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Evaluation of Sensory Acceptability and Nutrient Profile of Value Added Roties Enriched with Flaxseed Powder

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ABSTRACT

Flaxseed is being used extensively for the development of functional food due to health promoting properties and excellent nutrient profile. Effects of fortification of flaxseed at different levels were assessed on the nutritional and sensory quality of rice and ragi soft roties. Supplementation of flaxseed powder was done at 10% (CFM-I) and 20% (CFM-II) with rice or ragi flour and evaluated for sensory acceptability, nutrient profile and consumer preference. As the concentration of flaxseed increased, the energy, protein, fat and dietary fiber showed gradual increase and however, decreased in carbohydrate content. Organoleptic evaluation of roties by sensory panelist and consumers showed clear reduction of mean overall acceptability as the incorporation level of flaxseeds increased. Colour attribute significantly reduced ($p<0.05$) for CFM-II roties compared to control by consumers. Taste attribute significantly increased for CFM-II roties compared to control ($p<0.05$) due to appealing nutty taste of flaxseed flour. The presence of Linolenic acid was found in CFM-II roties (0.1%) whereas, it was not present in control and CFM-I roties. The percent of saturated fatty acids reduced in experimental roties compared to control roties. Hence the incorporation of flaxseed powder at 20% enhances dietary fiber, ALA (-inolenic acid) and protein in composite flour mixes without affecting the sensory acceptability of the products. The composite flour mixes studied can have therapeutic implications for the management of hormonal imbalance and chronic degenerative diseases.

Keywords : Flaxseeds, Roties, Value addition, Processing, Sensory evaluation

DIET is the greatest factor in lifestyle and has a direct and positive relation with health. Poor diet and its consequences like metabolic disorders are the common health problems in urban societies (Dariush, 2015). Provision of diet for the maintenance of physical and mental health is a basic right of an individual and the outcome of factors related to diet on health has been matter of concern since ancient times. The functional foods are considered to play a key role in disease prevention and the maintenance of good health. Flaxseed is emerging as one of the nutritive and functional ingredient in dietary foods producing metabolic and physiological health benefits in addition to its nutritional properties. The components of flaxseed, identified to exhibit the health benefits are fiber, lignans and linolenic acid. Moreover, flaxseed is a good source of high quality protein, soluble fibers and phenolic compounds. (Manjula, 2013)

Cereals and millets have been an essential part of the human diet since the beginning of agriculture. Rice (*Oryza sativa*) plays a fundamental role as staple food for more than half of the world's population that includes Asians and more particularly Indians. Rice provides more calories per hectare than any other cereals and other grains. Though the protein content of rice is less than that of wheat, the true protein digestibility and the biological value of rice protein are the highest among the other cereals. Finger millet (*Eleusine coracana*) also known as ragi in India is one of the important millet that occupies highest area under cultivation among the small millets and consumed by the major section of the population especially by South India. The finger millet contains important amino acids, B vitamins, especially niacin, B6 and folic acid, calcium, iron, potassium, magnesium and zinc.

Roti or unleavened bread or pancakes or flat breads are very popular worldwide; it constitutes a major source of protein and calories. Modifications have been experimented in order to improve the quality and delicacy of these flat breads in the due course of time at global as well as national levels. When ragi flour and bengal gram flour are incorporated to rice flour to prepare soft roti (unleavened-gelatinized pancakes), the nutritional profile also enhances. Several evidence based research reports indicate that composite flour mixes are value added flour mixes of two or three food grains to enhance the nutritive value of the end product (roti). When flaxseeds are roasted and incorporated at certain minimum levels to cereal flours to prepare common food products without affecting the sensory acceptability, will enhance the fatty acid composition and also dietary fiber (Mridula *et al.,* 2013). The acceptable nutri rich products can be developed by using composite flour mixes and promoted to general public to prevent the ill effects of chronic degenerative diseases such as diabetes, cardiovascular disorders, cancer and recent health disorder among young women *i.e.,* PCOS. PCOS is a common endocrine disorder among women of reproductive age and is leading cause of infertility worldwide. (Megha and Vijayalaxmi, 2018). There is a need to disseminate the value addition indigenous technologies to women groups to improve their knowledge and consumption pattern. Women's knowledge has been the mainstay of indigenous technologies as they have greater responsibility both at domestic and farm sector (Sanitha Govind *et al.,* 2018). Increased consumtion of cereals and starchy vegetables have a significant influence on increased BMI. Creating awareness and educating women regarding nutrition, value addition & promotion of nutrient rich food can improve malnutrition condition (Ashwini *et al.,* 2018). There is a need to develop nutritious convenient value added functional foods to extend to the consumers with good acceptable attributes.

Hence, the present research has been carried out to develop a composite flour mix incorporated with roasted flaxseed flour to standardize a popular south Indian staple dish *i.e.,* rice and ragi soft roti (unleavened gelatinized pancake) and to evaluate sensory and consumer acceptability and analyze the nutritive value and fatty acid composition.

Material and Methods

Standardization of the Roties

Ingredients such as Rice, finger millet/ragi, bengal gram/chickpea, flaxseed, curry leaves, coriander leaves, green chillies, carrot and coconut were procured from local market. The composite flour mix is standardized using rice flour, ragi flour and bengal gram flour as the main base (Table 1). Standardized cups, spoons and weighing scale were used for accuracy. Relevant literature review was referred to fix the per cent incorporation of flaxseed in the composite flour. Flaxseed were roasted till the nutty aroma attains and powdered in a mixer. Flaxseed roasting is carried out to eliminate cyanogenic glycosides (Yang *et al.,* 2004). Roasted flaxseed flour was incorporated at two different levels *i.e.,* 10 and 20 per cent. Composite flour mix formulated was used for preparing common dietary product-roti, which was standardized by the common recipe used at domestic level. The flour mix was added to boiling water with a little oil and stirred

Table 1
Composition of composite flour mix

Composite flour mix	Rice flour (grams)	Ragi flour (grams)	Bengal gram flour (grams)	Flaxseeds flour (grams)	Other ingredients (grams)
Control	35	35	20	-	10
Mix I	30	30	20	10	10
Mix II	25	25	20	20	10

* Other ingredients - Curry leaves, carrot, coriander, coconut and green chillies

The Mysore Journal of Agricultural Sciences

to obtain firm dough, kneaded and Roties were prepared manually using a roller-pin and roasted with little oil smeared on it (Fig.1). Two variations were standardized for the sensory and nutrient evaluation and to select one best-accepted combination for the consumer acceptability.

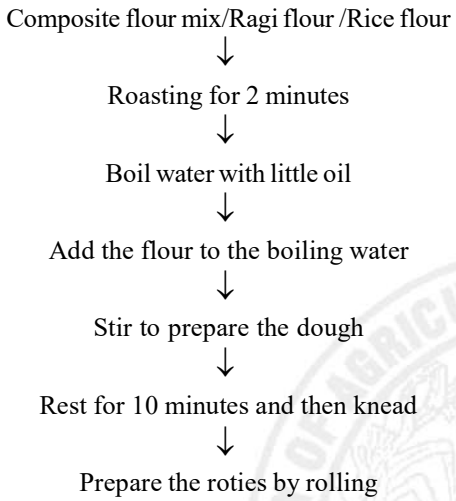

Fig. 1 : Flow chart of product preparation

Organoleptic Evaluation of Roties

The roties developed were evaluated for organoleptic qualities such as appearance, colour, texture, taste, flavour and overall acceptability by 20 semi-trained sensory panelists using nine-point hedonic scale and consumer acceptability was conducted by thirty consumers of the age group 20-60 years using five-point hedonic scale.

The nutritive value and fatty acid composition of the dried roties (experimental and control) were analyzed by a certified analytical laboratory - Merieux Nutri Sciences Private Limited, Bengaluru using the standard analytical protocol.

The suitable statistical package was used to analyze the data (SPSS, Version 17.0 for Windows, SPSS Inc., Chicago, USA). The differences in mean acceptability scores (mean value) of the roties prepared from control and experimental mixes were assessed and determined by Analysis of Variance Technique. Difference was considered significant at a probability level of five per cent($p<0.05$) and highly significant at one per cent($p<0.01$).

Results and Discussion

Physical & Cooking Characteristics of the Roties

The physical and cooking characteristics of the roties are presented in Table 2 which revealed that the diameter and weight of roti decreased after cooking in all the roties, which may be due to the evaporation of moisture content in dough and shrinking of flour molecules when exposed to heat. The thickness increased after cooking and was same in all the roties. There was no significant difference in the dough firmness though same quantity of water was added to all the mixes. The colour of the roties intensified as the level of flaxseed incorporation increased. The yield of roties of all the three mixes for 100g each was the same.

Table 2

Physical and cooking characteristics of the roties prepared from composite flour mixes

Physical characteristics		Control	Mix I	Mix II
Diameter (cm)	Before cooking	14	14	14
	After cooking	13.5	13.4	13.5
Thickness (mm)	Before cooking	1.5	1.5	1.5
	After cooking	1.7	1.7	1.7
Weight (g)	Before cooking	50	50	50
	After cooking	45	45	42
Water required (ml)	For dough preparation	100	100	100
Cooking time (min)	-	2	2	2
Colour	-	Reddish brown	Slightly dark	More dark
Yield (No)	-	3	3	3

Organoleptic Quality Evaluation of Roties by Sensory Panelists

It was evident that there was no significant difference in the sensory acceptability of control and mix I and II roties (Table 3). However, it was observed that the

TABLE 3

Analysis of variance of sensory attributes of the roties by sensory panelists (n=20)

Sensory attributes	Mean ± SD		ANOVA	
	Control	Mix I	F value	CD at 5 %
III a. Control roties				
Appearance	7.65 ± 0.87	7.4 ± 0.88	0.8	0.087
Colour	7.45 ± 1.46	7.35 ± 1.04	0.06	0.008
Texture	7.35 ± 0.87	7.6 ± 0.94	0.75	0.087
Taste	7.15 ± 0.81	7.1 ± 0.71	0.04	0.003
Flavour	7.35 ± 0.87	7.15 ± 0.81	0.56	0.056
Overall acceptability	7.55 ± 0.82	7.4 ± 0.75	0.36	0.031
III b. Mix I roties				
Appearance	7.65 ± 0.87	7.45 ± 0.75	0.59	0.056
Colour	7.45 ± 1.46	7.4 ± 0.82	0.01	0.035
Texture	7.35 ± 0.87	7.6 ± 0.99	0.71	0.087
Taste	7.15 ± 0.81	7.2 ± 0.83	0.03	0.003
Flavour	7.35 ± 0.87	6.8 ± 0.95	3.62	0.424
Overall acceptability	7.55 ± 0.82	7.3 ± 0.86	0.87	0.087
III c. Mix II Roties				
Appearance	7.4 ± 0.88	7.45 ± 0.75	0.03	0.003
Colour	7.35 ± 1.04	7.4 ± 0.82	0.02	0.003
Texture	7.6 ± 0.94	7.6 ± 0.99	0	0
Taste	7.1 ± 0.71	7.2 ± 0.83	0.16	0.014
Flavour	7.15 ± 0.81	6.8 ± 0.95	1.56	0.171
Overall acceptability	7.4 ± 0.75	7.3 ± 0.86	0.15	0.014

* Indicates significant difference at 5% level,
Hedonic scale: 9 point

mean values of all attributes of mix I and mix II roties had decreased compared to control mix roties, which might be due to the incorporation of flaxseed flour except for the texture. The fat content of flaxseed flour might have improved the texture of the roties. It was notable that mean scores of flavour had declined futher for roties of mix II when compared to control and mix I roties, which can be attributed to the slight bitter aftertaste of flaxseed flour at the incorporation level of 20 per cent. However, there was no significant statistical difference between the attributes of roties from all the three mixes. Similar findings were reported by Ganorkar and Jain (2014) in case of cookies fortifies by flaxseed. Several studies have revealed similar findings that incorporation of flaxseed flour has not affected the sensory acceptability significantly (Aurea *et al.,* 2012; Demery et al 2015; Farzana *et al.,* 2015). Khouryieh and Aramouni (2013) reported that flaxseed flour incorporation up to 12 per cent substantially enhanced the nutritional qualities of the cereal bars without affecting their sensory and quality properties.

Consumer Acceptability of the Roties Prepared from the Composite Flour Mixes

The results of consumer acceptability test indicated that the consumer acceptability between experimental roties (mix I *vs* mix II) showed that colour acceptability of mix I was significantly higher than mix II and that of taste of mix II was significantly more compared to mix I. The darker appearance might have affected the acceptability of the roties of mix II due to the higher percent incorporation of flaxseed flour (20 %), hence might have decreased the scores of colour attribute. But there was no significant difference in overall acceptability of roties by the consumers. However, mean values of all attributes decreased for roties of composite flour mix I and II when compared to control mix, significantly decreased for colour at 5 per cent level in case of roties of mix II (Table 4). It was interesting to note that the mean scores of taste attributes were significantly higher for experimental roties of mix II when compared to control ($P<0.05$) which can be attributed to the appealing nutty taste of flaxseed flour. Shobha and Ravishankar (2017) observed that consumers liked the products such as vada, thalipattu and dosa prepared by the multipurpose mix developed by incorporating ragi flour at 50 per cent. However, the deviation in taste was not statistically significant between control and mix I roties, might be due to the lower percent of incorporation (10 %) of flaxseed flour. But there was no significant difference in overall acceptability for all three variations of roties by the consumers. Erica *et al.* (2010) reported that cakes were accepted by consumers up to 30 per

The Mysore Journal of Agricultural Sciences

TABLE 4

Assessment of consumer acceptability of the roties (n=50)

Sensory attributes	Mean ± SD		ANOVA	
	Control	Mix I	F value	CD at 5 %
IV a. Control roties				
Appearance	4.1 ± 0.54	4.1 ± 0.54	0	0
Colour	4.1 ± 0.60	4.13 ± 0.73	0.03	0.001
Texture	4 ± 0.64	4 ± 0.69	0	0
Taste	3.5 ± 0.77	3.73 ± 0.82	1.26	0.076
Flavour	3.53 ± 0.77	3.46 ± 0.73	0.11	0.006
Overall acceptability	4.06 ± 0.52	3.93 ± 0.73	0.65	0.024
IV b. Mix I roties				
Appearance	4.1 ± 0.54	3.8 ± 0.76	3.07	0.126
Colour	4.1 ± 0.60	3.73 ± 0.52	6.29 *	0.188
Texture	4 ± 0.64	3.93 ± 0.78	0.12	0.006
Taste	3.5 ± 0.77	4.23 ± 0.67	15.5 *	0.754
Flavour	3.53 ± 0.77	3.83 ± 0.74	2.32	0.126
Overall acceptability	4.06 ± 0.52	4.1 ± 0.60	0.05	0.001
IV c. Mix II Roties				
Appearance	4.1 ± 0.54	3.8 ± 0.76	3.07	0.126
Colour	4.13 ± 0.73	3.73 ± 0.52	5.96 *	0.224
Texture	4 ± 0.69	3.93 ± 0.78	0.12	0.006
Taste	3.73 ± 0.82	4.23 ± 0.67	6.54 *	0.350
Flavour	3.46 ± 0.73	3.83 ± 0.74	3.69	0.188
Overall acceptability	3.93 ± 0.73	4.1 ± 0.60	0.90	0.038

* Indicates significant difference at 5% level,
Hedonic scale: 5 point

cent of flaxseed flour incorporation. Preeti and Renu (2013) also reported that the color of the flaxseed flour fortified samples attained more dark colour as the fortification was increased in the biscuits and formulations made with up to 30 per cent flaxseed flour as partial replacement of wheat flour had good acceptance. They observed that a bakery product with flaxseed flour supplementation is a useful strategy to increase the consumption of fiber and omega-3 in the human diet.

Per cent Nutrient Composition of Roties Prepared from Composite Flour Mixes

The composition of the proximate nutrient composition of roties prepared from composite flour mixes is presented in Table 5. The control mix roties had the percent composition of 10.41 g moisture, 9.43 g protein and 4.75 g fat. The proximate composition of nutrient in composite flour mix I roties was 10.05 g moisture, 10.70 g protein and 5.79 g fat, and in composite flour mix II roties was 8.89 g moisture, 12.98 g protein and 10.92 g fat.

TABLE 5

Per cent Nutrient Composition of the Roties Prepared from Composite Flour Mixes

Parameter	Control	Composite flour Mix I	Composite flour Mix II
Moisture (g)	10.41	10.05	8.89
Protein (g)	9.43	10.70	12.98
Total Fat (g)	4.75	5.79	10.92
Carbohydrate (g)	73.03	73.03	65.72
Energy (Kcal)	373.95	387.03	413.08
Dietary Fiber (g)	16.96	21.17	29.61
Iron (mg)	2.8	4.7	2.0
Calcium (mg)	200	200	200

*(Protocol AOAC 996.06)

The dietary fiber, iron and calcium content of the roties were 16.96 g, 2.8 mg and 200mg for control mix, 21.17 g, 4.7 mg and 200 mg for mix I and 29.61 g, 2.0 mg and 200 mg for mix II, respectively. It was evident that the control mix roties had slightly more moisture compared to composite flour mix I and II roties. The carbohydrate value was lower in mix II roties when compared with control and mix I roties. The energy, protein, fat dietary fiber values was highest in mix II roties followed by mix I roties and was least in control roties. This may be due to higher amount of incorporation of flaxseed flour. Iron content was more in mix I roties followed by control roties and mix II roties. Calcium values remained same for roties of all the three mixes. Erica *et al.* (2010) reported that cakes made with 5, 15, and 30 per cent of flaxseed flour had dietary fiber levels ranging from 3.5 g, 5.1 g, 6.92 g

and linolenic acid ranging from 445 mg, 1240 mg, 2,500 mg, respectively.

Iron content was more in mix I roties followed by control roties and mix II roties. Calcium values remained same for roties of all the three mixes. Dietary fiber value was least in control mix roties and highest in mix II roties. These results indicate, flaxseed incorporation improves the nutritive value of the food.

Fat Content and Fatty Acid Composition of Roties Prepared from Composite Flour Mixes

Analysed values of fatty acid composition (Table 6) indicated that presence of Linolenic acid was found to be at 0.1 per cent in mix II roties whereas it was not present in either control or mix I roties. Similar study conducted by Jyotsna (2012) revealed that the fatty acid profile of cookies influenced by flaxseeds at 15 per cent RGF (roasted and ground flaxseed) had 4.75 - 5.13 per cent linolenic acid. Whereas, the control cookies had negligible content of linolenic acid. Prasad *et al.* (2016) developed rice roti fortified with flax seed flour along with other ingredients at different concentration (10, 15 and 20 per cent), observed that incorporation of flaxseed at 10 per cent was well accepted and the incorporation of the flax seed increased the fatty acid composition of the linoleic acid, and oleic acid from 44.17 to 48 and 26 to 27.13, respectively. It was notable in the present study that percent of saturated fatty acids reduced in composite flour mix roties compared to control roties. The same was lower for roties of mix II compared to roties of mix I. The results of analyzed nutrient value and fatty acid composition also revealed that optimum nutrient value and significant omega-3 fatty acid (ALA) was present in the roties of composite flour mix II.

TABLE 6

Per cent Fatty Acid Composition in Roties Prepared from Composite Flour Mixes

Name of the compound	Values		
	Control	Mix I	Mix II
Caproic acid	Nil	0.06	0.04
Caprillic acid	1.61	0.98	0.64
Capric acid	1.38	0.77	0.48
Lauric acid	12.06	6.27	3.80
Myristic acid	5.48	2.76	1.67
Palmitic acid	12.55	10.55	8.94
Stearic acid	4.38	4.95	5.32
Oleic acid	30.38	27.97	25.01
Linoleic acid	29.12	30.70	26.77
Linolenic acid	Nil	Nil	0.1
Palmitoleic acid	0.25	0.11	0.11
Arachidonic acid	Nil	0.33	0.29
Eicosenoic acid	0.24	13.08	Nil
Behenic acid	0.85	0.53	0.39
Erucic acid	Nil	Nil	Nil
Lignoceric acid	Nil	Nil	Nil
Recenoteic acid	Nil	Nil	Nil
Heptadecanoic acid	0.11	0.26	Nil

*(Protocol AOAC 996.06)

By this study it was evident that there was no significant difference in the dough firmness though same quantity of water was added to all the mixes and the colour of the roties intensified as the level of flaxseed incorporation increased. Sensory evaluation indicated that flavour of roties of mix II (20 per cent incorporation) declined when compared to control and mix I (10 %) roties, which might be attributed to the slight bitter aftertaste of flaxseed flour. There was no significant statistical difference between the attributes of roties from all the three mixes. Consumer acceptability test revealed that though mean values of all attributes decreased for roties of composite flour mix I and II when compared to control mix by the consumers, the deviation in taste was not statistically significant between control and mix I roties, might be due to the lower percent of incorporation (10 %) of flaxseed flour.

Flaxseed can be incorporated at level of 20 per cent with composite flour mixes of cereals, millets and pulse flours to obtain nutritious and tasty roties with acceptable sensory attributes. The significance of value added roties using flaxseed flour provides ALA (linolenic acid) to a notable extent, which can have therapeutic implication for the management of

The Mysore Journal of Agricultural Sciences

hormonal imbalance and chronic degenerative diseases. The composite flour mixes have potential dietetic as well as traditional utility to extent functional health benefits for prevention of health disorders such as PCOS, diabetes, cardiovascular diseases, cancer, etc.

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