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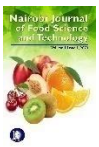
Development and evaluation of food multi-mix (FMM)



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Abstract

An experimental study was conducted on Development of a Food Multi- mix. The objective of the study was to standardize different formulations of multi- mix by using Barley (*Hordeum vulgare)*, Foxtail millet (*Seteria italic)*, Soybean (*Glycine max)*, Yardlong bean (*Vigna unguiculata ssp. Sesquipedalis)*, Sprouted mung bean (*Vigna radiata),* Banana flower and Banana seeds (*Musa acuminata)*. Acceptability trails were conducted by a semi- trained panel in the Department of Food, Nutrition and Dietetics using 9- point hedonic scale. The present study was made with an attempt for development of multi-mix with the ingredients which had high nutritive value and aids various health problems like Diabetes, Cholesterol, Cardiovascular Diseases, Gastrointestinal Diseases, Inflammation, Post- menopausal Syndromes and many other chronic diseases. Six formulations were developed namely FMM 1, FMM 2, FMM 3, FMM 4, FMM 5 and FMM 6 (FMM= Food Multi- mix) using different ratios of the selected ingredients. Among the six developed FMMs, two FMMs i.e. FMM 3 and FMM 6 were selected based on sensory scores and accepted products were further analyzed for Moisture Content and Shelf- life storage for one month. The nutritive value of all the developed FMMs was calculated. The shelf- life and the sensory scores of the formulated FMMs did not change much in terms of all the sensory attributes in one month of storage and the products were still acceptable.

Keywords: acceptability trails, formulations, hedonic scale, multi-mix, panel

Public Interest Statement

The idea of product development in the form of Multi- mix raised because this can be not only used as for medicinal purpose, but also as a supplementary diet. In the busy schedule where people have less time for preparing a healthy meal, it is an easy and cheap method for preparing a multi- mix and consuming it. It also involves the principle of using under-utilized healthy ingredients which helps in protection from various underlying and chronic diseases.

Introduction

Food Multi-Mix (FMM) is defined as a mixture of locally available ingredients which are affordable, culturally acceptable and commonly consumed food items or recipes mixed in different proportions, keeping in notice the 'nutrient strengths' of each ingredient of the multi- mix to keep the nutritive value of the FMM without using any external fortification. Doing so by harnessing local food ingredients and employing Food Science, Technology and Food Product Development techniques to develop edible products to meet the needs within a cultural context is desirable (F. B. Zotor,2015). The Food Multi-Mix (FMM) concept is built on the notion in seeking ways to improve nutrition in resource-poor environments scant local food ingredients can be harnessed effectively for recipe development to provide composite diets for multiple uses including for optimum health and therapeutic purposes (P. Anuma, 2015).

The recipes can further be reviewed and then the process of optimization can be undertaken where necessary in order to improve the nutrient balance and nutritive value of the recipe as the developed FMM for multiple uses. The FMM concept states that irrespective of environment, it is only achieved through the application of knowledge of Food Science and Technology, nutrition, human biochemistry and metabolism in health and disease to make effective use of the ingredients to meet human requirements of food. (P. Anuma& F. Zotor, 2009). The flexibility and advantage of the approach to multi-mix is that the combination of traditional food ingredients can be customized within any community harnessing their own available natural, affordable, culturally acceptable and commonly consumed resources within their specific physiological and clinical needs for targeted interventions (Adewuya, 2009).

WHO and FAO focus on the utilization of under- utilized legumes and millets which are of high quality protein, dietary fiber and other micronutrients with numerous health benefits (Baruah DK *et al.,* 2018). The significant use of functional foods that provide health benefits beyond their nutritional contribution has raised the public interest. Such

foods are significantly related to improved health and nutritional status of human as well as reducing risk of acute and chronic diseases (A. Uswa*et al.,* 2019).

India is a country with populations suffering from various underlying diseases and these diseases can be minimized and controlled with the consumption of the Food Multi-mix (FMM) from ingredients using Barley(*Hordeum vulgare)*, Foxtail millet (*Seteria italic)*, Soybean (*Glycine max)*, Yardlong bean (*Vigna unguiculata ssp. Sesquipedalis)*, Sprouted mung (*Vigna radiata),* Banana flower and Banana seeds (*Musa acuminata)* which are easily available in the markets and have significant effects on several diseases. These ingredients have an important role to play in satisfying the demand for nutritious, delicately flavored and attractive natural foods of high therapeutic value. They are accepted as being rich in vitamins, minerals and dietary fiber and therefore they serves as a healthy diet. Some studies shows that high beta- glucan Barley (*Hordeum vulgare)* significantly reduce high cholesterol level (ADA,2015). Regularly adding barley to our diet may reduce risk factors for heart disease, such as high blood pressure and “bad” LDL cholesterol. Barley is a very healthy grain rich in vitamins, minerals and other beneficial plant compounds. It is also high in fiber, which is responsible for most of its health benefits, ranging from a better digestion to reduced hunger and weight loss. The type of insoluble fiber found in barley may prevent the formation of gallstones, helping your gallbladder function normally and reducing the risk of surgery. The type of insoluble fiber found in barley appears to reduce cholesterol levels by preventing its formation and increasing its excretion through the feaces. Whole-grain barley may help improve insulin production and reduce blood sugar levels, both of which may reduce the likelihood of type 2 diabetes. Fiber and other beneficial compounds found in barley may fight off certain types of cancer, particularly those of the colon (P. Alina, 2018). A study on Foxtail millet (*Setaria italic)* reported to possess hypolipidemic and low-glycemic index (Xin R. *et al*.,2018). The richness in calcium, dietary fiber, polyphenol and protein contents make them unique among the cereals. Generally, they show significant amounts of amino acids like methionine and cystine and also have high fat content than rice and maize. They have nutraceutical properties in the form of antioxidants which prevent deterioration of human health such as lowering blood pressure, risk of heart disease, prevention of cancer and cardiovascular diseases, diabetes, decreasing tumor cases etc. (C. Nandini *et al.,2018).* Soybeans provide protein, fiber, iron and antioxidants that can make them a healthful addition to the diet. It is recommended to increase the intake of soybeans gradually to reduce the risk of intestinal discomfort (W. Kathy,2020). Another study on Soybean (*Glycine max*) shows that it lowers cholesterol, decrease blood glucose levels

and improves glucose intolerance (Chuel Kim, 2016). Yardlong beans (*Vigna unguiculata ssp. Sesquipedalis)* have low-glycemic index. They contain large quantities of soluble and insoluble fibers. Dietary fiber present in the beans helps to protect the colon mucosa. They are one of the finest sources of folates. Adequate folate in the diet around conception and during pregnancy may help prevent neural-tube defects in the newborns. They contain a good amount of vitamin-C helps build immunity to combat infections, contribute to maintaining blood vessel elasticity and helps in providing protection from cancers (Jenna Fletcher, 2019). Furthermore, they are excellent sources of vitamin-A which maintains mucosal integrity, enhances skin complexion, and improves night vision. They also provide average amounts of minerals such as iron, copper, manganese, calcium, magnesium (R. Umesh,2009). Mung beans (*Vigna radiata)* are high in nutrients and antioxidants, which may provide health benefits. In fact, they may protect against heat stroke, aid digestive health, promote weight loss and lower "bad" LDL cholesterol, blood pressure and blood sugar levels. A study on mung beans showed that bioactive compounds present in them have emerged as an increasing scientific interest due to their role in the modulation or prevention of chronic degenerative diseases (K. Ganeshan,2017). A study on Banana *(Musa acuminata)* blossoms and seeds reported that it balances out the blood sugar levels and is ideal for cell health and anti-ageing (Helen West,2016). Banana flower inhibits the growth of pathogenic bacteria like *Bacillus subtalis* and *Escherichia coli*. It also helps in healing wounds. It increases the progesterone hormone in the body and reduces menstrual bleeding. They reduce anxiety and boost the mood and act as natural anti-depressants (Namita, 2019). The ingredients selected are enriched with high nutritional value and are easily available and affordable, hence, the research entitled "Development of Food Multi-Mix" has been undertaken to develop a convenient Food Multi-mix with the following objectives:

- To develop a Food Multi-mix (FMM).
- To analyze the moisture content and nutritive value of the food multi-mix.
- To examine the shelf-life of the food multi-mix.

Materials and Methods

To carry out the research entitled "Development and Evaluation of Food Multi-Mix", the selected ingredients i.e. Foxtail Millet, Barley, Soybean, Yardlong Bean, Sprouted Mung Bean, Banana Blossom and Banana Seeds were collected and made into six different formulations in different ratios. The formulations were cooked and further sensory analysis was done for different sensory attributes. The nutritive values were also recorded

for each formulation. And further to check the shelf- life, storage study was carried out. All the steps have been discussed briefly under following headings:

Collection of Samples

Fresh samples of Foxtail Millet, Barley, Soybean, Yardlong Bean, Mung Bean, Banana Blossom and Banana Seeds were collected from the local markets of Guwahati, Assam.

Processing of raw materials for product development

The raw ingredients were processed to make them ready for development of Food Multi-Mix. All the raw materials i.e., Foxtail Millet, Barley, Soybean, Yardlong Bean, Mung Bean, Banana Blossom and Banana Seeds were processed into flours in order to incorporate them for development of Food Multi- Mix. Banana Blossom, Banana Seeds, Yardlong Beans and Mung Beans (Sprouted) were oven dried at 60°C for 2-3 days and then processed into fine flour. All the flours were then sieved finely so that powdered were in uniformity. For additional ingredient, Ginger- Garlic Powder was used to enhance the taste and flavor.

Sample identification

Sample identification FMM1, FMM2, FMM3, FMM4, FMM5, FMM6 were the codes given for identification of products to be prepared from the ingredients Foxtail Millet, Barley, Yardlong Bean, Sprouted Mung Bean, Banana Blossom and Banana Seeds.

Preparation of formulations

The ingredients were mixed in different ratios of each ingredient for six different formulations. The preparations of different formulations are discussed along with the given table:

Formulations	Ingredients used (in grams)							Additional ingredients (in grams)
	Foxtail millet	Barley	Yardlong beans	Banana flower	Soya-bean	Germin-ated moong	Banana seed	Spices
FMM 1	70	10	5	5	10	0	0	2
FMM 2	60	15	5	5	15	0	0	2
FMM 3	50	20	5	5	20	0	0	2
FMM 4	60	10	5	5	8	10	2	2
FMM 5	70	50	5	5	8	5	2	2
FMM 6	40	15	5	5	15	15	5	2

*FMM- Food Multi- Mix

Sensory ealuation for formulated product

The acceptability trial was done including 30 semi trained panelists in the Food Science Laboratory of the Department of Food, Nutrition and Dietetics using 9- point Hedonic scale. The panel members evaluated the samples on the basis of color, appearance, taste, texture, flavor and overall acceptability.

Packaging materials

Packaging is the technology of enclosing or protecting products for distribution, storage, scale, and use. The Multi- mixes were kept in six plastic bottles for product development. The bottles and containers were washed and kept for drying. After drying the multi- mixes were stored in both plastic and glass. The bottles were kept in room temperature (26°C) for further evaluation.

Moisture content analysis

The moisture content was determined by oven drying method using standard AOAC (1975) procedure. 5 grams of samples was weighed into a previously weight moisture cup and dried in an oven at 60°C till a constant weight was attained.

$$\text{Moisture} = \frac{\text{Initial Weight (g)} - \text{Final Weight (g)}}{\text{Sample Weight (g)}}$$

Analysis of nutritive value

Nutritional value or nutritive value as part of food quality is the measure of a well-balanced ratio of the essential nutrients- carbohydrates, fats, proteins, minerals, and vitamins in items of food or diet in relation to the nutrient requirements of their consumer. The nutritive value of a food product is calculated by adding the amount of nutritive value of each nutrient (in grams).

Shelf- life (storage) of the developed product

Shelf life or storage study was done to assess the overall hygiene maintained during the process of preparation of multi- mixes. For that, sensory evaluation was performed.

Sensory evaluation across storage

The shelf life of the Multi- Mix is extremely important. The developed Multi- Mixes were stored in plastic and glass containers for 30 days and its quality parameters i.e. color, appearance, texture, flavor, consistency, overall acceptability, etc. were studied after cooking. The Multi- Mixes were stored at room temperature (26°C).

Results and discussion

1. ORGANOLEPTIC EVALUATION FOR SENSORY ATTRIBUTES

Organoleptic evaluations for the samples were carried out for the parameters- colour, taste, texture, consistency, flavor and overall acceptability.

Sample	Colour	Appearance	Taste	Texture	Flavour	Consistency	Overall acceptibility
FMM 1(A)	6.6±0.49	6.4±0.49	6.5±0.50	6.7±0.46	6.43±0.50	6.3±0.46	6.4±0.49
FMM 1(B)	6.5±0.50	6.6±0.47	6.8±0.34	6.8±0.37	6.93±0.36	6.9±0.30	6.9±0.97
FMM 1(C)	8.2±0.48	8.2±0.55	8.2±0.55	8±0.45	8.43±0.56	8.36±0.55	8.4±0.56
FMM 2(A)	6.6±0.56	6.7±0.73	6.6±0.71	6.5±0.77	6.76±0.62	6.76±0.62	6.7±0.62
FMM 2(B)	6.8±0.56	7.0±0.66	6.8±0.64	6.7±0.50	7.06±0.69	7.06±0.58	7.0±0.69

FMM 2(C)	8.2±0.73	8.4±0.62	8.5±0.50	8.3±0.49	8.63±0.49	8.6±0.49	8.7±0.46

DISCUSSION:All the sensory attributes i.e. color, appearance, taste, texture, consistency, flavor and overall acceptability are higher for FMM 3 and FMM 6 because they contained the ratio of all the ingredients i.e. Barley, Foxtail Millet, Soybean, Sprouted Mung Bean, Yardlong Bean, Banana Blossom and Banana Seeds, in balanced amount especially foxtail millet and soybean, which gave a perfect desireness for the product and accepted by maximum panelists.

All the sensory attributes i.e. color, appearance, taste, texture, consistency, flavor and overall acceptability are lower for FMM 1 and FMM 4 because the amount of Barley and Soybean flour was very less.

Analysis of moisture content

The moisture content of the mostly preferred multi- mixes FMM 3 and FMM 6 were 0.3g and 0.4g per 100g of sample respectively.

Table 8: Amount of Moisture content in FMM 3 and FMM 6

MOISTURE CONTENT	FMM 3	FMM 6
	0.3g	0.4g

Analysis of nutritive value

The results of nutritional composition like moisture, protein, fat, carbohydrate, crude fibre, energy and minerals like calcium, phosphorus and iron of multi- mixes are discussed in the following table.

Table 1: Nutritive Value of FMM 1:

NAME OF INGREDIENTS	NUTRIENT VALUE								
	Moisture(g)	Protein (g)	Fat (g)	Crude Fibre (g)	Carbohydrate (g)	Energy (kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Foxtail millet	8.4	8.61	3.01	5.6	42.63	247	21.7	203	1.96
Barley	1.25	1.15	0.13	0.39	6.96	33.6	2.6	21.5	0.16

Yardlong bean	4.39	0.14	0.02	0.55	0.42	17.35	2.5	2.95	0.02
Banana blossom	0.09	0.08	0.03	0.25	0.49	2.55	2.8	3.67	2.82
Soybean	0.81	4.32	1.95	0.37	2.09	43.2	24	69	1.04

Table 2: Nutritive Value of FMM 2:

NAME OF INGREDIENTS	NUTRIENT VALUE								
	Moisture (g)	Protein (g)	Fat (g)	Crude Fibre (g)	Carbohydrate (g)	Energy (Kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Foxtail millet	7.2	7.38	2.58	3	36.54	210.6	18.6	174	1.68
Barley	1.88	1.72	0.195	0.59	10.44	50.4	3.9	32.25	0.25
Yardlong bean	4.39	0.14	0.02	0.55	0.42	17.35	2.5	2.95	0.24
Banana blossom	0.09	0.08	0.03	0.25	0.49	2.55	2.8	3.67	2.82
Soybean	1.21	6.48	2.92	0.55	3.13	64.8	36	103.5	1.56

Table 3: Nutritive Value of FMM 3:

NAME OF INGREDIENTS	NUTRIENT VALUE								
	Moisture (g)	Protein (g)	Fat (g)	Crude Fibre (g)	Carbohydrate (g)	Energy (kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Foxtail millet	6	6.15	2.15	4	30.45	175.5	15.5	145	1.4
Barley	2.5	2.3	0.26	0.78	13.92	67.2	5.2	43	0.33
Yardlong bean	4.39	0.14	0.02	0.55	0.42	17.35	2.5	2.95	0.02
Banana blossom	0.09	0.08	0.03	0.25	0.49	2.55	2.8	3.67	2.82
Soybean	1.62	8.64	3.9	0.74	4.18	86.4	48	138	3.08

Table4: Nutritive Value of FMM 4:

NAME OF INGREDIENTS	NUTRIENT VALUE								
	Moisture (g)	Protein (g)	Fat (g)	Crude Fibre (g)	Carbohydrate (g)	Energy (kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Foxtail millet	7.2	7.38	2.58	4.8	36.54	210.6	18.6	174	1.68
Barley	1.25	1.15	0.13	0.39	6.96	168	13	107.5	0.83
Yardlong bean	4.39	0.14	0.02	0.55	0.42	17.35	2.5	2.95	0.02
Banana blossom	0.09	0.08	0.03	0.25	0.49	2.55	2.8	3.67	2.82
Soybean	0.648	3.45	1.56	0.29	1.67	34.56	19.2	55.2	0.83
Sprouted mung bean	5.61	3.2	0.11	1.63	6.26	34.7	13.2	36.7	0.67

Table 5: Nutritive Value of FMM 5:

NAME OF INGREDIENTS	NUTRIENT VALUE								
	Moisture (g)	Protein (g)	Fat (g)	Crude Fibre (g)	Carbohydrate (g)	Energy (kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Foxtail millet	8.4	8.61	3.01	5.6	42.63	247	21.7	203	1.96
Barley	6.25	5.75	0.65	1.95	34.8	168	13	107.5	0.83
Yardlong bean	4.39	0.14	0.02	0.55	0.42	17.35	2.5	2.95	0.02
Banana blossom	0.09	0.08	0.03	0.25	0.49	2.55	2.8	3.67	2.82
Soybean	0.648	3.45	1.56	0.29	1.67	34.56	19.2	55.2	0.83
Sprouted mung bean	2.8	1.6	0.05	0.81	3.13	17.35	6.6	18.35	0.34

Table6: Nutritive Value of FMM 6:

NAME OF INGREDIENTS	NUTRIENT VALUE								
	Moisture (g)	Protein (g)	Fat (g)	Crude Fibre (g)	Carbohydrate (g)	Energy (kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Foxtail millet	4.8	4.92	1.72	3.2	24.36	140.4	12.4	116	1.12
Barley	6.25	5.75	0.65	1.95	34.8	50.4	3.9	32.25	0.25
Yardlong bean	4.39	0.14	0.02	0.55	0.42	17.35	2.5	2.95	0.24
Banana blossom	0.09	0.08	0.03	0.25	0.49	2.55	2.8	3.67	2.82
Soybean	0.648	3.45	1.56	0.29	1.67	64.8	36	103.5	1.56
Sprouted mung bean	8.41	4.8	0.17	2.44	9.39	64.8	36	103.5	1.56

Discussion

This study revealed that the formulated Food multi- mix from locally available ingredients is more superior and nutritionally rich as compared to products available in markets. The nutrient content has the ability to meet the health requirements for various underlying diseases.

Sensory evaluation over storage

After one- month of storage in both glass and plastic containers, a sensory evaluation was conducted of the most accepted products i.e. FMM 3 and FMM 6, to check the acceptability of the product. The mean quality parameters i.e. color, appearance, texture, flavor, consistency, overall acceptability, etc. were studied after cooking by 30 panelists again.

Sample	Colour	Appearance	Taste	Texture	Flavour	Consistency	Overall acceptibility
FMM 3	8.2±0.48	8.1±0.55	8.2±0.55	7.8±0.45	8.43±0.56	8.6±0.55	8.4±0.56
FMM 6	8.0±0.73	8.3±0.62	8.5±0.50	8.2±0.49	8.63±0.49	8.6±0.49	8.7±0.46

Discussion

It was found that all the sensory attributes i.e. color, appearance, taste, texture, consistency, flavor and overall acceptability of both the multi- mixes after one- month of shelf- life storage were not much affected and the products were acceptable. This was because of the proper maintenance over the period of storage of the products in air tight containers and the moisture content were less in the product.

Conclusion

From the present study it can be concluded that the food multi- mix formulated showed to have high nutritional value and thus has a potential of having many health benefits. The high nutritive value has the ability to aid various health problems like Diabetes, Cholesterol, Cardiovascular Diseases, Gastrointestinal Diseases, Inflammation, Post-menopausal Syndromes and many other chronic diseases. The shelf life of the multi-mixes when stored in an airtight container or properly sealed packaging materials has the capability to be stored for more than one month as the samples were not spoiled even after a period of one month. They retained its original properties of color, appearance, texture, taste, consistency and flavor. The highest nutritional properties of the multi-mixes are known for its various benefits on human health and controlling diseases because of its high nutritional content. The multi-mix will be a convenient ready-to-eat food which can be consumed in various forms and can be made into dried pallets which can be stored for a long period of time.

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Authorship and Level of Contribution: MS performed and wrote the research paper. DS analyzed and guided through the whole process.

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