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Nutritional Composition and Shelf Life Evaluation of Millet based Composite Mix

K. Geetha[1], Geetha M. Yankanchi[1], Nethravathi Hiremath[1], Shilpa Yatnatti[1], Jyothi T. Sajjan[1], B.M. Veena[1]

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ABSTRACT

Background: Under nutrition is a condition due to insufficient intake of energy and nutrients to meet an individual's needs to maintain good health. Cereals and millets based supplementary foods represents good source of essential nutrients. Recently, millets are tagged as nutri-cereals and its health promoting benefits are attracting consumers worldwide. The current study was aimed to develop millet based ready-to-use composite mix and to evaluate its quality in terms of usage in various traditional foods and shelf life.

Methods: RTU composite mix was developed using locally available cereals, millets, pulses and oilseeds. The nutrient composition of developed mix was analyzed. The traditional region specific foods namely *Dose, roti* and *Mudde* (*Ragi ball*) was prepared and subjected for sensory evaluation. Further mix was stored up to three months at room temperature and evaluated for microbial load, moisture, free fatty acid and peroxide value.

Result: Protein, fat, carbohydrate and energy content of the mix were 18.5 g, 9.56 g, 58.21 g and 393.24 kcal per 100 g respectively. *Roti* was best accepted (7.63), followed by *mudde* (7.50) and *dose* (7.03). Free Fatty Acid (FFA) was increased from 1.08 per cent to 1.56 per cent oleic acid, whereas peroxide value (PV) was increased from 7.46 to 9.35 mEq O_2/kg of oil during storage. Total bacterial count (TBC) was increased from 4.5×10^2 to 8.1×10^3. The developed RTU mix which has nutritional potential needs to be popularized to address under nutrition and for overall good health of the society.

Key words: Nutritional composition, RTU composite mix, Sensory evaluation, Shelf life.

INTRODUCTION

Under nutrition is the condition when people do not eat (or absorb) enough nutrients to cover their nutritional needs required for energy and growth, or to maintain a healthy immune system. Micronutrient deficiencies are a sub-category of under nutrition and occur when the body lacks one or more micronutrients (Burgess, 2008). Despite the high and relatively stable overall growth of the economy, India's agriculture sector is underperforming and a vast section of the population remains undernourished (Gulati *et al*., 2012). A quarter of women of reproductive age in India are undernourished, with a body mass index (BMI) of less than 18.5 kg/m (Source: NFHS 4 2015-16). Undernourished girls have a greater likelihood of becoming undernourished mothers who in turn have a greater chance of giving birth to an undernourished baby, perpetuating an intergenerational cycle of under nutrition. A recently developed home-based treatment for severe acute malnutrition is improving the lives of thousands of children a year. Ready-to-use therapeutic Food (RUTF) has revolutionized the treatment of severe malnutrition - providing foods that are safe to use at home and ensure rapid weight gain in severely malnourished children (WHO).

Cereals and millet based supplementary foods represents good source of carbohydrates, rich in dietary fibre, phenolic compounds and also minerals. Apart from the rich sources of macro nutrients, these food grains also form a good source of micronutrients and phytochemicals to form balanced composites of high biological value (Pradeep *et al*., 2014). Over the past three decades cultivation and production of nutritious cereals is decreasing significantly because of poverty, shifting consumption pattern from a balanced diet, widespread prevalence of nutritional deficiencies and also low consumption of nutritious cereals (Seetharama and Rao, 2004). Food composites prepared with locally cultivated and commonly consumed food grains offers convenience in terms of accessibility and affordability. Such mixes, which can be transformed into locally consumed traditional foods finds its wide application for outreach of different population groups. Though there are number of composite mixes are available in the market, the present developed composite mix is developed with combinations of millets, cereals, pulses, nuts and milk powder to make

[1]All India Coordinated Research Project on (Home Science) Foods and Nutrition, University of Agricultural Sciences, Bangalore-560 065, Karnataka, India.

Corresponding Author: Geetha M. Yankanchi, AICRP on (Home Science) Foods and Nutrition, University of Agricultural Sciences, Bangalore-560 065, Karnataka, India.
Email: geethanutrition@gmail.com

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the mix nutritionally dense and to provide one third of daily calorie requirements especially for women. The processing of this mix is simple and ingredients used are locally grown and available in the market, so that women enterprises at rural or urban can afford this technology and produce this composite mix for their socio-economic benefit, i+n addition to addressing malnutrition prevailing in the society. This millet based composite mix can be popularized in millet grown regions. Since, localities surrounding Bangalore are particularly finger millet growing areas, this locally produced food grain is selected as the basis for formulating composite mix. With this background, considering valuable, nutritional and beneficial properties of food grains, especially millets, a ready to use (RTU) millet based food mix was developed for underweight and evaluated for its quality in terms of usage in various traditional foods and shelf life.

MATERIALS AND METHODS

Methodological steps followed in preparation and evaluations of ready to use (RTU) composite mix are as follows:

Procurement of raw ingredients

Raw ingredients required for the preparation of RTU composite mix *viz*., finger millet, rice, groundnuts, soy flour, desiccated coconut powder, puffed Bengal gram *dal* flour and milk powder were procured from local market in Bangalore, Karnataka, India.

Processing of raw ingredients

Preliminary processing methods were employed for the ingredients used in the preparation of RTU composite mix. Finger millet was washed in cold water tied and kept in damp cloth for 8-10 hours. After steeping period, finger millets were popped on heavy bottom *Kadai.* Popped finger millet was further milled to fine powder. Rice was cleaned, washed and roasted till light brown and milled into flour. Ground nuts were roasted and powered. For the appropriate mixture of finger millet, rice and groundnut powder other ingredients such as desiccated coconut powder, puffed Bengal gram *dal* flour and milk powder were added and blended to form a uniform RTU composite mix. The flow chart for the composite mix development is as presented in Fig 1. The product standardization and composition of ingredients were adjusted based on their suitability to traditional food preparations and energy content of the composite mix.

Nutrient analysis

The developed RTU mix was analyzed for protein, fat, ash and crude fiber by using standard protocol (AOAC, 1990). Carbohydrate was calculated by difference method and calorific value was obtained by multiplying the carbohydrate and protein content by four and fat by nine kcals. Dietary fiber was estimated by an enzymatic gravimetric method (Prosky, 1990). Micro nutrients *viz*., iron, zinc, copper and calcium were analyzed using atomic absorption spectrometry (AOAC, 1990).



Pic 1: Ready to use (RTU) Composite mix and ingredients used for its preparation.

Development of region specific traditional foods

The traditional region specific foods were prepared from RTU composite mix (Pic 1). Breakfast food namely *Dose* and *roti,* lunch or dinner food item namely *Mudde* (*Ragi ball*) was prepared. Standardized protocol for preparation of the products is presented in Fig 2.

Organoleptic evaluation

All the three developed traditional foods were subjected for sensory evaluation, based on nine point hedonic scale by 30 semi-trained panel members. Scores and opinions for each developed food products were recorded for further analysis and interpretation.

Shelf life evaluation of composite mix

RTU composite mix was packed in LDP (low density Poly ethylene) pouches with 350 gauge for up to three months at room temperature. Further stored product was periodically (initial, 15, 30, 45, 60, 75 and 90 days) evaluated for microbial load, moisture, free fatty acid and peroxide value.

Statistical analysis

All the observations were recorded in triplicates and pooled data was analyzed with suitable statistical test. Nutrient composition, sensory analysis and storage parameters were analyzed with one way analysis of variance to draw inferences.

RESULTS AND DISCUSSION

Ready to use food mixes are composite of all the ingredients, which require minimum steps to process into ready food product. There are many such composite mixes are available in the market. But, locally available food ingredients offer convenience in procurement, processing and also reduce

the cost of production for RTU food mixes. The present study was aimed to develop low cost, energy dense millet based composite mix with feasible and affordable processing techniques, which can be adopted by women enterprises for scaling up of this product for their own nutritional benefits and economic gains through production and marketing of this composite mix. Development of traditional foods which are regionally consumed render high acceptance by the target population especially in the rural area. Analysis of nutritional composition of developed composite food mix helps to identify its efficacy towards improvement in underweight among population. Shelf stability in terms of quality parameters aid in recommendations for storage period.

Nutritional composition of RTU composite mix

Macro and micro nutrient composition of RTU composite mix is presented in Table 1. Moisture content of RTU composite mix was 5.79 per cent. Protein, fat and carbohydrate content was 18.5, 9.56 and 58.21 g per 100 g

Table 1: Nutrient composition of RTU composite mix.

Nutrients (per 100 g)	Mean±SD
Moisture (%)	5.79±0.08
Protein (g)	18.59±0.32
Fat (g)	9.56±0.12
Carbohydrate (g)	58.21
Reducing sugar (mg)	58±0.03
Starch (g)	42.75±0.30
Energy (Kcal)	393.24
Total minerals (g)	2.86±0.08
Iron (mg)	1.42±0.04
Zinc (mg)	3.98±0.02
Calcium (mg)	275±2.18
Crude fibre (g)	4.99±0.33
Dietary fibre (g)	18.90±2.33
Total phenol (mg GAE/g)	0.39
TAA in % (10 µg of vitamin C Equivalent)	5.18

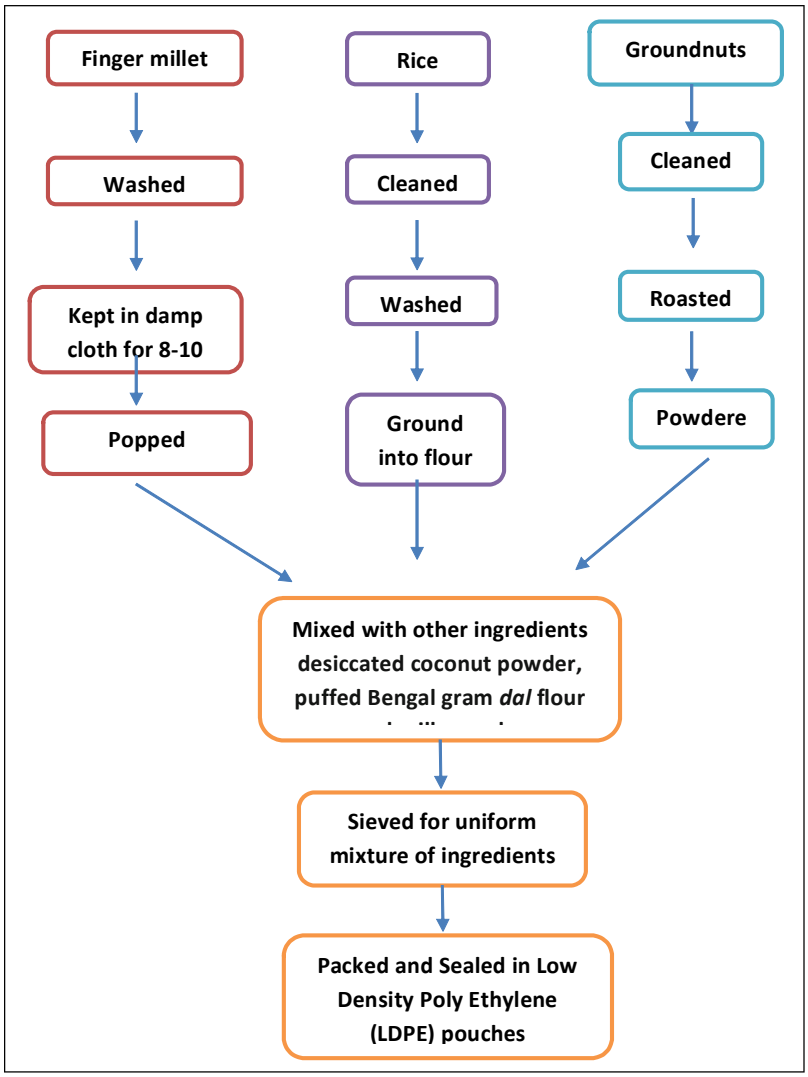

Fig 1: Flow chart for the preparation of millet based composite mix.

respectively. It contained 393.24 kcal of energy per 100 g. Among the micro nutrients, composite mix contained good amount of calcium (275 mg). Iron and zinc content was 1.42 and 3.98 mg respectively. Crude and dietary fiber content was 4.99 and 18.90 g per 100 gm.

Cereals and legumes are important part of human nutrition particularly in the dietary pattern of low economic population. They are best combination for nutrition as they mutually complement each other in improving bioavailability of nutrients. Nutritional composition of multigrain composite mixes was studied by Itagi and Singh (2012) reported that, mixes had 10 to 12 per cent moisture, 56 to 61 per cent carbohydrate, 15 to 20 per cent protein, 9 to 13 per cent crude lipid and 2 to 3 per cent ash. Energy value ranged from 1600 to 1700 kJ/100 g. These findings are supportive to present research findings. However moisture content was less in RTU composite mix may be due to processing methods employed such as drying and roasting and also initial moisture content of food grains.

Vasantha and Sangeetha (2017) reviewed nutritional significance of cereals and legumes based food mix and reported that, composite mix and weaning food mix prepared out of cereals and legumes incorporating vegetables, nuts and oil seeds have tremendous nutritional value.

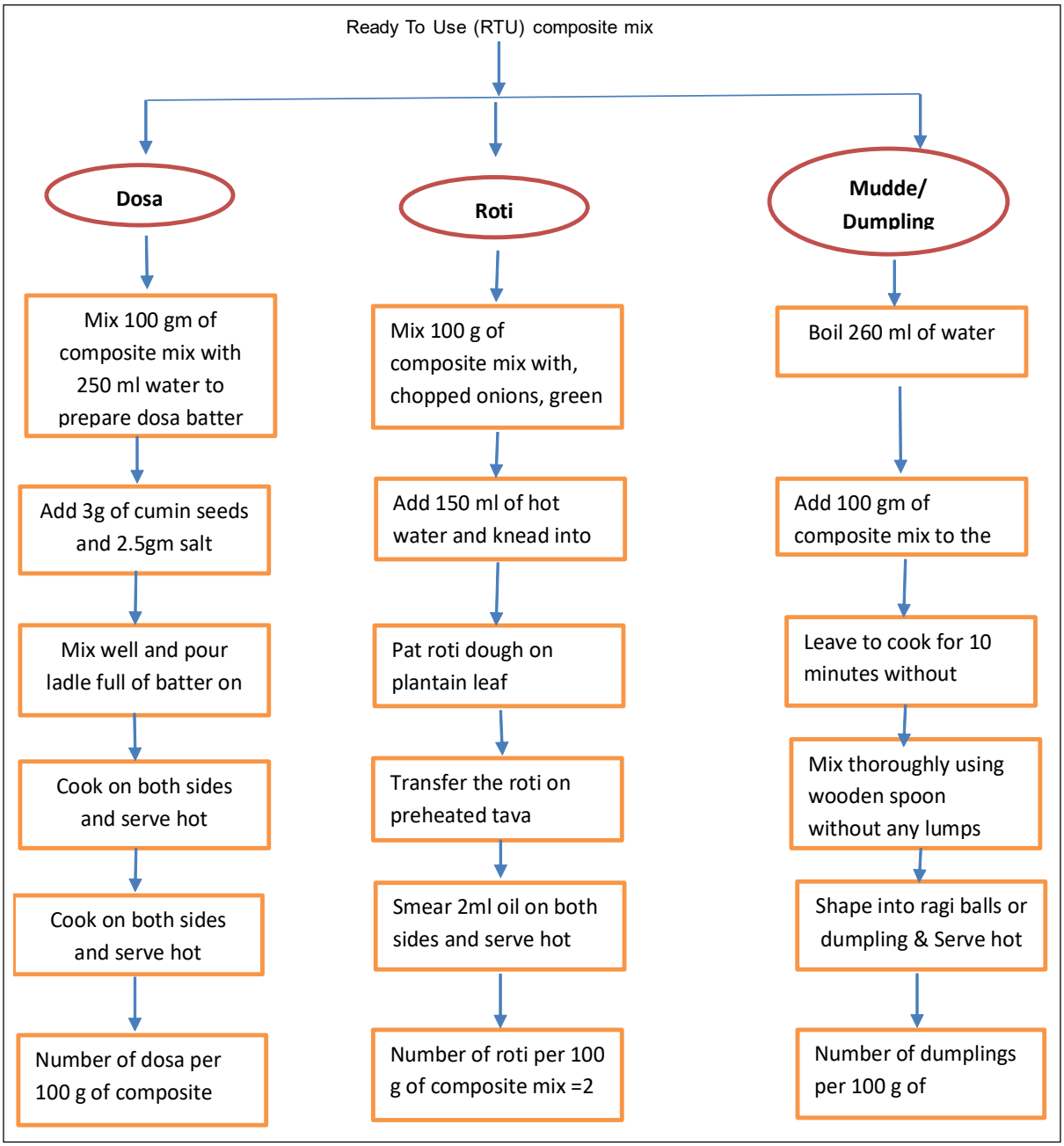

Fig 2: Flow chart for preparation of traditional foods from millet based composite mix.

Nutritional composition of products prepared from RTU composite mix

Computational values for nutritional composition of traditional region specific foods per 100 gm presented in Table 2. Moisture content was more in *Mudde* (ragi ball) *i.e.* 50.23 compared to *dose* (48.15%) and *roti* (41.35%). All the nutrients were observed to be more in *roti* followed by *dose* and *mudde*. Protein content among the products ranged from 12.41 to 9.62 g, fat content was between 4.50 and 6.10 g. Developed products contained range from 210 to 248 kcal. Dietary fiber, calcium, irons and zinc content of *roti* was 12.20, 177.42, 2.80 and 2.44 respectively, whereas it was 9.45, 137.0, 2.02 and 2.54 in *mudde*. Statistically significant difference was found between all the developed food products for nutritional composition of 100 gm of cooked weight.

Though the same composite mix was used, preparation method of all the three food products was different. Quantity of water used in the preparations was also varied, which significantly influence on textural and moisture content of the developed products. In the preparation of *roti* less water was used to form stiff dough, followed by *dose* wherein thick batter of composite mix was prepared. More proportion water is used in the preparation of *mudde* as it is needed for gelatinization of the composite flour. In the preparation of *roti,* application of oil is necessary for easy handling of the dough and preparation. Addition of ingredients to composite mix such as oil, onions, green chillies and cumin seeds has increased the fat, protein and energy value of roti. These are certain factors significantly contributing to the differences in nutritional value of the developed products. Itagi and Singh (2012), reported that, Generally traditional food items are prepared with various combinations of food grains-cereals, millets, legumes *etc*. Taking into consideration their contribution to either nutrition or functional properties these multigrain composite mixes can be used for the preparation of various or specific food items. In the present study an attempt has been made to check adoptability of developed millet based composite mix in development of various traditional foods. However, differences in the cooking methods of selected foods altered the nutritional composition of the product significantly. Blah and Joshi (2013) evaluated nutritional content of traditional recipes consumed by ethnic communities of Meghalaya, India and found that, the nutrient content of the vegetarian breakfast and snack items had similar nutritive values, those snacks prepared without oil as a cooking medium are rich in calories and carbohydrate but a minor source of fat, fibre and protein. The overall protein content of certain products was considerably high.

Sensory evaluation

Sensory analysis of the developed traditional foods by RTU composite mixes is presented in Table 3. It was observed that, *roti* was best accepted with more overall acceptability scores (7.63), followed by *mudde* (7.50) and *dose* (7.03). Only appearance wise *mudde* scored more (7.63), whereas all other sensory properties were best accepted for *roti*. However, significant difference was found for texture, taste

Table 2: Nutritional composition of products prepared from RTU composite mix.

Nutrients	Per 100 gm. of cooked weight			F test	SEM	CD
	Dosa	Roti	Mudde			
Moisture (g)	48.15	41.35	50.23	2.51*	0.41	1.01
Protein (g)	9.97	12.41	9.62	61.13*	0.27	0.67
Fat (g)	4.80	6.10	4.50	51.77*	0.18	0.45
Ash (g)	1.34	2.13	1.30	101.69*	0.07	0.17
Crude fibre (g)	1.44	1.80	1.39	74.69*	0.04	0.10
CHO (g)	33.93	35.81	32.75	23.34*	0.51	1.25
Energy (Kcal)	219	248	210	1461.57*	0.72	1.76
Total dietary fibre (g)	9.79	12.20	9.45	455.63*	0.10	0.24
Calcium (mg)	142.48	177.42	137.00	5361.75*	0.42	1.05
Iron (mg)	2.09	2.80	2.02	72.43*	0.068	0.16
Zinc (mg)	2.04	2.44	2.54	4.60^{NS}	0.062	0.15

Note : *Significant @5%, NS- Non - significant.

Table 3: Sensory evaluation of the products developed from RTU composite mix.

Sensory attributes	Per 100 gm of cooked weight			'F' test	'p' value
	Dose	Roti	Mudde		
Appearance	7.03	7.35	7.63	2.82^{NS}	0.06
Aroma	7.20	7.62	7.33	1.48^{NS}	0.23
Texture	7.00	7.50	7.75	4.70*	0.01
Taste	6.97	7.68	7.15	3.23*	0.04
Overall acceptability	7.03	7.63	7.50	4.94*	0.01

Note : *Significant @5%, NS- Non - significant.

and overall acceptability among the developed foods. All the three developed food products possess different textural properties. *Dosa* prepared from composite mix was soft and little mushy due to which least score was obtained. This might be due to inclusion of milk powder in the composite mix, the proteins in milk powder when subjected for heat lead to millard reaction and responsible for corresponding textural changes. Though sensory scores were found to be low for dosa compared to other two products, these changes could be acceptable when compared to the nutritional significance of addition of milk powder is considered. Tumwine *et al.,* (2018) reported that, germination of millet grains and incorporation of skimmed milk and vegetable powders resulted in a nutrient enhanced composite flour with improved functional properties, scaling up of such composite mixes can contribute towards improving the nutrition of children in developing country. Since composite mix was mainly contained finger millet flour, it was best suitable for *mudde* preparation with highest scores for texture. Dough was prepared with less water and *rotis* were made using oil which extended good taste for roti. Singh *et al.* (2017) conducted research on nutritional profiling and sensory evaluation of multigrain flour based indigenous fermented food and reported addition of different proportions of soybean and flaxseed affects the body and texture of the prepared products. The body and texture becomes softer as the amount of incorporation increases. Addition of different proportions of soybean flour and flaxseed powder affects the colour and appearance of the prepared products. Sankararao *et al*. (2016), studied sensory properties of composite flour bread and reported that, the addition of soy flour, flaxseed flour and ragi flour reduced the score for almost all the parameters as compare to control. These findings indicate the incorporation of ingredients has significant influence on sensory parameters of the developed products. Physico-chemical properties of each ingredients contributes mainly to appearance and textural properties. In the present study the ingredients used in the composite flour was more suitable for *roti* compared to *dose* and *mudde*.

Storage stability

Moisture, free fatty acid (FFA) and peroxide value (PV) were recorded periodically for the composite mix up to 90 days. Table 4. It was observed that, all the parameters were progressively increased till the end of storage period. Initially moisture was 5.97 per cent, it was increased to 7.03 per cent

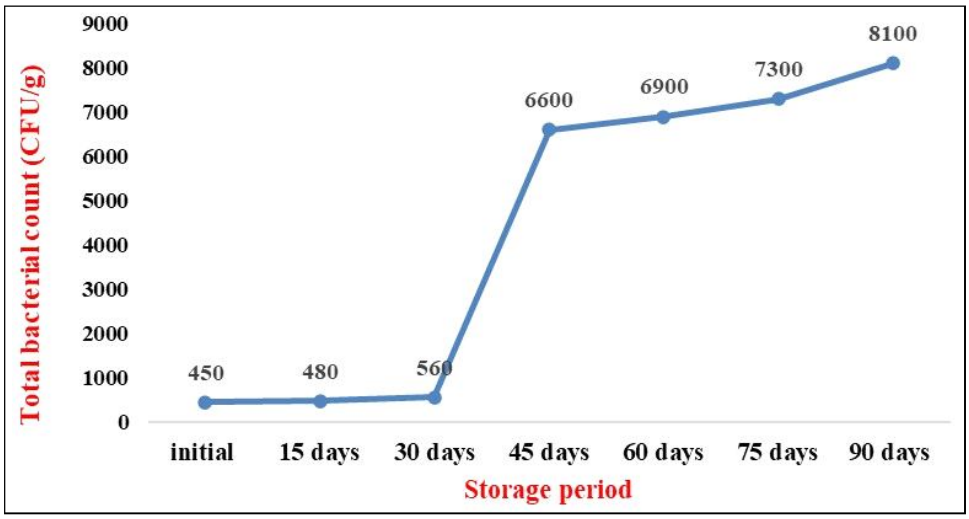

Fig 3: Total bacterial count (TBC) of RTU mix during storage.

Table 4: Storage stability of composite mix.

Storage duration (Days)	Moisture (%)	FFA (% oleic acid)	PV (mEq O2/kg of oil)
Initial	5.79	1.08	7.46
15 days	5.82	1.10	7.65
30 days	5.96	1.18	8.12
45 days	6.04	1.25	8.90
60 days	6.15	1.30	8.98
75 days	6.88	1.42	9.02
90 days	7.03	1.56	9.35
F Value	1662*	78.35*	784.19*
SEm ±	0.017	0.027	0.037
CD	0.038	0.059	0.080

Note: *Significant at 5%.

at the end of the storage period. FFA was increased from 1.08 per cent to 1.56 per cent oleic acid. PV was 7.46 at the initial period whereas it was increased to 9.35 mEq O2/kg of oil. Significant increase in all the storage parameters was observed. Gautam and Gupta (2017) studied storage stability of different homemade extruded food products prepared by using malted composite flour and reported that, the mean values of peroxide were ranged from 0.59 to 7.4 and found to be in acceptable limits for consumption up to 3 months. Moisture content increased up to 50-75 per cent during 90 days of storage period. Tangariya *et al*., (2018) studied quality of composite flour and reported that, peroxide value in composite flour (CF) was 0.791, 1.044 and 1.492 mgEq/kg whereas, free fatty acid was 0.334%, 0.440% and 0.546% on 0, 30th and 60th day respectively.

Peroxide value measures the content of hydro peroxides and is often used as an indicator of the primary products of lipid oxidation. The PV increased more rapidly at high temperatures (25°C and 35°C) than at low temperature (15°C). When stored at 15°C, the PV of YH 9326 and YH 22 peanut was within the acceptable limits (10 meq/kg) to ensure food freshness throughout the storage period (Lui *et al*., 2019). These findings are in supportive to present research findings. The storage temperature for composite mix was 23-25°C, hence, even though significant increase in PV was observed over storage period, the products were within acceptable limits. Similarly, FFA are products of lipid oxidation. During storage period due to oxidation of fat, increase in FFA was observed and highest value recorded at the end of the storage period. Due to gaseous exchange, from outside environment through LDP pouches, moisture was absorbed by the composite mix, leading to increase in moisture per cent. But this moisture level is not supportive for rapid microbial growth, as it requires high moisture per cent.

Microbial load of composite mix

Total bacterial count (TBC), mould and E-coli load were studied periodically (0, 15, 30, 45, 60, 75, 90) during storage period. Initial load of TBC was 4.5×10^2 cfu/g which was gradually increased to 8.1×10^3 at the end of the storage period. Mould count was less than 10 throughout the storage period whereas *E-coli* was not detected. Tangariya *et al*. 2018, studied quality of composite flour and reported, bacterial count of 2.2×10^2 cfu/g at one month storage which increased to 5.5×10^2 cfu/g after two months of storage period (Fig 3). Changes in microbiological quality of dried Persimmons (*Diospyros kaki* Thunb.) stored at various temperatures was studied by (Hyun *et al*., 2019) and reported that, the initial populations of total mesophilic bacteria, coliforms, yeasts and molds on dried persimmon-1 were 4.60±0.26, 1.92±0.47, 5.14±0.31 and <0.48 $\log_{10}$ CFU/g, respectively. These observations are found to be in line with present study. Microbial loads were observed to be within safety limits as prescribed by Food Safety Standards Authority of India (FSSAI), indicating its storage stability up to three months.

CONCLUSION

Nutritionally millet based composite food mixes comprises of good combinations of micro and macro nutrients. In this regard, region specific food grain mixes helps in prevention of malnutrition especially among children and women. The developed ready to use (RTU) composite food mix was suitable for preparation of traditional foods with acceptable sensory attributes, which can be stored up to three months without much adverse changes in the shelf life parameters. Popularization of such composite mixes through government supplementary programmes and capacity building of self-help groups may lead to outreach of nutritionally significant and low cost products to wide populations to address under nutrition and for good health of the society.

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