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NUTRIENT ENRICHMENT OF LITTLE MILLET (*Panicum miliare*) FLAKES WITH GARDEN CRESS SEEDS

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ABSTRACT

Little millet (*Panicum miliare*) is one of the nutritious minor millet. Garden cress seed was blended with little millet at 5 per cent to prepare iron enriched little millet flakes. Addition of garden cress seeds significantly increased iron content in Millet Garden Cress seed (MGC) flakes by 7.18 per cent and recorded 65.83 mg iron per 100 g of flakes compared to control little millet flakes (61.42 mg/100g). Protein content of MGC flakes was 13.15 per cent and fat content was 114.28 per cent higher than control millet flakes. However, MGC flakes recorded significantly lower total carbohydrates (64.53%) and total dietary fiber (22.70%) than control millet flakes (66.14 and 24.10%). Both the flakes recorded zero *trans* fats. Iron enriched flakes exhibited a shelf life of five months whereas control flakes were acceptable for more than six months.

Keywords: Little millet, Garden cress seeds, flakes.

INTRODUCTION

Millets are a group of small seeded species of cereal crops, widely grown around the world for food, feed and fodder. Little millet (*Panicum miliare*) is one of the nutritious but neglected crops grown in both plains and hilly regions. Studies have indicated promising potentials of millets such as sorghum, barley, kodo, proso and foxtail millet for successful extrusion technology for Ready To Eat (RTE) foods (Berglund *et al.*, 1994, Celis *et al.*, 1996, Ferriola and Stone, 1998, Singh *et al.*, 2004 and Singh *et al.*, 2006). In recent times in food industries value addition has become an important way of increasing the market value of foods using several ingredients for their nutrient or nutraceutical components. *Lepidium sativum* L. or garden cress seed is a special seed used in special food preparations given to girls at menarche and after delivery in traditional Indian foods. It is rich in iron (100 mg/100g) and also contains several nutraceutical components. The seeds possess fair levels of protein (22.50%), fat (27.50%), dietary fiber (30.00%) and calcium (0.377 %) and thus an important nutraceutical grain for nutrient enrichment (Sood and Sharada, 2002). Trial was conducted to develop MGC-RTE flakes by adopting conventional extrusion technology.

MATERIAL AND METHODS

Dehulled little millet and garden cress seeds used in the investigation were procured in bulk from local market. The millet grains were manually sorted by sedimentation in water to remove the chaff and sandy particles and dried in oven at 60 ± 5ºC. The grains thus processed were stored in cold storage (4ºC) for further analysis and processing. Garden cress seeds were cleaned from foreign material and stored in polyethylene bags for further use.

Conventional batch processing methods were followed for the development of MGC-RTE little millet flakes. The tempered grains were subjected to controlled partial gelatinization in steam under pressure of 20 to 24 lbs/psi for 20 minutes, followed by air cooling to surface dryness. The garden cress seeds were mixed with partially gelatinized little millet grains at 5 per cent level and the grains were then passed through a roller with a gap of 0.25 mm to press the grains into flakes. The rolled flakes were dried under sun optimally and extruded in single screw extruder. The extruded strands were cut into grits that were dried in shade for 4 to 8 h and rolled. The rolled flakes were toasted to procure value added Millet Garden Cress seed (MGC) RTE flakes. The control RTE little millet flakes was processed similarly without garden cress seeds.

The nutrient composition was analysed by standard procedures (Anon., 1990). Dietary fiber was estimated by following the method of Asp. *et.al.* (1983), whereas *trans* fatty acid content was estimated by using gas chromatographic method (Anon., 1990). The RTE flakes were evaluated with warm skimmed milk for sensory quality by semi trained panel members of Rural Home Science College, University of Agricultural Sciences, Dharwad. A nine point hedonic scale was used to evaluate the flakes. Acceptability Index was calculated by calculating the percentage. For storage quality analysis,

the samples were packed in unit packs in metallized polyester polyethylene pouches, heat sealed and stored in cardboard boxes at ambient temperature of 24.30 to 27.48°C and relative humidity of 58.55 to 83.00 per cent. The storage quality was evaluated in terms of sensory quality, moisture uptake, and peroxide value, at initial and final day of storage. Paired t test and F test were applied to evaluate sensory profile and storage quality of flakes.

RESULTS AND DISCUSSION

Nutrient composition of little millet is presented in Table 1. It was observed that little millet was a rich source of dietary fiber (15.80 %) and total minerals (0.39 %). It also recorded good amount of protein (7.45%) however, contained lower carbohydrate (64.87 %) contents.

Table 1 - Nutrient composition of dehulled little millet

Nutrients (%)	Dehulled little millet
Moisture	10.00
Protein	7.45
Fat	1.49
Total carbohydrates*	64.87
Total minerals	0.39
Total dietary fiber	15.80
Soluble dietary fiber	5.30
Insoluble dietary fiber	10.50
Energy (Kcal)*	303
Calcium(mg)	22.02
Iron(mg)	8.18
Copper(mg)	0.19
Zinc(mg)	3.40
Manganese(mg)	0.17

* Computed values

Data in Table 2 depicts the nutrient composition of value added, MGC flakes in comparison with control flakes. Addition of garden cress seeds significantly increased the iron content by 7.18 per cent and recorded 65.83 mg iron per 100 g of MGC-RTE flakes. Iron content of control millet flakes was 61.42 mg/100g. One serving (30 g) of MGC-RTE flakes provided 19.75 mg of iron which could provide more than about 40.00 and 65.00 per cent of suggested recommendations for different population groups of males and females, respectively. The increase in iron content was marginal compared to control flakes; this could be due to the partial adherence of garden cress seeds during rolling process, leading to loss of the nutraceutical ingredient in further processing.

Table 2 - Nutrient composition of control and MGC- RTE flakes

Nutrients (%)	Control- *RTE* little millet flakes		MGC RTE flakes		Per cent change over control
	Per 100 g	Per serving (30 g)	Per 100 g	Per serving (30 g)	
Moisture	1.45	0.44	3.06	0.92	111.03
Protein	7.45	2.24	8.43	2.53	13.15
Fat	0.14	0.04	0.30	0.09	114.28
Total carbohydrates*	66.14	19.84	64.53	19.36	-2.43
Total minerals	0.72	0.22	0.98	0.29	36.11
Total dietary fiber	24.10	7.23	22.70	6.81	-5.81
Soluble dietary fiber	6.50	1.95	5.00	1.50	-23.08
Insoluble dietary fiber	17.60	5.28	17.70	5.31	0.57
Energy(Kcal)*	296	89	295	89	-0.34
Calcium (mg)	29.30	8.79	29.30	8.79	0.00
Iron (mg)	61.42	18.42	65.83	19.75	7.18
Copper (mg)	0.29	0.09	0.37	0.11	27.58
Zinc (mg)	2.76	0.83	2.61	0.78	-5.43
Manganese (mg)	0.29	0.09	0.30	0.09	3.45
Trans-fats (%)	0.00	0.00	0.00	0.00	0.00

*Computed values

The RTE little millet flakes recorded moisture of 1.45 per cent. Addition of garden cress seeds significantly increased the protein and fat contents of MGC-RTE flakes (8.43% and 0.30%) compared to control RTE flakes (7.45% and 0.14%) by 13.15 per cent and 114.28 per cent, respectively. However, MGC-RTE flakes recorded significantly lower total carbohydrates (64.53%) and total dietary fiber (22.70%) contents than control RTE millet flakes (66.14 and 24.10%). Total mineral content of MGC-RTE flakes was significantly high of 0.98 g/100 g as against a low of 0.72 g/100g in control. The calorific value was 295 Kcal/100g. Copper and manganese contents were

significantly high of 0.37 and 0.30 mg/100g respectively than control RTE flakes. *Trans* fats are indicted in several metabolic disorders (Hayakawa *et al.*, 2000). However, both the flakes were free from *trans* fatty acids, as recorded 0.00 per cent each.

MGC- RTE flakes were although as acceptable as control RTE millet flakes (Table 3), aroma was rated low, could be due to the sharp flavour of benzyl derivatives of garden cress seeds (Macleod and Islam, 1976). However the product recorded a score of 6.50 indicating the product quality between 'moderately good' and 'very good' for aroma attribute.

Table 3 - Mean sensory scores# of control and value added MGC RTE flakes

Attributes	Control- RTE little millet flakes	MGC *RTE* flakes	't' value
Colour and appearance	7.66	7.16	1.34^{NS}
Taste	7.83	7.00	1.88^{NS}
Texture	7.83	7.25	1.50^{NS}
Aroma	7.25	6.50	1.96^{NS}
Over all acceptability	7.50	6.91	1.26^{NS}
Mean total score	38.07	34.82	-
Acceptability index	84.6	77.37	-

- Scores (Nine point hedonic scale, 9- Excellent, 8- Extremely good, 7- Very good, 6- Moderately good, 5- Good, 4- Fair, 3-Very fair, 2- Poor, 1- Very poor), NS- Non significant, MGC Flakes - Millet Garden Cress seeds Flakes

Effect of storage on control RTE millet flakes is presented in Table 4. The fresh RTE little millet flakes were rated high for colour and appearance (7.66), taste (7.83), texture (7.83), aroma (7.25) and over all acceptability (7.50), with mean total score of 38.07 and acceptability index of 84.60. But with increase in storage period the scores significantly (P≤0.05) decreased in all the attributes except for colour and appearance. Thus, little millet flakes were found acceptable even at the end of storage period of six months. Whereas, MGC-RTE flakes (Table 5) were acceptable till end of 5th month of storage with good sensory scores and turned unacceptable with respect to taste, texture, aroma and overall acceptability by the end of 6th month of storage period.

Table 4 - Effect of storage on organoleptic scores# of control - RTE little millet flakes

Storage period (months)	Colour and appearance	Taste	Texture	Aroma	Over all acceptability	Mean total score	Acceptability index
0	7.66	7.83^{a}	7.83^{a}	7.25^{a}	7.50^{a}	38.07	84.6
1	7.66	7.25^{ab}	7.42^{a}	7.17^{a}	7.33^{a}	36.83	81.84
2	7.66	7.16^{ab}	7.75^{a}	7.00^{ab}	6.83^{ab}	36.40	80.88
3	7.33	6.50^{bc}	7.25^{a}	6.33^{bc}	6.42^{b}	33.83	75.17
4	7.34	6.58^{c}	7.00^{ab}	6.33^{bc}	6.33^{b}	33.58	74.62
5	7.16	5.91^{cd}	6.33^{b}	6.17^{c}	6.25^{b}	31.82	70.71
6	7.42	5.41^{d}	5.17^{c}	5.25^{d}	5.41^{c}	26.01	57.80
F value	0.86^{NS}	13.52*	9.53*	13.25*	14.94*	-	-
CD	-	0.79	0.85	0.75	0.72		

- Scores (Nine point hedonic scale, 9- Excellent, 8- Extremely good, 7- Very good, 6- Moderately good, 5- Good, 4- Fair, 3-Very fair, 2- Poor, 1- Very poor), *P ≤ 0.05, Values in the same column bearing different superscripts are significantly different. NS- Not significant

Table 5- Effect of storage on organoleptic scores# of MGC-RTE flakes

Storage period (months)	Colour and appearance	Taste	Texture	Aroma	Over all acceptability	Mean total score	Acceptability index
0	7.17^{a}	7.00^{a}	7.25^{a}	6.50^{a}	6.92^{a}	34.84	77.42
1	7.00^{a}	6.42^{a}	7.00^{a}	6.42^{a}	6.33^{a}	33.17	73.71
2	7.00^{a}	6.42^{a}	6.58^{ab}	6.25^{a}	6.67^{a}	32.92	73.15
3	6.92^{a}	6.33^{a}	6.58^{ab}	6.00^{a}	6.33^{a}	32.16	71.46
4	7.00^{a}	6.08^{a}	6.00^{b}	6.17^{a}	6.25^{a}	31.50	70.00
5	6.75^{a}	6.25^{a}	6.08^{b}	6.17^{a}	6.17^{a}	31.42	69.82
6	5.17^{b}	4.50^{b}	4.75^{c}	4.58^{b}	4.25^{b}	23.25	51.66
F value	4.80*	5.05*	6.75*	3.83*	6.65*	-	-
CD	0.89	0.97	0.89	0.93	0.94	-	-

- Scores (Nine point hedonic scale, 9- Excellent, 8- Extremely good, 7- Very good, 6- Moderately good, 5- Good, 4- Fair, 3-Very fair, 2- Poor, 1- Very poor), *P≤0.05, Values in the same column bearing different superscripts are significantly different, MGC Flakes - Millet Garden Cress seeds Flakes

The moisture content of control RTE millet flakes increased by 250 per cent whereas MGC-RTE flakes by 122 per cent by the end of sixth month. Both the flakes recorded 0.01 per cent each free fatty acids at the end of sixth month of storage (Data not shown in tables) Uptake of moisture, lipid and iron contents could have triggered the auto oxidation of lipids in MGC-RTE flakes and restricting the shelf life to 5 months.

Thus, development of iron enriched value added ready-to-eat little millet flakes was successful as this MGC-RTE flake provided fair amounts of iron (19.75mg %) along with appreciable amounts of protein (8.43%), fiber (22.70%) and total minerals (0.98%).

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