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Development and fortification of *Ragi Millet (Eleusine Coracana)* and moringa based health food *Sattu*

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Abstract
Indian traditional food *sattu* is generally made from puffed chickpea and wheat/barley flours. It is the ready to eat instant product having high biological value. In the present investigation, finger millet *ragi* based *sattu* was prepared from puffed chickpea and roasted *ragi* flour in the ratio of 70:30 and it was as further improved by the addition of 10% skimmed milk powder to make more nutritive. After mixing with sugar (40%), the product was evaluated for various sensory attributes on 9 point hedonic scale. The mean score values for various sensory attributes of traditional *sattu* were found to vary in between 7.8 to 8.8. The *ragi* based *sattu* made from Local and MR-2 cultivars showed the variations in the range of 7.4 to 7.7 and 7.5 to 7.9 respectively. The *paustik ragi sattu* made after addition of 10% skimmed milk powder and 10% Moringa leaf powder revealed the sensory values in the range of 7.8 to 8.6 and 7.9 to 9.2, respectively for Local and MR-2. Thus, it was concluded that *ragi* could be used satisfactory in place of wheat up to a maximum level of 25 percent without any adverse affect on sensory quality of product. The proximate composition highly *pausitik ragi sattu* revealed that on supplementation of milk powder, the quality of product was enhanced in terms of both quality and quantity. The *paustik ragi sattu* developed from Local and MR-2 contained 13.72% and14.56% protein1.25% and1.17% fat, 75.30% and 75.34% carbohydrates, 0.77% and 0.89 % ash, and 1.10% and 1.30% crude fiber, respectively. Among the various kind of *ragi sattu*, highly *paustik ragi sattu* with milk powder could be consider as the best and recommended especially for growing children due to rich calcium 225 mg/100g. Hence, *sattu* made from *ragi* flour could be considered as a good and cheap source of calcium and fiber for young children, pregnant and lactating mothers.

Keywords: vivek millet thresher, skimmed milk powder, *pausitik ragi sattu*

Introduction

Heritage foods in India are an integral and vital part of Indian culture. With a history of some 3000 years or more the Indian civilization has given food a very important place in social and cultural life of the people. Millets are characterized by having smaller seeds in proportion to the size of the mature plant used for food, feed and forage all over the world particularly tropical and certain parts of the warm temperate region of the world, that belong to the grass family *poaceae*. Minor millets grains are not only nutritious but they also play an important role in controlling the various nutritional disorders/diseases *viz*., constipation, diabetes, cardiovascular (Arora S *et al*. 2002) [3]. Yenagi *et al.* (2013) [10] reported Finger millet and foxtail millet flour can be incorporated in bakery items like biscuits, *nan-khatai*, chocolate, cheese, cakes, muffins, etc. Research findings have revealed that substitution of 40% wheat flour with finger millet flour in baked products *viz*; cake and biscuits is possible.

Cereals and pulses have remained at central position as basic foods to provide energy and proteins (Malleshi *et al* 1986) [7]. In developing countries, these commodities provide more that 90% of the total energy and proteins and substantially contribute toward dietary proteins and minerals Hadimani *et al*. (1993) [6]. Though many of the traditional preparations from cereals and legumes containing other ingredients such as gram and dry fruits have been used for their curative or for disease preventive properties, the concept of health or functional foods emerged only during sixties when it was realised that despite nutritionally poorer diets, occurrence of chronic diseases is much lower in people dependent on cereals and legumes diet. In context of this, the present study was conducted on a very common traditional food i.e. *sattu* which was made from processed flours of chickpea, ragi and soybean.

Materials and methods

Ragi Millet (*Eleusine coracana)* collected from Reginol research station JNKVV center Dindori and Rewa Madhya Pradesh Finger millet (ragi) kernel has a fragile endosperm with an intact seed coat. Due to these characteristic, the grains cannot be polished similar to rice or other cereals. Hence the grain needs to be invariably pulverized to make flour directly from flour mill. This is also called ragi flour

and used for product development with or without fortification. Moringa variety PKM-2 leaf were dried and make powder at Krishi Vigyan Kendra Seoni. The detailed procedure for preparation of the products has been described in the flow sheet-1.

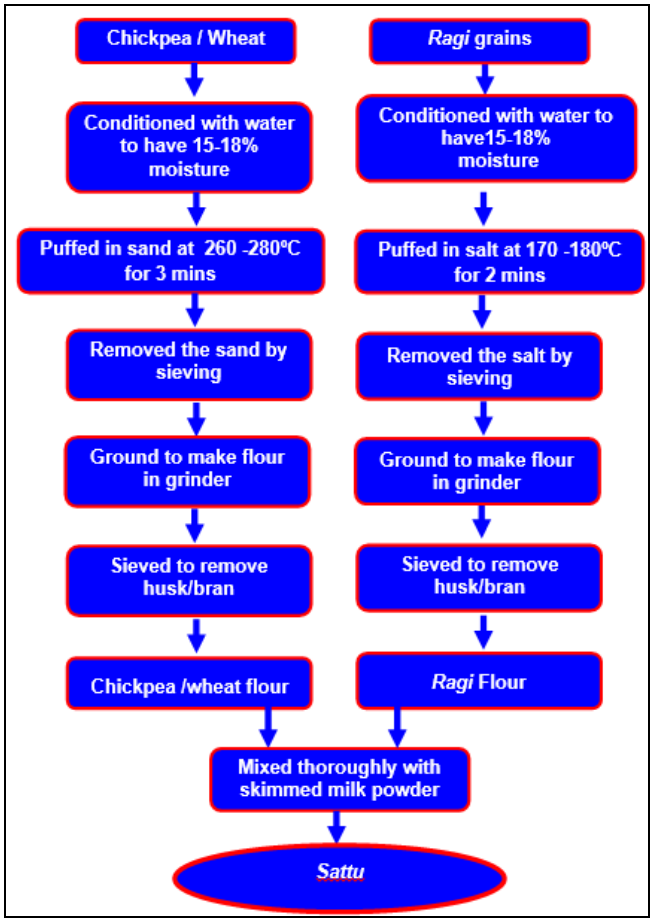

Fig 1: Flow sheet Formulation and development of *ragi* based *sattu*

Finger Millet (*ragi*) based *sattu*

500 g of food grains were taken moistened with water (50 ml), kept for 2-3 hours and puffed in a iron pan using hot sand at 260-280ºC for 60-90 seconds and then cooled at ambient conditions. The puffed grains were rubbed by hand to remove the husk and then ground to make fine powder with electric grinder. Other grains were also processed in a similar way. The flours were sieved 60 mesh and stored in air tight plastic containers at ambient conditions l (Shrivastava *et al*. 2001) [8]. Wheat based *sattu was* prepared from puffed chickpea flour and puffed wheat flour in the ratio of 70:30 as used as control. The ragi based *Sattu* was made from various cultivars of ragi flour *viz*; local, MR-2 and GPU-26 replacing the wheat flour in the ratio of 70:30 and called as *ragi* based *sattu*

The *ragi* based *sattu* was further improved by the 10% addition of moringa leaf powder, 10% skimmed milk powder and denoted as improved *ragi* based *sattu*. These different kinds of *sattu* were evaluated for sensory and nutritional characteristics after mixing with 30% sugar by the standard procedures.

Sensory Evaluation

The sensory evaluation of various kinds of products made from finger and little millet were judged on 9 points hedonic scale for various sensory quality characteristics and overall acceptability using expert panelist according to the method as described by Amerine *et al*. (1965). The observations recorded for appearance, colour, texture, taste, flavour and overall acceptability of the products were recorded for interpretation of results.

Table 1: Sensory evaluation of ready to eat sweet *ragi* based sattu

Sensory attributes	Wheat based sattu	*Ragi* based sattu		*Ragi* sattu fortified with moringa leaf powder & milk powder		Average mean
	Control	Local	MR-2	Local	MR-2	
Appearance	7.8	7.6	7.8	7.6	7.9	7.7
Colour	8.8	7.7	7.9	8.6	9.2	8.3
Taste	7.9	7.6	7.7	7.8	8.0	7.7
Texture	7.8	7.5	7.5	7.6	8.2	7.7
Flavour	8.8	7.4	7.9	8.6	8.8	8.1
Over all acceptability	8.2	7.6	7.7	8.0	8.5	7.9

Estimation of nutritional quality

Crude fat estimated by petroleum sprit (BP 40-60ºC) extraction, using Soxhlet apparatus. The KEL PLUS Nitrogen Analyzer - Micro Digestion Series used for the determination of Proteins (N × 6.25). Moisture, crude fiber, Ash, determined by the AOAC (1992) [1] methods. Protein, fat, carbohydrate, calcium, Phosphorus and iron value of food products will be analysed by the Standard procedure. Total calorific value calculated by multiplying the calculated values of energy.

Ragi based *sattu*

Sattu one of the traditional product made from chickpea and whaet/barley flour. It is the ready to eat instant product having high biological value. In the present investigation, *ragi* based *sattu* was prepared from puffed chickpea and roasted *ragi* flour in the ratio of 70:30 and it was as further improved by the addition of 10% addition of moringa leaf powder and 10% skimmed milk powder to make more nutritive. The sensory evaluation of the traditional *sattu*, *ragi sattu* and *paustik ragi sattu* were made after mixing with 30% sugar in sweet *sattu* on 9 point hedonic scale.

Sensory evaluation of sweet *ragi* based *sattu*

The resulted data on sweet *ragi* based *sattu* have been tabulated in Table 1.The mean score values for various sensory attributes like appearance, colour, taste, texture, flavuor and overall acceptability of traditional *sattu* were found to vary in between 7.8 to 8.8. The *ragi* based *sattu* made from Local and MR-2 cultivars showed the variations in the range of 7.4 to 7.7 and 7.5 to 7.9 respectively. The *paustik ragi sattu* made after addition of 10% addition of moringa leaf powder and 10% skimmed milk powder revealed the sensory values in the range of 7.8 to 8.6 and 7.9 to 9.2, respectively for Local and MR-2**.** The *ragi* Cultivars did not reveals any significant differences in the values of various sensory attributes. Sweet *sattu* made after addition of 30% sugar with appropriate water to make gruel used for sensory evaluation.

Nutritional composition of sweet *ragi* based *sattu*

The Nutritional composition *of* various kinds of *sattu* have been presented in Table 2. The traditional sweet *sattu* based on wheat flour contained 12.32% protein. 1.61% fat, 75.5%

carbohydrates, 0.73% ash, and 1.66% crude fiber. The total calorific value of the product was found to be 365 Kcal/100g product. The value for various minerals *viz*. calcium, phosphorus and iron were107.3, 166.1 and 3.34 mg/100g of the product, respectively. However, *ragi* based *sattu* made from Local and MR-2 cultivars contained 10.78% and 11.34% protein,.1.32% fat, 75.76% and 75.94% carbohydrates,0.68% and 0.75% ash, and 1.54% and 1.99% crude fiber, respectively. The total calorific values for Local and MR-2 *ragi* based *sattu* were found 358 to 368Kcal/100g of product respectively. Verma and Patel, (2013) reported that finger millet not only improved the taste but at the same time enriches the food value in terms of protein, calcium and fibre, B vitamins, *in vitro* protein digestibility and decreased the levels of anti-nutrients in food grain. The values for calcium were 161.6mg and 165.1mg, phosphorus 179.2mg and 181.4 and iron 4.20mg and 4.24 mg/100g product for Local and MR-2 respectively. The *paustik ragi sattu* developed from Local and MR-2 contained 13.72% and14.56% protein1.25% and1.17% fat, 75.30% and 75.34% carbohydrates, 0.77% and 0.89 % ash, and 1.10% and 1.30% crude fiber, respectively. The calorific value of the *paustik sattu* was found to be 367 and 369 Kcal/100g of product respectively for Local and MR-2. The values for calcium, phosphorus and iron were 211.2mg and 225.5mg, 189.3mg and 191.8mg and 4.47 and 4.52mg/100g of product, respectively for Local and MR-2 based *ragi* poustik *sattu*. Shrivastava D.C. (2016) [5] reported that malt was developed from finger millet cultivars. The results showed that the average values for various sensory attributes *viz*:, colour, flavor and taste varied in the range of 8.1 to 8.5 in comparison to the wheat malt used as control (7.9 to 8.4). The finger millet malt was good in taste and flavor similar to wheat malt Thus *ragi* based *sattu* were found to rich in minerals and significantly superior in comparison to wheat based sattu.

Table 2: Nutritional composition of sweet *ragi* based *sattu.*

Nutrients per 100 g	Wheat based sattu	*Ragi* based sattu		*Ragi* sattu fortified with moringa leaf powder &milk powder		Average mean	SEm±	CD at 5%
	Control	Local	MR-2	Local	MR-2			
Protein (g)	12.32	10.78	11.34	13.72	14.56	12.6	0.251	0.014
Fat (g)	1.61	1.32	1.32	1.25	1.17	1.26	0.352	0.254
Carbohydrates (g)	75.52	75.94	77.76	75.34	75.30	76.08	0.451	0.621
Total ash (g)	0.73	0.68	0.75	0.77	0.89	0.77	0.567	0.031
Crude fiber (g)	1.66	1.54	1.99	1.30	1.10	1.48	0.158	0.142
Calcium (mg)	107.3	161.6	165.1	211.2	225.5	190.8	0.863	0.162
Phosphorus (mg)	166.1	179.2	181.4	189.3	191.8	185.0	0.721	0.032
Iron(mg)	3.34	4.20	4.24	4.47	4.52	4.35	0.698	0.156
Total calorific value(Kcal/100 g)	365	358	368	367	369	366	0.032	0.015

Keeping quality of sattu

The storage studies of sattu conducted in tin boxes and polyethylene containers at room temperature for the period of 6 months, revealed that the content of free fatty acid found to vary from 27.5 to 38.1 in terms of mg KOH per 100 g of *sattu*. The results showed that there was a slight increase during the storage period and values weres slightly higher in tin boxes than polyethylene bags (Table 4). Therefore, it was concluded that the product could be well stored in polyethylene container for the period of 6 month without any deterioration.

Table 3: Fat acidity of sattu stored in different containers for the period of 6 months

Types of Sattu	Caontainers	Period of storage (months)			
		0	2	4	6
Ragi Sattu	Tin boxes	28.2	30.1	33.5	35.1
	Polyethylene bags	27.5	29.2	32.9	33.2
Paustik ragi sattu	Tin boxes	32.3	30.5	35.1	37.1
	Polyethylene bags	33.7	33.7	35.3	36.2
Highly paustic ragi sattu	Tin boxes	30.5	33.2	35.2	38.1
	Polyethylene bags	31.9	34.1	33.1	35.2

Result expressed in term of mg of KOH/100 g of *sattu*

Table 4

	Product	Container	Storage Period
SEm±	0.91	0.74	1.05
C.D. 5%	NS	NS	NS

Table 5: Sensory score rating of Sttu stored in different containers for the period of 6 months

Types of sattu	Containers	Sensory score ratings
Sattu	Tin boxes	7.8
	Polyethylene bags	8.2
Ragi sattu	Tin boxes	8.0
	Polyethylene bags	8.3
Paustik ragi sattu	Tin boxes	8.0
	Polyethylene bags	8.3

Conclusion

Popped ragi grains flour can be successfully used in place of wheat or barley for the formulation of ragi-based sattu upto the level of 30% without any changes in sensory quality characteristics. Nutritionally, ragi sattu was also superior in certain nutrients like calcium, fibre and important essential amino acids lysine and methionine except protein which was 2 per cent lower in ragi sattu. Further, on supplementation of 10% addition of moringa leaf powder enhanced the protein content. Being rich in calcium and balanced protein, ragi-based sattu can be recommended to young children and pregnant & lactating women for fulfilling the additional nutritional needs required during growth and development. Being rich in fibre, ragi-based sattu can be considered as health/functional food in the prevention of constipation.

Thus, based on the above observations, ragi based sattu can be easily made at house-hold or/and commercial level and need to be popularized in rural areas through various extension activities. The cost of the all types of sattu based on the cost of ingredients was found to be 22-25/kg.

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