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Production of Nutrient Rich Vermicelli with Malted Finger Millet (Ragi) Flour

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A B S T R A C T

In present investigation attempts have been made to develop nutrient rich vermicelli by addition of wheat and malted ragi flour in different proportions (90:10 80:20, 70:30, 60:40 and 50:50) for optimization of ratio for production of better quality vermicelli. It was observed that among all the formulations tried, vermicelli sample prepared with 70:30 (wheat: malted ragi flour) combination had similar sensory score as that of control. Higher values of protein, fibre and minerals like calcium, iron and phosphorous than the control sample were reported in vermicelli samples incorporated with 30 % of malted ragi flour. This nutrient rich vermicelli was good source of minerals to the consumers.

Introduction

Wheat is consumed in various forms by millions of human being in the world. Approximately 85 to 90 % of wheat is consumed as staple food in the form of flat unleavened bread called *chapattis*, *parathas*, *roti*, *nan*, *phulke* depending on the method of baking. Wheat is major ingredient in bakery and pasta products due to presence of gluten and its property to form dough and retain gases. It is commercially utilized by large and small scale industries for the production of leavened products such as cake, biscuits, cookies, bread etc. *Triticum durum* is hard and has high protein content and mainly used for production of semolina, macaroni, and pasta products (Adsule and Kadam, 1986). Wheat is rich in manganese, phosphorus, magnesium, and selenium. It is also a good source of zinc, copper, iron, and potassium. It is rich in vitamin B_6, niacin, thiamin, riboflavin, and pantothenic acid. Vitamin E and K are also present in smaller, but still significant amounts. The nutritional value of wheat is extremely important as it takes an important place among the few crop species being extensively grown as staple food sources.

Finger millet is commonly known as *ragi* (*Eleusine coracana*). It is also known as African millet and Black millet. India is one of the leading countries with respect to production and utilization of *ragi*. It is extensively grown in Karnataka, Tamil Nadu, Andhra Pradesh, Bihar, Maharashtra and Gujarat. Finger millet needs a fairly high rainfall, but will tolerate poor soil.

Finger millet is especially valuable as it contains the amino acid methionine, which is lacking in the diets of hundreds of millions of the poor who live on starchy staples such as cassava, plantain, polished rice or maize meal. The finger millet proteins are rich in two of essential amino acids (methionine and tryptophan) and substantial amounts of the essential amino acids, except lysine (Malleshi and Klopfenstein, 1998; Fernandez *et al.*, 2003).

Finger millet is a good source of iron and calcium which especially relevant to populations inhabiting northern Nigeria where the high incidences of prevalence of iron deficiency anemia in pregnant women (VanderJagt *et al.*, 2007) and calcium deficiency rickets in young children (Thacher *et al.*, 2000; Vander Jagt *et al.*, 2001). Finger millet is popular food among diabetic patient in the country. Traditionally finger millet is processed either by malting or fermentation (Rao and Muralikrishna, 2001). Malting of finger millet improves its digestibility, sensory and nutritional quality as well as pronounced effect in the lowering the antinutrients. Malting characteristics of finger millet are superior to other millets and ranks next to barley (Malleshi and Desikachar, 1986; Pawar and Dhanvijay, 2007). There is also overall improvement in the flavour profile of *ragi* during germination process (Nirmala and Muralikrishna, 2002; Ram *et al.*, 1979; Rao and Belavady, 1978).There are various benefits of malting such as improved availability of vitamin-C, phosphorus and also lysine and tryptophan are synthesized (Dulby and Tsai, 1976).

The malted finger millet had higher amylase activity than sorghum and other millets (Malleshi and Desikachar, 1986; Senappa, 1988). Malleshi and Desikachar, (1986) reported that finger millet has highly agreeable flavour with adequate starch hydrolyzing enzymes.

Vermicelli (little worms) is a type of *pasta*, round in shape and somewhat thinner than *spaghetti*. Pasta is the most suitable snack food for satisfying nutritional requirements and safeguarding health (Costantini, 1985). Vermicelli is a popular instant food product which falls under the category of extruded product and is made from wheat flour. It is snack food item rich in proteins and liked by people from all walks of life, irrespective of age. With changing lifestyle greater awareness about health preference for instant food items like vermicelli become very popular and presently it is an item of mass consumption.

Materials and Methods

Wheat grains of *Godawari* (NIDW-295) variety and finger millet grains of *Phulenachni* variety were procured from research stations of MPKV, Rahuri and used for preparation of vermicelli.

Preparation of wheat suji

Wheat grains were cleaned and subjected to tempering and conditioning treatment. Water was added to wheat sample to increase moisture by 3% and conditioned overnight. The conditioned grains were milled to obtain *suji* using laboratory flour mill.

Malted ragi flour

The malting of *ragi* was performed by using the process described by Desai *et al*., (2010). Cleaned grains were washed under water for 5-7 times, soaked for 5 h in fresh water and then drained to remove excess water. The grains were then tied in a muslin cloth and 5 Kg weight was kept on it and incubated for 24 h at 27 ± 3^{0}C for germination. The germinated grains were dried in shade for 2 days followed by grinding in Brabender flour mill to make flour.

Preparation of vermicelli

The wheat *suji* and malted finger millet flour was mixed in different levels such as 100:0 (T_o), 90:10 (T1), 80:20 (T_2), 70:30 (T3), 60:40 (T_4), and 50:50 (T_5).The pre-decided blends of wheat *suji* and *ragi* flour were mixed with salt (2%) and required amount of water was added to prepare dough of desirable consistency by kneading the dough properly.

Physico–chemical analysis

The wheat *suji,* malted *ragi* flour and vermicelli were subjected to proximate analysis such as moisture, protein, fat, crude fibre, ash, iron, calcium and phosphorous content using standard procedures given by Rangana (1986)

Sensory evaluation

The vermicelli samples were evaluated for different sensory attributes *viz.* colour and appearance, texture, flavour, taste and overall acceptability, by panel of 10 semi–trained judges, using a 9 point hedonic scale (Amerine *et al.,* 1965).

Statistical analysis

The data obtained was analyzed statistically to determine statistical significance of treatments by using Completely Randomized Design (CRD) stated by Panse and Sukhatme (1967).The analysis of variance revealed at significance of $p<0.05$ level, S.E. and C.D. at 5 % level was mentioned wherever required.

Results and Discussion

Chemical composition of wheat flour

The moisture content of wheat variety *Godawari* (NIDW-295) *suji* was 12.95 % (Table 1). The values for moisture content of wheat flour ranged from 9 to 18 % (Kent Jones and Amos, 1967), 10.3 to 13.8 % (Nannor, 1992) and 10.71 to 13.80 % (Supekar *et al.,* 2005). The value of carbohydrate content obtained in present investigation (72.22 %) was in agreement with the result obtained by Agarwal (1963).The result indicated that protein content of wheat *suji* was 12.60 %. The mean values for protein content for wheat cultivars reported by earlier researchers were 9.52 to 13.04 % (Austin and Nair, 1964; Aalami *et al.,* 2007). The values for fat content are in good agreement with Khan *et al.,* (1987) who reported crude fat in the range of 0.88 to 2.93 % in different wheat varieties. The crude fibre content was 0.38 %, which is in good agreement with the result obtained by Desai *et al*., (2010); Kulkarni *et al*., (2012) and Singh *et al*., (2005). The ash content of wheat is chiefly composed of minerals like phosphorus, calcium, iron and potassium. The ash content of wheat *suji* was found to be 0.95 %. The ash content of whole wheat flour ranged from 0.82 to 2.50 % (Adsule and Kadam, 1986). Aalami *et al*., (2007) reported that ash content of wheat semolina of different durum varieties varied from 0.79 to 0.86 %.

The iron content was (2.13 % mg) and the values for calcium content (18.56% mg) obtained were in agreement with the result recorded by Desai *et al*., (2010); Kulkarni *et al*., (2012) and Singh *et al*., (2005).

The wet and dry gluten content recorded were 39.40 % and 13.80 % respectively. The wet gluten content of Russian durum was in the range of 24.1 to 43.5% (Mustafar and Guseinov, 1973) and in Indian durum wheat it ranged from 35.3 to 52 % (Rao *et al.,* 1976). The recoveries of wet and dry gluten ranged from 22.2 to 39.2 % and 8 to 12.2 % respectively (Adsule *et al.,* 1985). Pharande *et al*., (1988 b) reported the values of wet and

dry gluten as 35.2 % and 11.9 % for N-8223, 30.0 % and 10.3 % for NI-5439 and 33.4 % and 11.0 % for N-59 cultivars of wheat respectively. Aalami *et al*., (2007) reported that wet gluten content of wheat semolina of different durum varieties varied from 25.2 to 34.4 %. The sedimentation value is based on the fact that gluten protein absorbs water and swells completely when treated with lactic acid. The sedimentation value of NIDW-295 was found to be 31 ml. Austin and Nair (1964) reported that the sedimentation values for Indian and foreign wheat cultivars in the range of 52 to 63 ml and 54 to 63 ml respectively. The sedimentation values reported were 15.8 and 14.5 ml for DWL-5023 and PBW-34 cultivars respectively (Singh and Paliwal, 1986). However, Ram *et al*., (2001) reported the sedimentation values of wheat, which ranged from 35 to 37 ml for 13 wheat lines from Durgapur and 29 to 58 ml for 13 wheat lines from Pantnagar. Pinckney *et al*., (1957) classified wheat flours on the basis of sedimentation value into four groups as 1st (60 and over), 2nd (40 to 59), 3rd (20 to 39) and 4th (less than 20). They reported that 3rd group wheat flour was suitable for the production of "all purpose" flour.

Chemical composition of finger millet flour

It was found that plain and malted finger millet variety *phulenachani* flours contained 13.57 and 12.45 mg/100 g irons respectively (Table 2). The iron content of finger millet ranged from 3.3 to 14.8 mg/100g (Babu *et al.*, 1987). Singh and Shrivastav (2006) reported that the iron content of 16 finger millet varieties ranged from 3.61 to 5.42 mg/100g. The calcium content was 335.40 and 397.67 mg/100g for plain and malted finger millet flours respectively. The finger millet contained calcium in the range of 162 to 487 mg/100g with mean 320.8 mg/100g (Vadivoo *et al.*, 1998), 329 mg/100g in white variety and 296 mg/100g in brown (Seetharam, 2001). Bhatt *et al*., (2003) reported 344 mg/100g calcium content in finger millet flour. The phosphorus content was 238.33 and 254.50 mg/100g for plain and malted finger millet flour respectively.

Table.1 Proximate composition of wheat flour

Proximate composition	Wheat (NIDW-295)
Moisture (%)	12.95
Carbohydrate (%)	72.22
Protein (%)	12.60
Fat (%)	0.90
Crude fibre (%)	0.38
Ash (%)	0.95
Iron (mg/100 g)	2.13
Calcium (mg/100 g)	18.56
Phosphorus(mg/100 g)	107.67
Wet gluten (%)	39.40
Dry gluten (%)	13.80
Sedimentation value (ml)	31.00

Table.2 Proximate composition of plain and malted finger millet flour

Proximate composition	*Ragi* (*PhuleNachani*)	Malted *Ragi* (*PhuleNachani*)
Moisture (%)	10.50	10.56
Carbohydrate (%)	77.23	78.93
Protein (%)	6.33	6.42
Fat (%)	1.08	1.14
Crude fibre (%)	3.15	3.36
Ash (%)	1.91	1.96
Iron (mg/100 g)	13.57	12.45
Calcium (mg/100 g)	335.40	397.67
Phosphorus(mg/100 g)	238.33	254.50

Table.3 Nutritional composition of vermicelli prepared with blends of wheat and malted finger millet flour

Treatments	Carbohydrate (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Iron (mg/100g)	Calcium (mg/100g)	Phosphorus (mg/100g)
T_0	76.93	11.97	0.86	2.80	0.36	1.88	15.02	104.18
T_1	77.32	11.35	0.88	2.90	0.66	2.91	53.92	118.85
T_2	77.74	10.73	0.91	3.00	0.95	3.74	91.83	133.56
T_3	78.19	10.12	0.93	3.11	1.24	4.95	129.75	148.21
T_4	78.64	9.50	0.96	3.20	1.56	6.00	166.78	162.90
T_5	79.08	8.88	0.98	3.31	1.85	7.03	204.57	177.58
Mean	**77.98**	**10.43**	**0.92**	**3.05**	**1.10**	**4.42**	**110.31**	**140.88**
SE +	**0.058**	**0.063**	**0.023**	**0.018**	**0.027**	**0.031**	**0.047**	**0.039**
CD at 5 %	**0.181**	**0.195**	**0.071**	**0.057**	**0.083**	**0.097**	**0.147**	**0.120**

Table.4 Sensory evaluation of vermicelli prepared with different blends of wheat and malted finger millet flour

Treatment	Colour and appearance	Texture	Flavour	Taste	Overall acceptability
T_0	8.75	8.00	8.00	8.75	8.50
T_1	8.00	7.75	7.50	8.00	8.00
T_2	7.75	7.50	7.25	7.75	7.63
T_3	7.50	7.25	7.00	7.50	7.38
T_4	7.00	7.00	6.75	7.25	7.13
T_5	6.75	6.75	6.50	6.75	6.88
Mean	**7.63**	**7.38**	**7.17**	**7.67**	**7.58**
SE +	**0.176**	**0.204**	**0.177**	**0.144**	**0.119**
CD at 5 %	**0.554**	**0.628**	**0.544**	**0.444**	**0.366**

Nutritional composition of Vermicelli

It was observed that with increased amount of processed finger millet flour upto 50 per cent there was increase in carbohydrate content of vermicelli from76.93 to 79.08 % (Table 3).It was observed that there was positive relation of carbohydrate content and inverse relation of protein content and levels of malted processed finger millet flour. The decrease in protein content from11.97 to 8.88 % in vermicelli was observed with increase in *ragi*flour. The decrease in protein content with vermicelli might be due to the lower protein content in malted finger millet flour compared to wheat. The mean increase in fat content from 0.86 to 0.98 % was observed with increase in *ragi* flour in wheat flour from 0 to 50 % and also ash content from 2.80 to 3.31 %. It was observed that there was positive relation of ash content and levels of malted finger millet flour. Shukla and Srivastav (2014) recorded carbohydrates (78.54 %), proteins (6.7 %), crude fat (1.15 %) and crude fibres (1.28 %) in noodles incorporated with 50 per cent finger millet flour. They reported increase in carbohydrates, fats and fibres while decrease in protein content of noodles with increased level of finger millet up to 50 per cent. The protein content gradually decreased from 16.3 to 11.3 % while fibre content marginally increased from 17.4 to 19.4 % with no significant difference in fat content for control and *ragi* incorporated vermicelli.

It was observed that with increased amount of malted finger millet flour up to 50 per cent resulted in increased iron content from 1.88 to 7.03 mg/100g in vermicelli. The mean increase in the calcium content was observed from 15.02 to 204.57 mg/100g with increased level of *ragi* flour with wheat flour. The increase in the phosphorus content was observed from 104.18 to 177.58 mg/100g with increased levels of malted finger millet flour. It was observed that there was direct relation of phosphorus content and levels of malted finger millet flour. Shukla and Srivastav (2014) recorded increased ash content (1.4 %), iron (5.5 mg/100g) and calcium (88.3 mg/100g) in noodles incorporated with 50 per cent finger millet flour. The ash content gradually increased from 1.06 to 1.46 per cent while fibre content marginally increased from 2.4 to 3.9 mg/100g for control and *ragi* incorporated vermicelli.

Shukla *et al.,* (1986) reported that total carbohydrate ranged from 73.7 to 83.1 % and 4.6 to 5.7 % protein in malted finger millet. Rao (1994) reported 8.2 and 11.3 % protein content in brown and white varieties of malted finger millet respectively. Hemanalini *et al.,* (1980) have reported that malted finger millet flour resulted in 32, 26 and 33% losses in calcium, phosphorous and iron respectively. Such losses have been observed, due to removal of seed coat of finger millet grains. Sprouted finger millet contained 323.85 mg calcium, 230 mg phosphorous and 5 mg iron. Ionisable iron (27.1 and 55%) and soluble zinc (81 and 25%) content increased significantly after malting, in brown and white finger millet (Rao, 1994). Mamiro *et al.,* (2001) reported that germination of finger millet for 48 h significantly increased the in vitro extractability of calcium, iron and zinc.

Sensory evaluation of vermicelli

The increased amount of malted finger millet flour up to 50 per cent, there was decrease in colour and appearance, texture, flavour, taste and overall acceptability which ranged from 8.75 to 6.75, 8.00 to 6.75, 8.00 to 6.50, 8.75 to 6.75 and 8.50 to 6.88 respectively (Table 4).

The vermicelli samples of (T_3 treatment 70:30) were more acceptable than other treatments and were comparable to control. Kulkarni *et al*., (2012) reported that noodles prepared with 30 per cent finger millet flour

and 70 % wheat flour combination had same sensory score as that of control and also higher values of protein, fibre and minerals than the control sample. Eneche (1999) observed that biscuits prepared using 65 per cent millet flour and 35 per cent pigeon pea meal blend were highly acceptable in sense of flavour, texture and general acceptability. Sahoo (2010) reported similar sensory score of cake samples prepared with wheat (malted) and finger millet flour (50:50).

In conclusion the use of finger millet in vermicelli improved the nutritional status of vermicelli with respect to crude fibre, iron and calcium content by four, three and six fold respectively by addition of *ragi* flour upto 30 % in wheat flour. This vermicelli was also more acceptable on the basis of sensory parameters.

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