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Standardization of Herbal Enriched Finger Millet Based Composite Flour Mix

R. Latha Rani and K. V. Jamuna
Department of Food Science and Nutrition, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : latharanjurani@gmail.com

Authors Contribution

R. Latha Rani :
Carried out research, wrote manuscript and data analysis;
K. V. Jamuna :
Planning of research work, corrected the manuscript and provided facilities to conduct research

Corresponding Author :
R. Latha Rani
Department of Food Science and Nutrition, College of Agriculture, UAS, GKVK, Bengaluru - 560 065

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Abstract

Composite flour is a mixture of flours from cereals, pulses, oilseeds and tubers with or without addition of wheat flour. Medicinal herbs own many health benefits because of its, therapeutic or curative aids. Incorporation of herbs to food products helps to manage many diseases. Finger millet based composite flour (FBCF) had been developed with the incorporation of black rice, black soya bean, barnyard millet and pumpkin seeds. The present research investigation proceeded by standardizing the composite flour mix by using finger millet and other ingredients in the ratio of 70:30, 60:40, 50:50 and 40:60. The developed mixes were subjected to functional properties and sensory evaluation to select the best combination. Best accepted combination of FBCF analyzed for nutrient composition. Addition of 50 per cent finger millet and 50 per cent in combination of other ingredients had better functional properties and sensory scores compared to other treatments. Finger millet based composite mix had significantly higher protein (15.93 g/100 g) and carbohydrate (63.26 g/ 100 g) compared to control. Considering the literature studies herbs which are rich in antioxidant activity *viz., Amrutha balli*, Indian borage, *honagone* leaves, dried ginger, turmeric and clove had been selected to develop herbal mix. Herbal mix was standardized by considering the sensory evaluation scores of *kashaya*. Herbal mix treatment 3 (HMT3) had good sensory scores and antioxidant activity (83.33%) compared to other treatments. Further best accepted composite flour was used for the preparation of herbal enriched composite flour by incorporating the developed herbal mix at different composition. It can be concluded that finger millet based herbal enriched dosa mix treatment 3 (HFCFT3) had better sensory scores and also the developed mix had good nutritional composition and antioxidant activity.

Keywords : Composite flour, Herbal mix, Finger millet, Sensory scores

Composite flour (CF) is a mixture of different flours from cereal, legume or root crops with or without addition of wheat flour which helps to satisfy specific functional characteristics and nutrient composition [Bolarinwa *et al.,* 2015]. CF provides essential amino acid balance, dietary fibre, antioxidants and high mineral content as compared to wheat flour, which may help to overcome the problem of protein energy malnutrition and other diseases [Tangariya *et al.,* 2018]. The use of composite flour based on wheat and other cereals including minor millets in traditional and bakery products is becoming popular because of the economic and nutritional advantages of composite flour [Bolarinwa *et al.,* 2015]. Composite flour technology has been widely adopted round the globe for development of functional foods with the desired therapeutic value [Raihan and Saini, 2017]. Composite flour had a few advantages for developing countries because it reduces the import of finger millet flour and encourages the use of domestic agricultural products as flour.

Finger millet is the most nutritious among all major cereals and it has been perceived as 'super cereal' by

the United States National Academies [Ranganatha *et al.,* 2022]. Herbs are plants with savory or aromatic properties that are used for flavoring, garnishing food, medicinal purposes and for fragrances. The use of medicinal plants has attained an important role in health system all over the world. This involves use of medicinal plants not only for the treatment of disease but also as a potential material for maintaining good health [Yadav *et al.,* 2020]. Herbs are beneficial for human health because as it contains significant amount of micronutrients, vitamins, antioxidants, phytochemicals and fiber content that may help protect against degenerative diseases and micronutrient malnutrition [Gupta *et al.,* 2012]. A combination of composite flour along with herbal mix is rare and so this will help to achieve the expected outcome by balancing the unavailable nutrients.

Commercially many composite flour mixes are available in the market but ready to prepare herbal enriched mixes are less available. As the herbs own many health benefits, it's incorporation in food product helps to manage many diseases. Hence, considering the research need present quest has been put forth with the objectives:

1. To standardize the herbal enriched finger millet based composite flour mix
2. To analyze the functional properties and nutrient composition of developed mix

Material and Methods

Development of Finger Millet Based Composite Flour Mix : For the preparation of finger millet based composite flour mix, finger millet was substituted with other ingredients such as black rice, black soya bean, barnyard millet and pumpkin seeds. Each ingredient was cleaned, dried and powdered separately to prepare composite flour mix. The powdered ingredients were weighed at different levels and used for the preparation of finger millet based composite flour mix. Composite flour was developed by incorporating other ingredients at different levels (Table 1) by substituting finger millet flour at different ratios (70:30, 60:40, 50:50 and 40:60). Developed Composite flour mixes were analyzed for the functional properties and gruel was prepared and subjected for sensory evaluation. Nutritive value of best accepted flour mix was calculated and used for the enrichment with herbal mix.

Table 1
Formulation of composite flour mix

Ingredients	CFT1 (70:30)	CFT2 (60:40)	CFT3 (50:50)	CFT4 (40:60)
Finger millet	70	60	50	40
Black rice	15	15	15	15
Barnyard millet	5	10	15	20
Black soybean	5	10	15	20
Pumpkin seeds	5	5	5	5

CFT1 - Finger millet based composite flour treatment 1 (70:30); CFT2 - Finger millet based composite flour treatment 2 (60:40); CFT3 - Finger millet based composite flour treatment 3 (50:50); CFT4 - Finger millet based composite flour treatment 4 (40:60)

Fig. 1: Finger millet based composite flour gruel

Functional Properties of Composite Flour

Functional properties such as water absorption capacity, oil absorption capacity, swelling power, swelling capacity was analyzed to finger millet based and wheat based composite flour to select the best combination.

Water Absorption Capacity (WAC)

A suspension of 1.0 g of sample in 10 ml distilled water was agitated 4 times allowing 10 min. resting periods between each mixing and centrifuged at 3250 rpm for 25 min. The supernatant was decanted and tubes were air-dried and then weighed (Sindhu and Khatkar, 2016).

WAC (ml/g) = Volume of water/weight of sample absorbed

Oil Absorption Capacity (OAC)

The 3 ml refined groundnut oil was added to 0.5 g of sample and stirred for 1 minute. After 30 min. at room temperature, the tubes were centrifuged at 3200 rpm for 25 minutes. The volume of unabsorbed oil was determined (Sindhu and Khatkar, 2016).

OAC (ml/g) = Volume of fat/weight of sample

Swelling Capacity

The swelling capacity was determined by the method described by Potter and Hotchkiss (2012) 100 ml graduated cylinder was filled with the sample to 10 ml mark. The distilled water was added to give a total volume of 50 ml. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 min and left to stand for a further 8 min and the volume occupied by the sample was taken after the 8th min.

Foam Capacity

The foam capacity (FC) were determined as described by Hasmadi *et al.,* 2020 with slight modification. One gram of flour sample was added to 50 mL distilled water at 30 ± 2 °C in a graduated cylinder. The suspension was mixed and shaken for 5 min to foam. The volume of foam at 30 sec after whipping was expressed as foam capacity using the formula,

Where, AW = after whipping, BW = before whipping. The volume of foam was recorded one hour after whipping to determine foam stability as per percent of initial foam volume.

Flour Dispersibility

Dispersibility is an index that measures how well flour blends can be rehydrated with water without formation of lumps. The flour dispersions of 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 and 30 per cent (w/v) prepared in 5 ml distilled water was heated at 90 °C for 1 hr in water bath. The contents were cooled under tap water and kept for 2 hr at 10 ± 2 °C (Baranwal and Sankhla, 2019).

Bulk Density

The volume of 100 g of the flour was measured in a measuring cylinder (250 ml) after tapping the cylinder on a wooden plank until no visible decrease in volume was noticed and based on the weight and volume, the apparent (bulk) density was calculated (Jones *et al.,* 2000).

$$\text{Bulk density (g/ml)} = \frac{\text{Seed weight (g)}}{\text{Seed volume (ml)}}$$

Proximate Principles : Proximate principles of herbal enriched wheat based composite flour mix was analyzed. Proximate principles (PC) *viz.,* moisture, fat, crude protein, crude fiber and ash by standard methods (AOAC, 2005). Difference method was used to calculate carbohydrate and energy value by computation method.

Development of Herbal mix : Different herbs such as *Amrutha balli*, Clove, *Honagone* leaves, Indian borage, turmeric, dried ginger were procured. Herbs were cleaned and dried to remove moisture content. Further the herbs made into fine powder by using mixer and sieved with mesh size (212 µm). Herbal mix was standardized by adding selected herbs with different composition (Table 2) and subjected for sensory evaluation by a group of 21 trained panel members in the form of *kashaya*. The product was evaluated for sensory evaluation by using nine point hedonic scale (Amerine *et al.,* 1965). Further best

TABLE 2

Formulation of herbal mix

Herbs	HMT1	HMT2	HMT3	HMT4
Amruthaballi	1.75	1.5	1.0	0.5
Clove	0.25	0.5	1.0	1.5
Honagone leaves	2	2	2	2
Dried ginger	2	2	2	2
Indian borage	2	2	2	2
Turmeric	2	2	2	2

HMT1- Herbal mix treatment 1
HMT2- Herbal mix treatment 2
HMT3- Herbal mix treatment 3
HMT4- Herbal mix treatment 4

Fig. 2: Herbal mix kashaya drink

accepted combination was analyzed for antioxidant activity by three different methods such as DPPH (2, 2-diphenyl-1-picryl-hydrazyl-hydrate), FRAP (Ferric ion reducing antioxidant power) and ABTS (2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid).

Extraction of Sample : The sample (2g) was weighed accurately and extracted at room temperature with 85 per cent aqueous methanol under agitation using a magnetic stirrer for 30 min. The extracts were soaked overnight and mixtures were centrifuged at 2500 rpm for 10 min and the supernatants were collected and dried in hot air oven at 27-35 ºC, known amount of solvent added to dried supernatant. Extract kept in refrigerator for further antioxidant analysis.

Scavenging Ability toward DPPH Radical

DPPH method was used in the determination of the antioxidant avtivity, which is based on the quantification of free radical scavenging with modifications. This method depends on the reduction of DPPH• radical (purple) to a yellow colored diphenyl picrylhydrazine. A decrease in the DPPH absorbance indicates an increase of the DPPH• radical scavenging activity. A methanolic solution containing 0.06 mM of the DPPH• radical was prepared daily and protected from light. 0.1 mL of extract was added to 3.9 mL of DPPH• methanolic solution. The decrease in absorbance at 515 nm using a UV-Vis spectrophotometer was measured at 1 min intervals for the first 10 min and then at 5 min intervals until stabilization. All measurements were performed in triplicate (Lemine *et al.,* 2014)..

ABTS + Assay

The ABTS+ assay was performed according to method established previously with modifications. The pre-formed radical monocation (ABTS+•) was produced by oxidation of 7 mM ABTS stock solution with 145 mM potassium persulfate and then incubated in the dark for 16 h at room temperature before use. The ABTS + working solution was prepared by diluting the stock solution with ethanol until reach an absorbance of 0.70 ± 0.02 (at 734 nm). All samples were diluted approximately to provide 20-80 per cent inhibition of the blank absorbance. 30 µL of the extract was mixed with 3.0 mL ABTS + working solution. The absorbance of the mixture was measured at 734 nm after 6 min of incubation at room temperature. The ABTS scavenging capacity was expressed as µM Trolox/g mix (Xiao *et al.,* 2020).

Ferric Reducing Antioxidant Power (FRAP)

Ferric reducing antioxidant power assay was measured according to the procedure with some modifications. The FRAP reagent contained 2.5 mL of a 10 mM TPTZ (2,4,6-Tripyridyl-s-Triazine) solution in 40 mM HCl, 2.5 mL of 10 mM FeCl3-6H_2O and 25 mL of 300 mM acetate buffer (pH 3.6). It was freshly prepared and warmed at 37 °C. A 900 µL FRAP reagent was mixed with 90 µL water and 30 µL of the extract. The reaction mixture was incubated at 37 °C for 10 min and the absorbance was measured at 593 nm. FRAP was expressed as µM de F_eSO_4/g of dry sample (Xiao *et al.,* 2020).

Development of Herbal Enriched Finger Millet Based Composite Flour Mix : Best combination of composite flour mix and herbal mix was used for the development of herbal enriched finger millet based composite flour mix. Standardized composite flour mix was substituted with herbs in the ratio of 85:15,

85 : 15 90 : 10 95 : 5

Fig. 3: Herbal enriched finger millet based *dosa*

90:10, 95:5 had been added to formulate herbal enriched composite mix. The developed mixes were used for the preparation of dosa and subjected for sensory evaluation to know the acceptability.

Statistical Analysis

The SPSS version 16 software programme was used to estimate the mean, standard deviation, standard error mean, 'S.E. diff'., 'CD' and 'F' value. One - way ANOVA was employed to know the difference between the products (Fisher and Yuest, 1963). The data thus obtained from nutrient contents were statistically analyzed by applying 't' test. The critical difference between the products was tested at 5 per cent significance.

Results and Discussion

Table 3 depicts the functional properties of finger millet based composite flour mix. The functional properties of food proteins are important in food processing and food product formulation (Alvarez-Jubetea *et al.,* 2010). As the addition of other ingredients in composite flour increases up to 50 per cent water absorption capacity, oil absorption capacity and bulk density increased in the treatments whereas, swelling power, per cent solubility, flour dispersibility and foaming capacity decreased. This might be due to the addition of soy bean in the composite flour mix, soy protein had the highest water-binding capacity and also it contain polysaccharides, which absorb a significant amount of water. Chandra *et al.* (2015) found higher results compared to present study, this is due to the addition of soy bean at higher level as compared to the present study.

Table 4 represents the nutrient composition of finger millet based composite flour mix. Finger millet based composite mix had significantly higher protein and carbohydrate compared to control sample. Higher protein content due to the higher amount of protein in the soy bean and pumpkin seeds. Bolarinwa *et al.* (2015) observed lesser results compared to present study this might be due to lesser quantity of soy bean used and addition of other ingredients which are not rich in macronutrients.

Fig. 4 and 5 depicts the sensory evaluation of finger millet based composite flour gruel and herbal kashaya respectively. Sensory scores of up to 50 per cent addition composite flour to finger millet flour (CFT3) was accepted by the panel members after that the scores were slightly decreased. Significant difference was found in flavor and taste among the different

Table 3

Functional properties of finger millet based composite flour mix

Treatments	Water absorption capacity (%)	Oil absorption capacity (%)	Swelling power (%)	Per cent solubility (%)	Flour dispersibility (%)	Foaming capacity (%)	Bulk density (g/ml)
CFT1	100±0.01 ^{b}	103±0.05 ^{a}	3.53±0.03 ^{d}	0.76±0.05 ^{a}	71.33±0.57 ^{a}	6.64±0.05 ^{a}	0.65±0.01 ^{a}
CFT2	110±0.01 ^{b}	103±0.11 ^{a}	3.59±0.01 ^{c}	0.56±0.05 ^{a}	70.00±1.00 ^{a}	6.62±0.15 ^{a}	0.61±0.01 ^{b}
CFT3	153±0.05 ^{a}	106±0.05 ^{a}	3.98±0.01 ^{a}	0.46±0.05 ^{b}	67.33±0.28 ^{b}	5.43±0.05 ^{b}	0.57±0.01 ^{c}
CFT4	156±0.29 ^{a}	101±0.01 ^{b}	3.71±0.01 ^{b}	0.40±0.01 ^{b}	62.41±0.14 ^{b}	5.13±0.05 ^{b}	0.56±0.01 ^{c}
F value	72.73 **	9.11 *	346.48 **	40.33 **	191.93 **	927.98 **	98.83 **
S. Em±	0.031	0.035	0.016	0.027	0.299	0.022	0.015
CD@ 5 %	0.103	0.115	0.051	0.089	0.976	0.072	0.051

CFT1- Finger millet based composite flour treatment 1 (70:30); CFT2- Finger millet based composite flour treatment 2 (60:40); CFT3- Finger millet based composite flour treatment 3 (50:50); CFT4- Finger millet based composite flour treatment 4 (40:60)

Note: S.Em: Standard Error of mean, C.D: Critical Difference, ** - Significant at 0.01 per cent level,

*- Significant at 0.05 per cent Different super scripts within a column indicate significant difference at 0.05 level by DMRT

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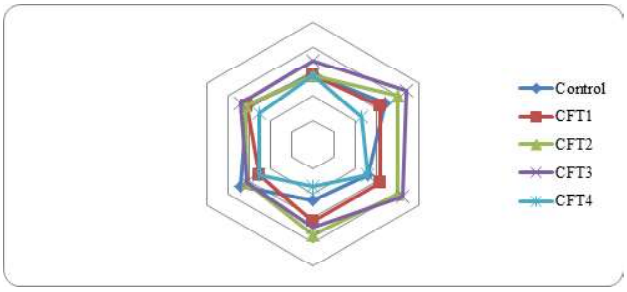
TABLE 4

Nutrient composition of finger millet based composite flour mix

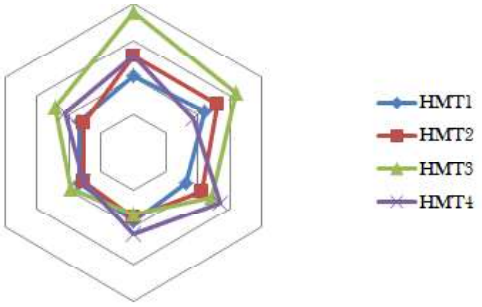
Treatments	Moisture (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	Crude fiber (g/100 g)	Ash (g/100 g)	Carbohydrate (g/100 g)	Energy Kcal
Control	5.58 ± 0.04	8.25 ± 0.31	7.82 ± 0.16	2.40 ± 0.07	2.35 ± 0.05	73.10 ± 0.19	395
CFT3	7.50 ± 0.39	15.93 ± 0.85	8.54 ± 0.27	2.70 ± 0.10	2.53 ± 0.02	63.26 ± 0.70	287
t value	8.49 NS	3.84 *	14.66 NS	5.54 NS	4.14 NS	23.16 *	27.37 *

** - Significant at 0.01 per cent level, *- Significant at 0.05 per cent, NS-Non Significant, # computed nutritive value



CFT1- Finger millet based composite flour treatment 1 (70:30)
CFT2- Finger millet based composite flour treatment 2 (60:40)
CFT3- Finger millet based composite flour treatment 3 (50:50)
CFT4- Finger millet based composite flour treatment 4 (40:60)

Fig. 4: Sensory scores of Finger millet based composite flour mix

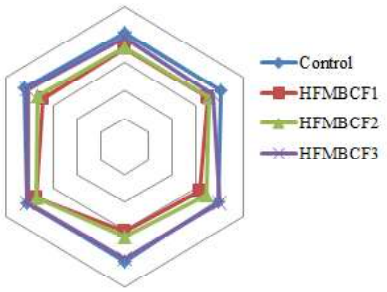


HMT1- Herbal mix treatment 1
HMT2- Herbal mix treatment 2
HMT3- Herbal mix treatment 3
HMT4- Herbal mix treatment 4

Fig. 5: Sensory scores of herbal kashaya drink

treatment. This might be due to soy bean proteins might modify flavor by binding flavors and off-flavors to generate flavors on cooking and to release reactants that may produce flavors, especially in hydrolysis or proteolysis. (Pawar *et al.,* 2020) observed higher sensory scores for porridge mix compared to present investigation. This might be due to amount of soy bean addition difference.HMT3 had better sensory scores with respect to appearance (8.38), color (8.09), flavor (7.71), taste (7.33), texture (7.47) and overall acceptability (7.71) compared to other treatment. Fig. 6 depicts the sensory scores of herbal enriched finger millet based composite flour dosa. HFMBCF3 treatment ranked first with overall acceptability score 8.25 followed by HFMBCF 2 with score of 7.28. Highly significant difference was observed in sensory parameters among the three treatments. This difference was found due to addition of herbal mix gives bitter flavour in dosa, bitterness might be due to higher amount of polyphenols and flavonoid content in herbs (Kumar *et al.,* 2021).

Table 5 showed the antioxidant activity of herbal mix by different method. As the concentration increases, antioxidant activity increased in the herbal mix. Among the three method ABTS method showed higher antioxidant activity 83.33 per cent at the



HFCF1- Herbal enriched finger millet based composite flour treatment 1 (FCF: HM 85:15)

HFCF2- Herbal enriched finger millet based composite flour treatment 2 (FCF: HM 90:10)

HFCF3- Herbal enriched finger millet based composite flour treatment 3 (FCF: HM 95:5)

Fig. 6 : Sensory scores of herbal enriched finger millet composite flour based dosa

TABLE 5
Antioxidant activity of herbal mix

Concentration (µg/ml)	% Radical scavenging activity		
	DPPH	FRAP	ABTS
100	40.92	32.13	50.66
150	47.54	38.13	58.66
200	59.13	46.46	69.33
250	64.93	50.94	81.41
300	76.52	66.69	83.33

concentration of 300 (µg/ml). Natarajan *et al.* (2006) observed higher results compared to the present study. This difference was observed due to different herbs addition and the level of addition of herbs variation in the herbal mix.

Addition of finger millet with other ingredients rich in protein and micronutrients plays an important role in maintaining overall health. Results concluded that 50 per cent of finger millet and 50 per cent of other ingredients had better sensory scores compared to other treatments. Best accepted composite flour mix had good nutrient composition compared to control. Addition of five per cent of herbal mix to finger millet based composite flour dosa had better sensory scores by panel members. To increase the consumption of macronutrients there is a need for fortification to the staple food because the single cereal foodies lacking in protein and fatty acids. Hence, finger millet based composite flour enriched with other cereal, millet, oilseed and herbs fortification to the finger millet helps to improve nutritional status of the population.

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