail millet, energy dense supplementary food, preschool children.

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Introduction: Foxtail millet (*Setaria italica* (L.) P. Beauvois) is known as a native of China and is one of the world's oldest cultivated crops. It ranks second in the total world production of millets and continues to have an important place in the world agriculture providing approximately six million tons of food to millions of people, mainly on poor or marginal soils in southern Europe and in temperate, subtropical and tropical Asia. It usually grows in altitudes from sea level to 2000 m, cannot tolerate water logging, is fairly tolerant of drought and can escape some droughts because of early maturity. Due to its quick growth grown as a short-term catch crop and well adapted to a wide range of elevations, soils and

temperatures. Its grain is used for human consumption and as feed for poultry and cage birds (Rao *et al*., 2017).

The whole grains and millets are inversely linked to body mass index, waist circumference, total cholesterol, and metabolic syndrome, mortality from cardiovascular diseases, insulin resistance and type 2 diabetes and are nutritionally superior to polished rice (Shobana *et al.,* 2013).

Germination or malting result in some biochemical modification like increase in free amino acids and total sugars and decrease in dry weight and starch content, as well as improved protein quality. Processings like germination, soaking, debraningand dry heating reduce antinutrients like phytic acid, tannins, and polyphenols that usually interact with proteins to form complexes (Saleh *et al.,* 2013).

Traditionally, millets were processed either by malting or fermentation. The malted and fermented flours were extensively used in preparation of weaning foods, instant mixes, beverages and pharmaceutical products (Rao and Krishna, 2001).

Germination is an inexpensive and effective method for improving the overall nutritional quality of food grains by enhancing their digestibility and reducing the contents of anti-nutritional factors (Chavan and Kadam, 1989).

Germination of millet grains increased the protein, ash, iron, calcium and phosphorus level of malted mixes developed. The use of locally available low-cost ingredients available in developing countries has great potential for producing highly nutritious, acceptable and dense foods. The addition of malt to foodsimproved their functional and nutritional qualities and can help in eradication of low birth weight (Swathi *et al*., 2016).

Roasting helps in the formation of desired flavour, and the quality and it improves the flavour, brown colour, texture and overall acceptability of the product (Ozdemir and Devres, 2000a, Pittia *et al*., 2001). Development of roasted flavour and aroma depends upon the temperature and time of roasting. Roasting results in lipid damageddue to oxidation reaction but the damage is less due to the presence of antioxidants like tocopherol and polyphenols that play major role for protection against fat deterioration (Chun *et al*., 2005).

Malted health food drink is among best substitute of a complete food. India is the world's largest malt bases drinks market accounts for 22% of the world's retail volume sales. Malted drinks are traditionally consumed as milk substitutes and also available in mixed with water and marketed as nutritious drinks mainly consumed by the old, the young and the sick persons. Malt is germinated cereal grains that have been dried in a process known as malting.

The grains are made to germinate by soaking in water, and are then halted from germinating further by drying with hot air (Dave and Paliwa, 2016).

Children develop malnutrition at critical period coincide with the introduction of complementary foods, which are nutritionally inadequate in many developing countries (Khanam *et al*., 2011). The multi-nutrient food mix was prepared from locally available raw material like course cereals, millets, soya bean and dairy products as the need of the hour is for nutritionally balanced, energy dense, easily digestible foods with functional benefits and cost effectiveness (Murugkar *et al*., 2013).

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Materials and methods:

Procurement of raw materials: New released foxtail millet was obtained from Agricultural College, PJTSAU, Polasa, Jagtial. The other ingredients like roasted bengal gram dal, milk powder and sugar were procured from local market of Hyderabad. The glassware and equipment were from Post Graduate & Research Centre, PJTSAU, Rajendranagar, Hyderabad.

Sensory analysis of germinated foxtail malt mix items was carried out by fifteen semi-trained panellists using 9-point hedonic scale and were scored for colour, consistency, taste, after taste, flavour, appearance and overall acceptability (Meilgaard *et al.*,1999).

Proximate analysis was carried to these malt mix as per the procedures followed by standard AOAC methods. Moisture, ash and protein (AOAC, 2005), fat (AOAC, 1997), carbohydrate and energy (AOAC, 1989), crude fibre (AOAC, 1990) and vitamin C (Ranganna, 2003) were used.

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Results and discussion: Malt mix composite of different formulation of germinated, dehulled and roasted malt along with roasted Bengal gram dal and milk powder in different ratio proportion were prepared as given in Table 1 below:

Table 1: **Compositions of malt mix**

Malt mix combinations	Foxtail millet flour (g)	Roasted Bengal gram flour (g)	Milk powder (g)
FMM1	95.00	-	5.00
FMM2	-	95.00	5.00
FMM3	47.50	47.50	5.00
FMM4	63.50	31.50	5.00
FMM5	31.50	63.50	5.00

FMM1- Malt mix formulation 1

FMM2- Malt mix formulation 2

FMM3- Malt mix formulation 3

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FMM4- Malt mix formulation 4

FMM5- Malt mix formulation 5

Sensory evaluation of malt mix: The composite of five malt mixes were prepared as porridges using mixture of 20g each to which 10g sugar and 100ml water were added and cooked for 4 to 5 minutes and the cooked malt mix weight was 85g.They were subjected to sensory evaluation and the results were as given in Figure 1.

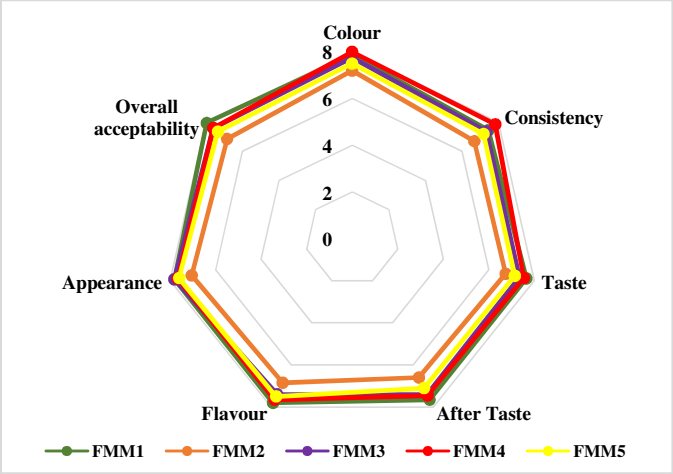

Figure 1: **Mean sensory evaluation of malt mix with sugar**

The best score for colour malt mix was given to FMM4 with 8.00±0.21 followed by FMM1 7.85±0.25. The best consistency was for FMM4 with 7.85±0.25 followed by FMM1 with 7.45±0.27. Taste which score highest was FMM1 7.65±0.29 and nextwas FMM47.55±0.23. The product as malted foxtail was leaving an aftertaste. The best scores for aftertaste were FMM1 followed by FMM4 with 7.65±0.26 and 7.45±0.22 respectively. The best flavour acceptance was also for FMM1 followed by FMM4 with 7.80±0.22 and 7.65±0.22 respectively. The best acceptance for appearance was for FMM1 and FMM3 respectively with score of 7.80±0.20 and 7.80±0.21 for both of them, followed by FMM4 with 7.65±0.23. Overall acceptability was highest for FMM1 with score 7.95±0.22 followed by FMM3 and FMM4 with same score of 7.60±0.21 and 7.60±0.23. All the sensory parameters were high for FMM1 and FMM4 and hence were selected for malt mix analysis.

Selection of best ready mix: FMM1 is foxtail millet without addition of Bengal gram dal and is taken as control whereas FMM4 is foxtail to Bengal gram dal in 2:1 ratio and selected as test sample.

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Analysis of best ready mix: Porridges prepared with developed ready mix and sensory evaluation was carried out and the best composition of ready mix was analysed for its proximate parameters for moisture, ash, protein, fat, crude fibre and vitamin C. Along with these analyses, carbohydrate content and energy were calculated and all of them were tabulated in Table 2 below.

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Table 2: **Nutritive value for selected ready to cook malt mix**

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Crude fibre (%)	Carbohydrates (%)	Energy (Kcal/100g)	Vitamin C (mg/100g)
CFMM	6.66±0.16	2.47±0.00	2.50±0.00	10.36±0.06	0.39±0.00	76.40±1.10	396.60±4.50	5.75±0.19
TFMM	7.83±0.16	2.65±0.15	3.95±0.29	12.58±0.14	0.63±0.03	72.34±0.20	375.30±2.70	4.40±0.19
Mean	7.25	2.56	3.22	11.47	0.51	74.37	372.40	5.07
SE of Mean	0.28	0.08	0.34	0.50	0.05	1.03	2.66	0.32
CD	0.71	0.67	1.26	0.33	0.14	4.90	29.75	1.67
CV%	2.81	7.48	11.12	0.83	7.88	1.87	2.27	9.40

Note: Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at $p \leq 0.05$

CFMM- Control foxtail malt mix

TFMM- Test foxtail malt mix

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The moisture, ash, fat, protein, crude fibre and carbohydrate content of CFMM was 6.66±0.16, 2.47±0.00, 2.50±0.00, 10.36±0.06, 0.39±0.00 and 76.40±1.10 % respectively and that of TFMM was 7.83±0.16, 2.65±0.15, 3.95±0.29, 12.58±0.14, 0.63±0.03 and 72.34±0.20 % respectively. The energy content of CFMM and TFMM werecalculatedto be 396.60±4.50 and 375.30±2.70 KCal / 100g whereasvitamin C content was 5.75±0.19 and 4.40±0.19 mg/100g respectively. The lowered vitamin C content in the test sample was due to reduced amount of germinated foxtail millet in comparison with control.

Tripati *et al.*, (2015) also reported protein, crude fibre and ash content of 10.65±0.12, 0.4±0.15 and 1.31±0.17 % respectively of malted finger millet. Laxmi *et al.* (2015) showed that malt mix of foxtail millet, wheat and chickpea prepared by steeping for 24 hours and germinated for 48 hours in proportions of 40:30:30 were rich in protein and carbohydrates. The maximum carbohydrates in foxtail millet flour was 58.64% and protein was 11.16%. These results were more or less similar to result reported in table 3.

Table 3: **Nutritive value for selected ready to cook malt mix for serve size**

Sample	Moisture (g)	Ash (g)	Fat (g)	Protein (g)	Crude fibre (g)	Carbohydrates (g)	Energy (Kcal)	Vitamin C (mg)
CFMM	5.66	2.09	2.12	8.80	0.33	64.94	337.11	4.88

TFMM	6.65	2.25	3.35	10.69	0.53	61.48	319.00	3.74
Mean	6.15	2.17	2.73	9.74	0.43	63.21	328.05	4.31

* Values were calculated and expressed for 85g of cooked CFMM and TFMM.

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The malt mix was developed for pre-school children of age group 1-3 years and RDA as per ICMR, (2010) showed the energy requirement as 1060 Kcal/day, protein is 16.7g/day, fat is 27g/day and vitamin C is 40 mg/day. The control of 85g contained fat 2.12g, protein 8.80g, crude fibre 0.33g, carbohydrate 64.94g, energy 337.11 Kcal and vitamin C of 4.88 mg/day whereas the test sample contained fat 3.35g, protein 10.69g, crude fibre 0.53g, energy 319.00 Kcal and vitamin C of 3.74mg/day. Fat, protein and crude fibre were higher for test sample than control while carbohydrates, energy and vitamin C were higher for control. The fat, protein, energy and vitamin C content of control was meeting about 7.85, 52.69, 31.80 and 12.20 % respectively of the RDA requirement of pre-school children of age group 1-3 years whereas test sample was meeting 12.40, 64.01, 30.09 and 9.39% respectively.

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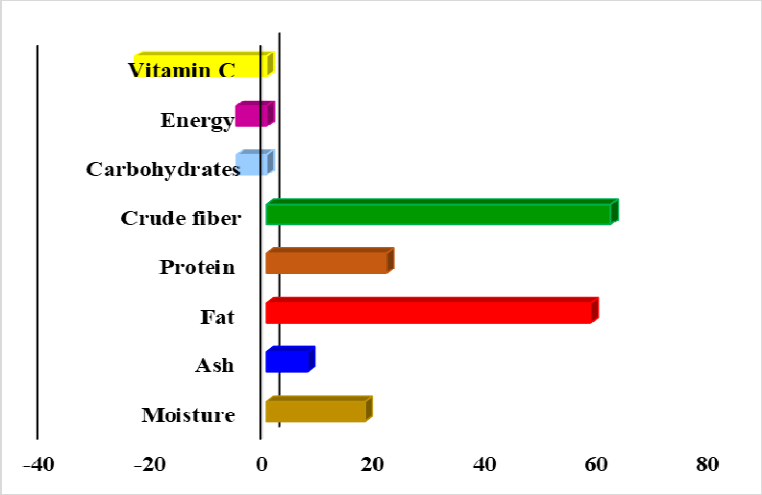

Figure 2: **Percentage change in proximate composition of malt mix**

The difference percentage change between two malt mix CFMM and TFMM for moisture, ash, fat, protein, crude fibre, carbohydrate, energy and vitamin C was found to be 17.57, 7.29, 58, 21.43, 61.54, 5.31, 5.37 and 23.47 % respectively as shown in figure 2. There wasan increase in the moisture, ash, fat, protein, crude fibre and carbohydrate content for TFMM whereas energy, and vitamin C decreased. Research studies showed that the fat level decreases during germination due to increased activity of the lipolytic enzyme during germination (Raham and Aal, 1986). The fat content was found to be reduced on malting and twice as much reduction in energy content (Laxmi *et al*., 2015). There can be a decrease in

carbohydrate level due to germination and fermentationbecause of increased α-amylase activity (Lasekan, 1996).

The Bengal gram dal composition of moisture, protein, fat, crude fibre and carbohydrates were 10.90, 24.0, 1.40, 0.90, 59.60% and energy was 347 Kcal/100g respectively. Legumes are known to reduce the risk of cardiovascular disease, fewtypes of cancers of colon, breast and prostate along with helping in managingbody weight due to its satiety value (Kamboj and Nanda, 2017). Hence, inclusion of Bengal gram dhal can improve the nutrient content of this malt mix.

Conclusion:Among the five malt mix composite prepared, FMM1 and FMM4 had the best sensory scores for colour, consistency, taste, after taste, flavour, appearance and overall acceptability. Proximate analysis was carried out for selected composite and moisture, ash, fat, protein and crude fibre content were high for TFMM whereas carbohydrates, energy and Vitamin C were high for CFMM.So,the incorporation of roasted Bengal gram with germinated foxtail millet were more beneficial than germinated foxtail millet alone on nutritious basis in preparation of malt mixes.

References:

AOAC. 1990. Official method of analysis for fiber. *Association of Official Analysis Chemists.* 14th Edition. Washington DC. USA.

AOAC. 1997. Official Methods of Analysis for fat (crude) or ether extract in flour. *Association of Official Analytical Chemists.* 16th Ed. 3rd Revision. Gaithersburg, Maryland 20877-2417. AOAC 920.85, chap 32, pp 05.

AOAC. 2000. Method of analysis, 17th Edition. *Association of Official Analysis Chemists.* Washington DC. USA.

AOAC. 2005. Official Methods of Analysis for ash in flour. *Association of Official Analytical Chemists.* 18th Ed. Arlington VA 2209, USA. AOAC 929.09, chap 32, pp 01.

AOAC. 2005. Official Methods of Analysis for moisture in flour. *Association of Official Analytical Chemists.* 18th Ed. Arlington VA 2209, USA. AOAC 929.03. 32: 02.

AOAC. 2005. Official Methods of Analysis for protein. *Association of Official Analytical Chemists.* 18th Ed. Arlington VA 2209, USA. AOAC 984.13, chap 04, pp 31.

Chavan, J.K and Kadam, S.S. 1989. Nutritional improvement of cereals by sprouting. *CRC Critical Review of Food Science Nutrition*. 28: 401-437.

200 Chun, J., Lee, J., and Eitenmiller, R.R. 2005. Vitamin E and oxidative stability during storage
201 of raw and dry roasted peanuts packaged under air and vacuum. *Journal of Food*
202 *Science*. 70:292–297.
203 Dave, K.K and Paliwal, R. 2016. A study on consumer perception on malted health food
204 drinks in Udaipur city. *International Journal of Management and Corporate Affairs*
205 (IJARS). 2(5): 1-27.
206 Laxmi, G., Chaturvedi, N and Richa, S. 2015. The impact of malting on nutritional
207 composition of foxtail millet, wheat and chickpea. *Journal of Nutrition and Food*
208 *Sciences*. 5(5): 1 - 3. DOI: 10.4172/2155-9600.1000407
209 Kamboj, R. and Nanda, V. 2017. Proximate composition, nutritional profile and health
210 benefits of legumes – A review. *Legume Research*. 1 – 8. DOI:10.18805/LR-3748.
211 Khanam, A., Chikkegowda, R.K. and Lingappa, B. S. 2011. Functional and nutritional
212 evaluation of supplementary food formulations. *Journal of Food Science and*
213 *Technology*. DOI 10.1007/s13197-011-0344-x.
214 Lasekan, O.O. 1996. Effect of germination on α-amylase activities and rheological properties
215 of sorghum (*Sorghum biocolor*) and acha (*Digitaria exilis*) grains. *Journal of Food*
216 *Science and Technology*. 33: 329-331.
217 Meilgaard, M., Civile, G.V and Carr, B.T. 1999. Sensory evaluation technique. 3rd Ed. CRC
218 press, Boca Raton.
219 Murugkar, D.A., Gulati, P and Gupta, C. 2013. Effect of sprouting on physical properties and
220 functional and nutritional components of multi-nutrient mixes. *International Journal*
221 *of Food and Nutrition Sciences*. 2(2). e-ISSN 2320-7876.
222 Özdemir, M. and Devres, O. 2000a. Kinetics of colour changes of hazelnuts during roasting.
223 *Journal of Food Engineering*. 44:31–38. http://dx.doi.org/10.1016/S0260-
224 8774(99)00162-4
225 Pittia, P., Rosa, M. D.and Lerici, C.R. 2001. Textural changes of coffee beans as affected by
226 roasting conditions. LWT – *Food Science and Technology*. 34: 168–175.
227 http://dx.doi.org/10.1006/fstl.2000.0749.
228 Raham, E.H and Aal, M.H. 1986. Changes in gross chemical composition with emphasis on
229 lipid and protein fractions during germination of fenugreek seeds. *Food chemistry*.
230 22:193-198.
231 Ranganna, S. 2003. Handbook of analysis and quality control of fruit and vegetable products.
232 2nd Ed. Tata McGraw Hill Publications Co.: New Delhi, India. 497– 528.

Rao, D.B., Bhaskarachary, K., Arlene C.G.D., Devi, G.S. and Tonapi V.A. 2017. Nutritional and Health benefits of millets. Indian Council of Agricultural Research- Indian Institute of Millet Research (ICAR-IIMR), Rajendranagar Hyderabad- 500030.

Rao, S.M.V.S.S.T and Krishna, G. M. 2001. Non-starch polysaccharides and bound phenolic acids from native and malted finger millet (Ragi, *Eleusine coracana*, Indaf-15). *Food Chemistry*. 72: 187-192.

Saleh, A.M., Zhang, Q., Chen, J. and Shen, Q. 2013. Millet grains: Nutritional quality, processing, and potential health benefits. *Institete of Food Technologists*. 12: 281-295.

Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N.G., Anjana, R.M., Palaniappan, L. and Mohan, V. 2013. Finger millet (ragi, *Eleusine coracana* L.): A review of its nutritional properties, processing, and plausible health benefits. *Advances in Food and Nutrition Research*. ISSN 1043-4526. 69: 1-39.

Swathi, M, Waghray,K. Babu, N. and Golla, R. 2016. Development of malted millet mixes for pregnant women and lactating mothers. *International Journal of Innovative Technology and Research.* 4 (6): 5323-5328.

Tripathi, J., Prasad, R., Gupta, A. and Puranik, V. 2015. Development of value added pasta with incorporation of malted finger millet flour. *Journal of Applied and Natural Science*. 7(2): 598-601.