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Research Paper

Development of calcium rich food products with finger millet malt (*Eleusine coracana* L.)

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■ **ABSTRACT :** Finger millet (*Eleusine coracana*) is rich in protein, iron, calcium, phosphorus, fibre and vitamin content. The calcium content is higher than all cereals. Finger millet is a versatile grain that can be used in many food preparations. Malting of finger millet improves its digestibility, sensory and nutritional quality as well as pronounced effect in lowering the antinutrients. Hence, the study was undertaken to develop calcium rich products with finger millet malt.In first phase of study finger millet malt was prepared and three products *viz.*, biscuits, *Pohe Papad* and vermcelli were selected for development. Finger millet malt was incorporatedat the levels of 0, 10, 20, 30, 40 in biscuits and 0, 10, 15, 20, 25 per cent in *Pohe Papad* and vermcelli along with soybean 20 per cent. Five variations of each product were prepared. Variation I was basic prepared without finger millet malt served as control sample and remaining four variations were experimental samples. In second phase of study all the products were organoleptically evaluated by panel members for their acceptability. The most accepted variation was selected for nutrient analysis. The proximate composition, fibre, calcium and iron were estimated in the laboratory. The results revealed that malted finger millet incorporation upto 30, 15 and 20 per cent in biscuits, *Pohe Papad* and vermcelli, respectively was accepted by panel members. Significant increase in values of nutrient *i.e.* protein, fibre, total mineral,iron and calcium was noticed in experimental variations of biscuits. Incorporation of finger millet malt in *Pohe Papad* and vermcelli could help to increase protein, fibre and calcium significantly. It can be concluded from the findings of the study that finger millet malt can be utilized successfully for development of calcium rich food product.

■ **KEY WORDS:** Finger millet malt, Calcium, Fibre, Protein

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Millet is a collective term referring to a number of small-seeded annual grasses that are cultivated as grain crops, primarily on marginal lands in dry areas in temperate, subtropical and tropical regions. The most important species are pearl millet, finger millet, prosomillet and foxtail millet. Finger millet [*Eleucine coracana* (L.) Gaertn.] is widely produced in the cooler, higher altitude region of Africa and Asia (International crop Research Institute for the semi-Arid Tropics/ FAO,1996).

Finger millet malt issuperior to other millet malts and it is ranked next to barley (Malleshi and Desikachar, 1986).Nutritionally, finger millet is good source of nutrients especially of calcium, other minerals and fibre. Total carbohydrate content of finger millet has been reported to be in the range of 72 to 79.5 per cent (Pore and Magar, 1979; Hulse *et al*., 1980; Joshi and Katoch, 1990 and Bhatt *et al*., 2003). Finger millet (*Eleusine coracana*), also known as *Ragi* is a good source of carbohydrate, protein, dietary fibre and minerals and an important staple food for people under low socio-economic group (Sripriya *et al*., 1997) and those suffering from metabolic disorders like diabetes and obesity (Mathanghi and Sudha, 2012). It is important because of its excellent storage properties and nutritive value (Shashi *et al.*, 2007). Its dietary fibre and mineral content is markedly higher than wheat, rice and fairly well balanced protein (Ravindran, 1991).

Malleshi and Desikachar (1986) reported that finger millet malt has highly agreeable flavour with adequate starch hydrolyzing enzymes. Malting of finger millet improves its digestibility, sensory and nutritional quality as well as has pronounced effect in lowering the antinutrients. The inherent qualities of finger millet make it superior compare to other cereals and also qualify for malting and preparation of malted foods. As it is resistant to fungal infection and elaboration of alpha and beta amylase during germination and during desirable aroma is developed during roasting/kilning makes it an ideal grain for malt foods. Mbithi *et al*. (2000) have also reported that the sulfur containing amino acids (methionine and cysteine) and lysine increased in finger millet during sprouting.

Although finger millet is a nutritionally important food item, there are no more food products in the market forconsumers. There is need to develop food products which have good self-life, ready to eat and easy to prepare such as biscuits, *Papad*, instant mixes, vermicelli etc. Hence, the present investigation was undertaken to formulate the calcium rich products using finger millet malt.

■ RESEARCH METHODS

Preparation of malted finger millet :

Finger millet was procured from local market for this study. The selected seeds were cleaned to remove dust, impurities and undersize seeds. The finger millet seeds were washed with water and soaked in water for 5 hr. Excess water was drained, seeds were tied in a muslin cloth and 5 kg weight was kept on it. These seeds were germinated at 27± 3ºC for 24hr and dried in shade for 2 days. The malted finger millet seeds were grounded into flour by using the electric grinder (Desai *et al.*, 2010). Finger millet powder was stored in air tight container for development of recipes and nutrient analysis.

Selection of level of incorporation :

Finger millet malt was incorporated at 10, 15, 20, 25, 30 and 40 per cent level in the selected recipes such as Biscuits, *Pohe Papad* and vermcelli along with soybean flour (20 %) to increase the protein content. Thus, five variations of each product were prepared for further sensory analysis. Variation one was basic recipe which was prepared without incorporation of finger millet and it served as control. Variations II to V were experimental variations with varying levels of incorporation of finger millet malt.

Organoleptic evaluation of prepared products :

The organoleptic evaluation was followed to find out the maximum level of incorporation of malted finger millet in developed food products.

Selection of panel members :

The sensory threshold test was carried out on 20 members to select panel members. Different concentrations of solutions for threshold test were prepared as described by Ranganna (1979) and were requested to evaluate the solution for strength of different tastes. Considering the accuracy in evaluation of taste, 15 panel members were selected out of 20 to act as judges for sensory evaluation of products.

Sensory evaluation :

The samples with different levels of incorporation of finger millet malt were prepared. All the selected panel members were requested to evaluate the developed food products. The judges were requested to score the recipes for different sensory characters namely colour, texture, taste, flavour and overall acceptability by using hedonic scale. Highly accepted variations were selected for further nutritional analysis.

Nutrient composition of malted finger millet flour and developed products :

Malted finger millet and recipes prepared without incorporation of malted finger millet and highly accepted variations were analyzed for proximate composition and mineral content. The nutrient analysis *viz.*, moisture, total mineral, fat, fibre was carried out by (AOAC, 1975) and protein was estimated by macrokjeldhal method. The carbohydrate content was calculated by NIN (1983) method. The calcium was estimated by EDTA (Ethylene Diamine Tetra Acetic Acid) method. The trace element, iron was estimated by atomic absorption spectrophotometer.

Statistical analysis :

The analysis of variance was followed for interpreting the differences between different variations for individual sensory characters. The statistical difference with regard to nutrient content of developed products prepared with and without incorporation of malted finger millet was tested by 't' test (Panse and Sukhantme, 1985).

■ RESEARCH FINDINGS AND DISCUSSION

The mean scores for organoleptic characteristic of biscuits prepared without and with varying levels of incorporation of malted finger millet are given in Table 1 the scores of sensory parameters ranges between 6.6 to 8.2 for 30 per cent incorporation of finger millet malt which was highly accepted by panel members. Statistical analysis showed that, there was significant difference in falvour and overall acceptability of products. In case of taste and texture statistically non-significant results observed.

Pohe Papad was prepared by adding 0 to 25 per cent finger millet malt and were evaluated for various sensory characteristics. The data pertaining to sensory scores are presented in Table 2. The finger millet malt incorporation upto 15 per cent in *Pohe Papad* were best accepted by panel members. Significant differences was noticed in all sensory parameters of *Pohe Papad* prepared with and without finger millet malt.

The mean values of organoleptic scores for the acceptability of vermicelli prepared without and with incorporation of finger millet malt are given in Table 3. Finger millet malt was incorporated in vermicelli from

Table 1 : Sensory scores of biscuit

Variations	Level of finger millet malt incorporation(%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavour	Overall acceptability
I	0	8.1	7.8	7.7	7.7	7.8
II	10	7.5	7.4	7.6	7.5	7.4
III	20	6.8	6.8	6.9	7.0	7.0
IV	30	6.6	7.6	8.2	8.2	7.6
V	40	6.0	6.6	6.6	6.3	5.8
C.D. (P=0.05)		1.0	1.1	1.1	1.1	1.1
S.E. ±		0.36	0.40	0.40	0.41	0.42
F-value		5.11*	1.46^{NS}	2.43^{NS}	2.96*	3.37*

NS=Non-significant * and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Sensory scores of *Pohe Papad*

Variations	Level of finger millet malt incorporation(%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavour	Overall acceptability
I	0	7.8	7.8	8.0	7.5	7.6
II	10	8.0	8.0	8.1	7.8	7.9
III	15	8.3	8.3	8.4	8.3	8.4
IV	20	7.6	7.3	7.6	7.3	7.2
V	25	6.6	6.5	6.9	6.8	6.7
C.D. (P=0.05)		0.67	0.95	0.84	0.75	0.91
S.E. ±		0.24	0.34	0.30	0.27	0.32
F-value		7.4*	4.0*	3.3*	4.4*	3.7*

NS=Non-significant * and ** indicate significance of values at P=0.05 and 0.01, respectively

0 to 25 per cent level. The finger millet malt incorporation upto 20 per cent in vermicelli was best accepted by panel members.Statistically significant differences was observed in all sensory parameters.

Findings regarding the organoleptic evaluation of products prepared under study were commonly used food products such as biscuits, *Pohe Papad* and vermicelli. It was prepared by utilizing finger millet malt. The organoleptic scores obtained by various food products with 15 to 30 per cent incorporation of finger millet malt indicated that finger millet malt can be utilized for development of food product.

The results of nutritional analysis of unmalted and malted finger millet is given in (Table 4). The processing influenced the nutrient content of finger millet. Malted finger millet contained slightly more amount of moisture, protein, fibre, fat as compared to unmalted finger millet whereas, total mineral and calcium increased significantly. The calcium content increased from 350 to 400 mg/100g. It is reported that during malting process calcium content increases whereas iron content decreases (Sangita and Sarita, 2000) which are accordance with the estimated values in the present study. Rao (1994) also found that malting decreases tannin, phytinphosphours *i.e.* reduced antinutritional factors from raw finger millet. Eipeson *et al.* (2007) concluded malting improves the bio-accessibility of iron and manganese of finger millet. Malleshi and Desikachar (1986) noticed that the malting process was useful to increase the calcium, phosphorus and vitamin C content of finger millet flour. Malting of finger millet improves digestibility and bioavailability of nutrients, improves sensory and nutritional quality.

The nutrient analysis of developed variations showed that addition of malted finger millet and soybean could increase the nutrient content of the developed products. The nutritional composition of biscuits developed by incorporation of finger millet malt and soybean is recorded in Table 5. Biscuits with addition of finger millet malt and soybean depicted that significant increase in values of nutrient *i.e.* protein, total mineral, fibre, iron and calcium.The calcium content increased from 80 to 249 mg/100g. It can be said that addition of malted finger millet and soybean in biscuits is beneficial to increase nutrient composition of the diet. Selvaraj *et al.* (2002) concluded that biscuits prepared

Table 3 : Sensory scores of *vermicelli*

Variations	Level of finger millet malt incorporation(%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavour	Overall acceptability
I	0	7.5	8.0	8.0	8.3	8.4
II	10	7.5	7.0	7.3	7.0	7.2
III	15	7.3	7.4	7.7	7.2	7.6
IV	20	7.5	8.2	8.2	8.4	8.4
V	25	6.0	6.5	6.5	6.7	6.4
C.D. (P=0.05)		0.83	0.67	0.65	0.71	0.60
S.E. ±		0.30	0.24	0.23	0.25	0.21
F-value		4.86*	8.10*	7.81*	9.26*	14.6**

NS=Non-significant * and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 4 : Nutrient composition of unmalted and malted finger millet flour

Nutrients	Unmalted finger millet flour	Malted finger millet flour	't' value
	Mean ± SD	Mean ± SD	
Moisture (g/100g)	12.72 ± 0.05	12.76 ± 0.1	0.61^{NS}
Protein (g/100g)	7.26 ± 0.23	7.45 ± 0.45	0.65^{NS}
Fat (g/100g)	1.24 ± 0.05	1.31 ± 0.02	0.06^{NS}
Fibre (g/100g)	3.5 ± 0.057	3.9 ± 0.1	0.85^{NS}
Total mineral (g/100g)	2 ± 0.06	2.5 ± 0.06	9.79*
Carbohydrate (g/100g)	73.28 ± 0.02	72.08 ± 1	2.07^{NS}
Iron (mg/100g)	3.38 ± 1	3 ± 0.86	0.49^{NS}
Calcium (mg/100g)	350 ± 5	400 ± 5	12.24**

NS=Non- significant * and ** indicate significance of values at P=0.05 and 0.01, respectively

with incorporation of finger millet had good keeping quality. So it can be used as ready-to-eat food product.

Nutritional composition of *Pohe Papad* with addition of malted finger millet and soybean presented in (Table 6) showed that significant increase in values of nutrients *viz.*, protein, fibre, carbohydrate and calcium. The calcium content increased from 21 to 130 mg/100g. Moisture, fat and total mineral content were non significant. Saikrishna (2011) reported that use of finger millet flour enhances the dietary fibre and mineral content.

In (Table 7) depicted that addition of malted finger millet along with soybean elevated the nutrient content of vermicelli with particular reference to protein, fibre, fat and calcium.The calcium content increased from 45 to147mg/100g. In case of vermicelli moisture, total mineral, iron content was statically non-significant. Mushtari Begum *et al*. (2003) suggested vermicelli developed with incorporation of finger millet for diabetic person. Kulkarni *et al*. (2012) reported that with 30 per cent level of incorporation of malted finger millet was accepted in noodles. Protein was increased

Table 5 : Nutrient composition of biscuits

Nutrients	Control	Accepted variation	't' value
	Mean ± SD	Mean ± SD	
Moisture (g/100g)	5.2 ±0.4	6.8 ±0.2	6.19*
Protein (g/100g)	11.84 ±0.8	16.63 ±0.7	7.80*
Fat (g/100g)	31.4±0.4	34.05 ±1	4.26^{NS}
Fibre (g/100g)	1±0.5	3.1 ±0.3	6.23*
Total mineral (g/100g)	1±0.15	2.2 ±0.1	11.52**
Carbohydrate (g/100g)	59.08±0.92	37.22 ±2.78	2.93^{NS}
Iron (mg/100g)	2.6 ± 0.4	4 ± 0.3	4.84*
Calcium (mg/100g)	80.07±1.03	249.± 25.5	52.35**

NS=Non-significant * and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 6 : Nutrient composition of *Pohe Papad*

Nutrients	Control	Accepted variation	't' value
	Mean ± SD	Mean ± SD	
Moisture (g/100g)	4.63 ± 0.35	5.3 ± 0.02	3.31^{NS}
Protein (g/100g)	6.2 ± 1.03	15.5 ± 0.4	14.41**
Fat (g/100g)	20 ± 2	22 ± 2	1.22^{NS}
Fibre (g/100g)	1.03 ± 0.15	1.9 ± 0.1	8.35*
Total mineral (g/100g)	1.7 ± 0.3	2.2 ± 0.1	2.73^{NS}
Carbohydrate (g/100g)	66.44 ± 2	53.1 ± 2	8.16**
Iron (mg/100g)	19 ± 1	16 ± 0.5	4.64*
Calcium (mg/100g)	21 ± 2	130 ± 5	35.05**

NS=Non- significant * and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 7 : Nutrient composition of *vermicelli*

Nutrients	Control	Accepted variation	't' value
	Mean ± SD	Mean ± SD	
Moisture (g/100g)	30.46 ± 1.19	31.84 ± 1	1.53^{NS}
Protein (g/100g)	12.59 ± 0.6	14.89 ± 0.31	5.89*
Fat (g/100g)	7.9 ± 0.1	9.4 ± 0.5	5.09*
Fibre (g/100g)	0.6 ± 0.1	1.7 ± 0.2	8.52*
Total mineral (g/100g)	0.9 ± 0.1	1.4 ± 0.2	3.87^{NS}
Carbohydrate (g/100g)	52.45 ± 0.9	40.77 ± 0.2	21.94**
Iron (mg/100g)	3.7 ± 0.4	3.6 ± 0.4	0.30^{NS}
Calcium (mg/100g)	45 ± 5	147 ± 6	22.62**

NS=Non- significant * and ** indicate significance of values at P=0.05 and 0.01, respectively

significantly in majority of accepted products with incorporation of finger millet along with soybean than the control products. This indicated that the all experimental products were better source of protein than control samples.

The difference in the calcium content of the products with and without incorporation of malted finger millet is highly significant. As finger millet is very rich in calcium, its incorporation in the products helped to elevate the calcium content of products by six folds. Availability of more calcium for slowing down of bone resorptionand enhancement of bone reabsorption, increases the co-efficient of bone density. Calcium deficiency leading to bone and teeth disorders and iron deficiency leading to anemia can be surmounted by introducing finger millet in daily diet of elderly.

Finger millet is rich in calcium and increases the bioavailability of minerals. Hence, finger millet malt utilization for value addition is more beneficial. Swant *et al*. (2012) suggested finger millet for value addition as finger millet is rich source of calcium.These products can be suggested for their nutrient content which will helpful for reducing bone and health problems. Protein and calcium content are critical component for maintaining bone density. Protein deficiency may be predisposing factor in osteoporosis.

Conclusion :

It is concluded that 30 per cent level of incorporation of finger millet malt in biscuits and 15, 20 per cent level of incorporation of finger millet malt in *Pohe Papad* and vermicelli, respectively were most accepted level of incorporation which helped to increase the protein and calcium content. Incorporation of malted finger millet malt along with soybean 20 per cent increased nutrient content such as protein, fibre and calcium in developed products. Therefore, finger millet malt can be utilized for development of calcium rich food products which will be helpful to reduce bone problems, with addition of soybean, protein content increased so these products are also helpful to reduce the protein deficiency.

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