

<https://doi.org/10.48047/AFJBS.6.14.2024.12228-12242>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Novel value-added Food Multi-Mix (FMM) made with *Musa balbisiana*: A comprehensive study on its quality assessment.

Daisy Sharma¹, Akumnaro Jamir¹, Radali Duarah¹, Mrinmoy Basak² and Manash Pratim Sarma^{3*}

1. Program of Food Nutrition and Dietetics, Faculty of Science, Assam down town University, Panikhaity, Guwahati, Assam, India
2. Professor, Faculty of Pharmaceutical Science, Assam down town University, Panikhaity, Guwahati, Assam, India
3. Program of Biotechnology, Assam down town University, Faculty of Science, Panikhaity, Guwahati, Assam, India

Volume 6, Issue 14, Sep 2024

Received: 15 July 2024

Accepted: 25 Aug 2024

Published: 05 Sep 2024

[doi: 10.48047/AFJBS.6.14.2024.12228-12242](https://doi.org/10.48047/AFJBS.6.14.2024.12228-12242)

ABSTRACT

The objective of the study was to evaluate the sensory parameters, nutritional parameters and shelf life of multi mix flour developed using Foxtail millet (*Setaria italica*), Banana (*Musa balbisiana*), Banana Blossom (*Musa acuminata colla*), Moong beans (*Vigna Radiata*). The Food Multimix were standardized for sensory attributes. The ingredients were processed and stored in air tight containers at room temperature. Different recipes were standardized with 100g of multi-mix, which included porridge, biscuits, pakoras, pancakes, steam cakes and roti. The sensory evaluation of the FMM was carried a 9- point hedonic scale. After the acceptability trials it was found that among the four formulations, the most preferred sample was A2 containing 50% Foxtail millet, 25 % Moong beans, 20% and 5% banana blossom. Therefore, based on the acceptability A2 was selected for carrying out further analysis. Physico-chemical tests of A2 showed that the moisture content was 9.6 %, the protein content was 14.58g, the fat was 2.41 g, the total ash was 3.54g and carbohydrate content was 54.63g. The amylose and amylopectin content were found to be 8.19 % and 91.81%. The total energy content of A2 was found to be 298 Kcal. The shelf-life of the FMM at room temperature for a period of 2 months was determined. The absence of microbial colony in the FMM indicated that the FMM is safe for human consumption when stored at room temperature for more than 61 days (i.e., 2 months). Data of the sensory and self-life evaluation of the formulated and prepared food multi-mix indicate that it is acceptable, safe, suitable and may improve the nutritional intake of people from various age groups.

KEYWORDS: Food multi-mix, Nutrient rich, Sensory Attributes, Acceptability.

INTRODUCTION:

Food Multimix (FMM) is defined as “a blend of locally available, affordable, culturally acceptable and commonly consumed foodstuffs mixed proportionately, drawing on the ‘nutrient strengths’ of each component of the mix in order to optimize the nutritive value of the end-product without the need for external fortification.”¹. Food multi-mix (FMM) development was pioneered by Gopaldas in 1974, in which certain criteria were adopted from Cameron and Hofvander, 1987 to ensure accurate food formulation, safety, and affordability

². Food multi-mix (FMM) assists in providing ingredients balance from each food group within the formulation and to ensure maximum nutritional value³. It has been reported that this concept has many applications and has been used to develop food products for clinical and non-clinical population groups (i.e., weanlings, infants, pregnant women, individuals infected with HIV/AIDS and individuals with type 2 diabetes)⁴

WHO and FAO focuses on the utilization of under- utilized legumes and millets which are of high quality protein, dietary fiber and other micronutrients with numerous health benefits⁵

. India has gained considerable progress in health determinants over the past few decades. However, the problem of chronic hunger and malnutrition seems to prevail on a large scale⁶. India is a country with populations suffering from different underlying diseases which ranges from malnutrition to overnutrition, another problem is infection especially among the children under 5yrs of age. It is a well-recognized fact that the “children of today are the citizens of tomorrow”⁷, so emphasis must be given to improve their nutritional status. These related complications diseases can be minimized and controlled with the consumption of the Food Multimix (FMM) prepared using nutrient rich foods like Foxtail Millet (*Setaria italica*), Moong Beans (*Vigna radiata*), Banana (*Musa Balbisiana*) and Banana blossom of *Musa Balbisiana*.

The ingredients used to prepare the FMM reported to have various medicinal properties as well as nutritionally rich. Recent studies showed that a diet including Foxtail millet may improve glycemic control and reduce insulin, cholesterol and fasting glucose in Type-II diabetes⁸. Moong beans and its extracts have been reported to have shown excellent health implications, such as hypoglycemic and hypolipidemic effects and antihypertensive, anticancer, anti-melanogenesis, hepatoprotective, and immunomodulatory activities. Moong beans supplemented with cereals, provide a perfect mix of essential amino acids with high biological value⁹. It has been reported that banana is rich in many bioactive

compounds, such as carotenoids, flavonoids, phenolics, amines, vitamin C, and vitamin E having antioxidant activities to provide many human health benefits¹⁰. consumption of banana blossoms reduces the blood sugar level and raise the hemoglobin level in the body as it is rich in fibre and iron which assists in the production of red blood cells. Banana blossom being a good source of both soluble and insoluble dietary fibre, is very helpful for people suffering from irritable bowel syndrome (IBS) and diarrhea. Including banana blossom to their diet plan can help reduce such problems. Since the blossoms are rich in vitamin C, it can be helpful in ulcer management because vitamin C plays important role in promoting tissue repair and wound healing^{10,11}.

MATERIALS AND METHODS

Selection and of the raw materials: The raw materials for the food multi mix was selected based on their nutritional property and ease of availability. All the ingredients used were locally available and after collection or raw materials they were processed in flour in order to formulate the composite multimix.

Principles of multi-mix formulation:

The protocol for multi-mix requires the use of local ingredients which are culturally acceptable, easily available and of low monetary value. The operating principle of multi-mix formulation comprises of three different steps.

Stage 1: Selection of ingredients must be from a staple food source, a protein source, a fat source, a fruit or a vegetable containing optimum number of vitamins and minerals. A multi-mix should not contain more than five ingredients.

Stage 2: Proximate analysis of all the ingredients used in dry weight basis.

Stage 3: The total energy content of the formulation was estimated by multiplying carbohydrate and protein of all the selected ingredients by 16.8 kJ and fat weight by 37.80 kJ. The Energy Density value should be in between 15.12 - 18.90 kJ/g (3.6 - 4.5 kcal/g) per 100 grams of sample.

Table 1. Nutrient composition of the functional ingredients used for formulation of Food Multi Mixes (FMM's)

Ingredients	Carbohydrate	Protein	Fat
Foxtail Millet	63.48	12.65	4.7
Green Gram	45	23	1.6
<i>Musa balbisiana</i>	78	8.3	1.29
Plaintain Flower	64.42	17.26	0.76
Sesame Seeds	10	20.9	62



Foxtail Millet



Moong Beans



Banana



Banana Blossom

Fig 1. Raw materials used for FoodMulti Mix

Table 2. Table showing the formulation of Food Multi Mixes (FMM's) expressed in terms of 100 grams and their energy density value:

Formulations	Ratio of Incorporation (in 100 grams)						
	Foxtail Millet	Moong Beans	Banana	Banana Blossom	Sesame Seeds	Energy (Kcal)	ED Value
A1	30	30	25	5	10	361.92	1514.2
A2	40	25	20	5	10	364.24	1523.9
A3	50	20	15	5	10	366.57	1533.7
A4	60	15	10	5	10	373.97	1564.6



















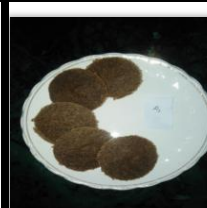





The food multi mixes were formulated as given in Table no 3.2 and their energy density value was calculated which is at par with the standards outlined for development for food multi mix. After the formulation at different level of incorporation was made i.e. A1, A2, A3 and A4. Each of them was incorporated in preparation of various food items.

Development of different products using the developed food multi mix: The developed multi mix was incorporated in different preparations in order to enhance the nutrition of the products. The different products prepared are presented in Table 3. The products were subjected to sensory evaluation and the product with highest scores was selected for further analysis

Proximate analysis of FMM: The food multi mix were analyzed for proximate analysis using standard protocols.

Storage studies: The storage study of the developed samples were conducted using different types of packaging materials like Plastic containers, Glass containers and LDPE zip loc bags in plastic containers for 3 months and its quality parameters i.e. color, appearance, etc. were studied. Samples were stored at room temperature.

Table 3 Different products made using the developed Food multi mix

Name of products	Formulations			
	A1	A2	A3	A4
1. Porridge				
2. Biscuit				
3. Pakora				
4. Pancakes				
5. Steamed cakes				
6. Roti				

RESULTS AND DISCUSSION:

Acceptability trials of the formulated products

Acceptability of a product is determined by sensory evaluation. Sensory evaluation has been defined as a scientific discipline used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing¹². Acceptability trials were conducted by a panel of semi trained judges consisting of 50 no of panelist and the scoring was done using 9-hedonic scale. The results are depicted in Table 3, and from the results it was evident that all the products were acceptable. Table also revealed that out of the all the product prepared incorporating the developed formulation of food multi mix, formulation A2 exhibited highest scores for all the sensory attributes in terms of colour, appearance, taste, flavor, crispness, and overall acceptability. Therefore, based on the sensory attributes for further analysis the formulation A2 was selected for further studies. Several studies have reported that biscuits prepared from millet flours added with wheat flour at different level of incorporation were highly acceptable^{13,14}.

Table 4 Mean acceptability scores of different FMM incorporated products:

Product	Formulation	Quality Attributions					
		Color	Appearance	Taste	Texture	Flavor	Overall Acceptability
Porridge	A1	7.1±0.83	6.9±0.94	7.3±1.1	6.9±0.83	6.7±1.26	7.0±1.7
	A2	7.0±1.0	6.8±1.46	7.2±1.4	6.7±0.9	6.6±1.28	7.3±0.64
	A3	7.2±1.0	6.5±1.43	7.3±0.9	6.8±0.6	7.3±1.1	7.6±0.91
	A4	6.7±0.9	6.1±1.22	6.0±2.09	6.3±1.34	6.2±1.46	6.5±1.5
Biscuits	A1	7.0±1.02	7.1±1.20	7.8±0.98	7.4±1.21	7.6±1.25	7.7±1.01
	A2	7.6±0.84	7.6±1.12	8.0±1.21	7.4±1.40	8.0±1.02	8.1±0.85
	A3	7.4±0.73	7.2±0.98	7.5±0.79	7.2±1.10	7.6±0.99	7.6±0.99
	A4	7.6±1.04	7.4±1.09	8.0±0.92	7.4±1.13	7.9±0.99	8.0±0.8
Pakora	A1	7.7±0.78	7.4±0.80	7.6±0.72	7.6±0.85	7.6±0.8	7.7±0.78
	A2	7.5±0.92	7.4±0.96	7.7±0.99	7.5±0.97	7.6±0.85	7.8±0.97
	A3	7.3±1.0	7.2±0.74	7.6±1.15	7.3±0.9	7.5±0.97	7.5±1.02

	A4	7.1±1.15	6.8±0.85	7.0± 1.0	7.1±0.76	7.3±1.01	7.3±0.78
Pancake	A1	7.1±0.79	7.0±0.73	7.0±0.94	6.9±0.88	6.9±0.97	7.4±0.58
	A2	7.1±0.7	7.1±0.57	7.1±0.7	6.9±0.76	7.05±0.86	7.3±0.85
	A3	7.4±0.91	7.4±0.80	7.2±0.94	7.0±1.04	7.1±0.94	7.3±0.95
	A4	7.3±0.90	7.2±0.76	7.2±0.92	7.4±1.01	7.3±1.00	7.2±0.94
Steam cake	A1	6.5±1.65	6.4±1.28	6.0±1.70	6.1±1.72	6.1±1.37	6.1±1.38
	A2	6.4±1.15	6.1±1.23	5.7±1.40	6.0±1.11	5.9±1.37	6.3±1.38
	A3	6.4±1.14	6.7±1.18	5.9±1.16	6.0±1.49	5.9±1.49	6.4±1.31
	A4	6.5±1.53	6.2±1.07	5.7±1.18	5.7±1.22	6.2±1.32	5.9±1.13
Roti	A1	6.2±1.32	5.8±1.56	6.1±1.78	5.2±1.28	5.6±1.52	5.7±1.54
	A2	6.3±1.14	6.2±1.02	5.9±1.41	5.5±1.65	5.8±1.52	6.0±1.20
	A3	6.0±1.37	6.4±1.20	6.1±1.44	5.4±1.43	6.0±1.18	5.1±1.34
	A4	5.7±0.90	5.9±1.41	5.1±1.19	5.4±1.46	5.9±1.16	5.6±1.15

Data expressed as mean ± standard deviation of 50 subjects (n=50)

Proximate composition of the Food multi mix:

From Table 5 it is evident that the moisture content of FMM (A2) was 9.6 %, the protein content was 14.58 g /100g, the fat content of Food multimix was 2.41g /100g, the total ash content was 3.54g per 100g. The total carbohydrate content of Food Multimix (A2) was found to be 54.63 g per 100g, total sugars content was 9.75 g per 100g, the total fibre contentment was 3.52g/100g and the total energy values was 298 Kcal per 100g.

The moisture content of food ingredients influences the taste, texture, appearance and shelf-life of food stuffs and the slightest deviation can adversely effect the physical properties of food material¹⁵. FAO/WHO suggested that a multimix should provide more than 20% of protein per 100g. The fat content of the FMM was found to be low, in a similar study it was found that significant decrease ($P \leq 0.01$) in fat content of a composite flour developed from mixed cereal grains and germinated field beans due to loss of fat in steeping water and the use of stored fats for sprouts to grow during germination¹⁶. Decrease in fat content level may also be due to malting of green moong beans (*Vigna radiata*) during its processing into flour. FAO (1990) reported that the ash content of a complementary food should be less than 5%. Therefore, the prepared sample, is at par with the recommended mineral values. Studies observed that the sugar content of bananas increase with drying¹⁷, in this study also the highest sugar bearing ingredient was *Musa balbisiana* among the other key ingredients contributing to the sugar content. FAO/WHO also recommended that a multi mix should provide more than 45% of carbohydrate per 100g of sample. Thus, it can be concluded that all the Food Multi Mixes developed were at par with the recommended carbohydrate values. Energy value according to BIS specifications should be 300- 400 Kcal.

Table 5. Proximate Analysis of Food Multimix

Nutrient composition (per 100grams)	Food Multimix A2
Moisture (%)	9.6 ±00
Protein (g)	14.58 ±1.11
Fat(g)	2.41±0.45
Total mineral (Ash) (g)	3.54 ±0.19
Total Fiber(g)	3.52 ±0.81
Total Carbohydrates (g)	54.63 ±0.74
Total Sugars (g)	9.75 ±0.32
Energy (Kcal)	298 ±0.31

Data expressed as mean ± standard deviation of 3 observations (n=3)

Carbohydrate components content of Food Multimix:

Starch consists of two macromolecules- amylose (linear starch chain) and amylo-pectin (branched starch chain)^{18,19}. It was found that the starch content in food multimix was. 39.76, the amylose content was 8.19 % and the amylopectin content was 91.81%. (Table 6)

Amylose is digested slowly and provides several benefits to human health. Recent clinical studies indicate that amylose is important in reducing the glycemic and insulin impact of foods²⁰ and in increasing the body's fat burning ability which may help to maintain a healthy weight²¹. Scientific evidence of the health benefits may promote a demand for high amylose grains in future markets. Amylopectin, the major component of starch is a larger branched molecule with α -D-(1-4) and α -D-(1-6) linkages. Amylopectin helps to modify food texture and consistency.

Table 6 Carbohydrate components content of Food Multimix

Carbohydrate Components	Food Multimix – A2
Starch	39.76 %
Amylose	8.19 %
Amylopectin	91.81 %

Shelf-life studies of the food multimix

The shelf life of developed products depends on a variety of factors, such as the preparation method, storage temperature, storing method, ingredients used, packaging method etc. The developed food

multimix A2 was stored in air tight containers made of plastic, glass and LDPE zip loc bags for a period of 2 months at room temperature in order to conduct the storage study(Fig- 2).

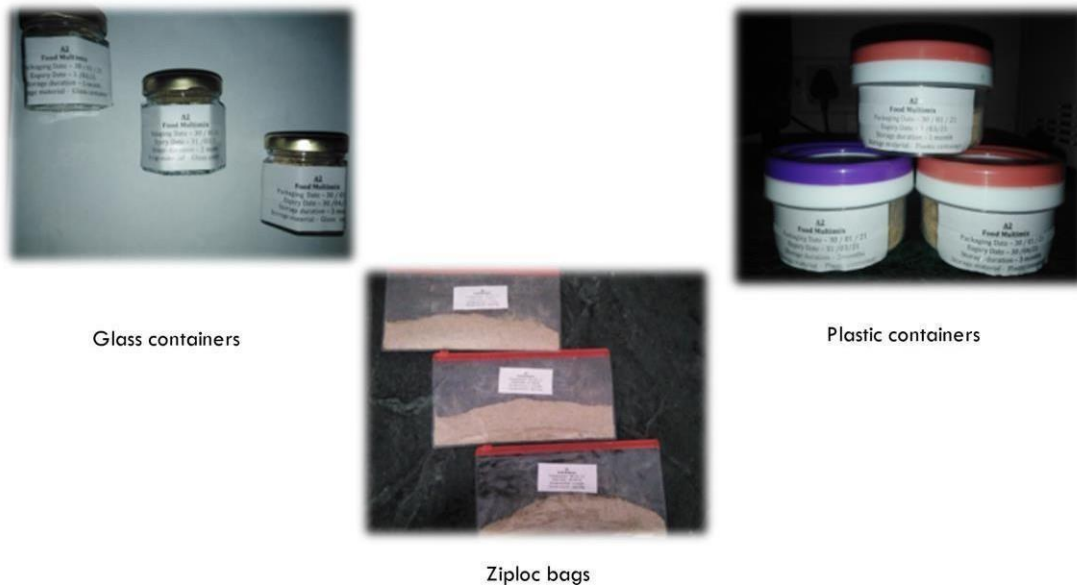


Fig 2: Food Multi- Mix in different Packaging Materials

No colony growths were found for Total Plate Count (TPC) even after 2 months of storage in all three packaging materials. Yeast and mould growth was also not detected. The overall bacteriological status of the prepared FMM was observed to be satisfactory. The obtained results revealed that the total viable bacterial count, total yeast and mold count were absolutely nil/g in the food multi-mix analyzed, when packets were opened. The low counts of the examined foods indicated adequate thermal process, good quality of raw materials and as a result of the good different processing conditions under which the production of foods was carried out.

CONCLUSION:

In conclusion, it can be summarized that the Food Multimix developed by us using foxtail millet, banana, banana blossom and moong beans have an excellent acceptability score and has the potential to be utilized and prepared incorporating various food recipes. Food Multimix can be utilised as a

replacement of the commonly used wheat flour for better improvement of nutritional health status among all age groups.

CONFLICT OF INTEREST: No

REFERENCES

1. F. B. Zotor and P. Amuna, “The food multimix concept: harnessing and promoting local composite complementary diets”, *Proceedings of the Nutrition Society* (2017), 76, 535–54
2. Gopaldas, T., Varakarajan, I., Greqal, T. and Shingwekar, A.G., Development of indigenous multi-mix for the preschool child. *Indian Paediatrics. Journal of the Indian Academy of Paediatrics*, (1974). p. 501-509.
3. Oosthuizen, D., Oldewage-Theron, W.H. and Ebuehi, O.A.T.*, Sensory and Shelf-life evaluation of a Food Multi-Mix formulated for rural children in South Africa, *Nigerian Food Journal*, Vol. 25, No. 1, 2007, pp. 56-66
4. F. B. Zotor and P. Amuna, “The food multimix concept: new innovative approach to meeting nutritional challenges in Sub-Saharan Africa”, *Proceedings of the Nutrition Society* (2008), 67, 98–104
5. Daisy Kameng Baruah , Mamoni Das and Rajeev Kumar Sharma. “Nutritional and Microbiological Evaluation of Ricebean (*Vigna umbellata*) Based Probiotic Food Multi Mix Using *Lactobacillus plantarum* and *Lactobacillus rhamnosus*” *Journal of Probiotics & Health*, 2018. 6:1
6. Upadhyay, R.P., Dwivedi, P.R., Rai, S.K. *et al.* Determinants of neonatal mortality in Rural Haryana: A retrospective population based study. *Indian Pediatr*, (2012). 49, 291–294

7. Renuka K. A Study to Assess the Effectiveness of Teaching Programme in Knowledge on Selected Infectious Disease Among Mothers of Under Five Children in Thiruvallur District. Asian J. Nur. Edu. & Research 1(2): April-June 2011; Page 57-59.
8. Nitya Sharma & Keshavan Niranjana "Foxtail millet : Properties, processing, health benefits and uses" Food Reviews International , Vol. 34, 4 (2018) , 329-363
9. Hou, D., Yousaf, L., Xue, Y., Hu, J., Wu, J., Hu, X., Feng, N., & Shen, Q., Mung Bean (*Vigna radiata* L.): Bioactive Polyphenols, Polysaccharides, Peptides, and Health Benefits. *Nutrients*, (2019). 11(6)
10. Singh, B., Singh, J. P., Kaur, A., Singh, N., Bioactive compounds in banana and their associated health benefits – A review. *Food Chemistry*, (2016). 206: 1–11.
11. Purabi Deka, Ananya Kashyap, Daisy Sharma, Chandrama Baruah, A Review on *Musa Balbisiana* Colla, *International Journal of Pharmaceutical Science Invention*, (2018) Vol 7(7)I, 14-17
12. Lawless, H.T. and Heymann, H., *Sensory evaluation of food: principles and practices*. Springer Science & Business Media 2010.
13. Shadang, C. and Jaganathan, D. Development and standardisation of formulated baked products Using millets. *Intern. J. Res. Appl. Nat. Soc. Sci.* (2014). 2(9): 75-78
14. Meghana, D.R.; Kamatar, M.Y. and Goudar, G., Enrichment of savoury biscuits with foxtail millet (*Setaria italica*) for good health. *J. Food Process Technol*, (2012).
15. Yvonne Appoldt and Gina Raihani, *Determining Moisture Content*, wiley food science, quality & safety e-newsletter, 2017
16. D'souza, M. R. ,Effect of traditional processing methods on nutritional quality of field bean. *Adv. in Bio Res.*, (2013). 14: 29-33

17. E.E Alagbe, Y.S Amlabu, E.O Daniel, M.E Ojewumi, Effect of Varying Drying Temperature on the Soluble Sugar and Nutritional Content of Banana, *The Open Chemical Engineering Journal*, 2020(11)
18. Tester RF, Karkalas J, Qi X ,Starch structure and digestibility enzyme-substrate relationship. *Worlds Poult Sci J* (2004) 60:186–195
19. Shrushti Kothekar, Shivangi Shukla, Suneetha V. A Brief Study on Starch Based Bio-Plastics Produced From Staple Food Items. *Research J. Pharm. and Tech* 2018; 11(11): 4878-4883.
20. Behall, K.M., Scholfield, D.J., Food amylose content affects postprandial glucose and insulin responses. *Cereal Chem*, 2005. 82, 654–659.
21. Higgins, J.A., Higbee, D.R., Donahoo, W.T., Brown, I.L., Bell, M.L., Bessesen, D.H.,. Resistant starch consumption promotes lipid oxidation. *Nutr. Metabol*, 2004 1, 8.