RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 11 | Issue 2 | October, 2018 | 346-352
ISSN–0974–2662 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/11.2/346-352**

Development and standarization of *Kharodi* fortified with *Ragi* flour

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Received : 26.07.2018; **Revised :** 21.08.2018; **Accepted :** 07.09.2018

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■ **ABSTRACT :** Present work have been undertaken to develop and standerize the *Ragi* fortified *Kharodi*. The *Kharodi* is prepared from pearl milet with fortitfication of *Ragi*. Four treatment were used with sample code T_0 (100-00), T_1 (70-30), T_2 (60-40) and T_3 (50-50) *i.e.* 30, 40 and 50 per cent are the per cent of the fortification. The prepared *Ragi* fortified *Kharodi* was evaluated for the its sensory acceptability using 9 point hedonic scale. It was found that treatment T_1 containing 30 per cent *Ragi* fortified in *Kharodi* got highest score as compare to other treatments. Hence this preparation was used for further study of nutritional analysis and its found better result. It was concluded that from the research *Ragi* fortified *Kharodi* sample T_1 containing 30 per cent of *Ragi* flour was most desirable in terms of sensory and nutritional quality profile.

■ **KEY WORDS :** *Kharodi*, Sensory evolution, Pearl millet, Ragi

■ **HOW TO CITE THIS PAPER :** Netke, V.J., Bornare, D.T., Vairagar, P.R. and Babar, K.P. (2018). Development and standarization of *Kharodi* fortified with *Ragi* flour. *Internat. J. Agric. Engg.*, **11**(2) : 346-352, **DOI: 10.15740/HAS/IJAE/11.2/346-352.**

Kharodi is Indian traditional product, mostly prepared in Maharashtra. *Kharodi* is generally prepared from pearl millet (*Bajra*). India is the largest pearl millet producer in the world. *Kharodi* is the major source of micro nutrients. It contain high amount of calcium and iron.The preparation of *Kharodi* generally pearl millet is used. Garlic, oil, sesame, salt are used in the prepration of *Kharodi*. *Kharodi* mostly prepare in rural area. It don't need to fry before eating that's why it have additional health benefit. In here prepration of *Kharodi* there are two millets (Pearl millet, Finger millet) used for the prepration of *Kharodi*. Finger millet (*Ragi*) have an more nutritional components compare other millet. The *Ragi* fortified *Kharodi* is more beneficial than traditional *Kharodi*. *Ragi* fortified *Kharodi* is the protein rich. Calcium content of *Ragi* is higher than all cereal.

Millets are a group of small seeded species of cereal crops, widely grown around the world for food and fodder. The group includes millets such as little millet (*Panicum miliare*), foxtail millet (*Setaria italica*), kodo millet (*Paspalum scrobiculatum*), common millet (*Panicum miliaceum*), barnyard millet (*Echinochloa frumentacea*), pearl millet (*Pennisetum glaucum* L.) and finger millet (*Elusine coracana*).

The millets have immense production potential with minimum inputs. Millet is one of the most important droughtresistant crops and the sixth cereal crop in terms of world agriculture production. Millet is widely grown in the semiarid tropics of Africa and Asia and constitutes a major source of carbohydrates and proteins for people living in these areas (Saleh *et al*., 2013). Traditional food processing methods play an important role in the utilization

of locally raw materials. These methods are minimal processing techniques which produce product with good quality and more nutrient retention. Traditionally developed products also facilitate consumption of cereals in more natural form and have long shelf-life. Introduction of ready-to-eat (RTE) breakfast cereals has revolutionized man s breakfast to represent the modern convenience foods because of their appearance, colour, flavour, visual texture, eating qualities, crispiness etc. The higher proportion of cereals that too in refined form deprive population with deficiencies related to quality protein, essential fatty 2 acids, fibre, micronutrients including vitamins, minerals and antioxidants.

Cereals have come to be recognized by person in all walks of life as economical, convenient, flavorful dry foods suitable for human consumption for all age groups in India. Millet is a generic term used for small sized grains that form heterogeneous group and referred as "coarse cereals". Among the food crop, millets are one of the oldest food group known to humans and probably the first grain used for cultivation purposes. India is the largest pearl millet growing country, contributing 42 per cent of total world production (Anonymous, 2007). Millet is one of the most important drought-resistant crops and the 6t cereal crop in terms of world agriculture production. They have substantive potential in broadening the genetic diversity in the food basket and ensuring improved food and nutrition security (Mal *et al*., 2010). Each millet is three to five times nutritionally superior to rice and wheat in terms of protein, mineral, vitamin, zinc, calcium, magnesium content and nutraceuticals. Along with nutrition, millets offer health benefits in daily diet and help in the management of disorders like diabetes mellitus, obesity, hyperlipidemia, etc.

METHODOLOGY

Ingredients :

The ingredients like Pearl millet Flour, Finger Millet Flour, sorghum flour and other minor ingredients like salt, oil, sesame seed etc. were purchased from local market of Aurangabad.

Physical properties of millets :

The knowledge of physical properties such as thousand grain weights, bulk density, true density, porosity, conveying, drying, aeration of grains is necessary for the effective and proper design of various separating, handling, storing and drying systems (Sahay and Singh, 1994; Tabatabaeefar, 2000). Therefore, in designing the proper equipment for the processing, transportation, separation and storing of the grains, it is necessary to have reliable data about the physical properties of millets.

Thousand Kernel weight :

Thousand kernel weight was determined by taking 1000 kernels of pulses and taking its weight.

Bulk density :

The bulk density was measured by pouring seeds into a stainless steel cylinder of known volume and removing excess seeds by rolling a cylindrical glass rod on the rim of the container without compacting the seeds (Carman, 1996 and Konak *et al*., 2002).

True density :

True density was determined as the ratio of sample mass to the true volume of theseeds using the toluene displacement method (Nimkar and Chattopadhyay, 2001; Aydin, 2002 and Konak *et al*., 2002).

Porosity :

The porosity, ε was calculated using following equation (Mohsenin, 1986)

$$£= 1- pb\ pt$$

where, pband and ptare are bulk and true density, respectively in kgm^{-3}.

Angle of repose :

It is the steepest angle between the base and slope of cone formed on a free vertical fall of grain mass to a horizontal plane when material is free falling or sliding. It was determined by making a circular pile of the grains freely falling. The height of the pile was taken (h) and its radius (r) is also taken. Angle of repose was then calculated by following formula. Angle of repose was determined using a method described by Mohsenin (1986).

$$\text{Angle of repose } (¤) = \tan^{-1} (h/r)$$

Compositional analysis of sorghum flour :

The sorghum flour was used for the estimation of moisture, fat, protein, ash, fibre and carbohydrate was by using standard procedures (AOAC, 2005) as referred below.

Moisture content :

Moisture content was determined by using hot air oven drying method. 10 g of sorghum flour sample of each material was taken in pre-weighed empty Petri plate and dried in hot air oven at 105^{0}C till constant weigh were obtained (6-7 hrs.). Then plates were cooled in desiccators. The moisture content was calculated by using formula.

$$\% \text{ moisture content} = \frac{\text{Final weight – Intial weight}}{\text{Weight of sample}} \times 100$$

Fat content :

The sample sorghum flour was transferred to a thimble paper and the top of the thimble was plugged with cotton. The thimble was next placed in the fat extraction chamber of the Soxhlet apparatus. A previously weighed flask was filled with solvent e.g. hexane and was attached to the extraction chamber. The condenser was attached to the assembly. Extraction was carried out at proper temperature for 5 hrs. The excess hexane was recovered by boiling it further. Then the flask was dried and the weight was recorded. Formula for calculation of fat content by using Soxhlet apparatus method.

$$\% \text{ fat content} = \frac{\text{Final weight of beaker – Empty weight of beaker}}{\text{Sample weight}} \times 100$$

Protein content :

The determination of protein content was carried out by Kjeldhal's method using 5 g of sorghum flour sample. The Kjeldhal methods based on wet combustion of the sample by heating with concentrated sulphuric acid in the presence of metallic other catalysts to effect the reduction of organic nitrogen in the sample to ammonia which retained in solution as ammonium sulphate. Then digested sample was distilled with NaOH and titrated with 0.1 N HCl. The percentage of nitrogen of was calculates by using following formula.

$$\% \text{ nitrogen} = \frac{\text{(Sample titre - Blank titre) x N of HCl x Volume of digest}}{\text{Weight of sample x Aliquot of the digest}} \times 100$$

Protein content = % Nitrogen × 6.25

Ash content :

About five g of the powder sample was accurately weighed into a pre-weighed silica crucible. It was then carbonized in silica crucible on burner followed by heating at about 600°C for 6 hrs in the muffle furnace to get complete white coloured ash, allowed to cool in the furnace. Then the crucible was transferred to a desiccator and weighed as possible to prevent moisture absorption. The ash was calculated using following formula.

$$\% \text{ ash content} = \frac{\text{Weight before ashing - Weight after ashing}}{\text{Weight of sample}} \times 100$$

Fibre content :

Fibre estimation carried with the help of muffle furnace. Moisture and fat free sorghum flour sample (2 g) digested with 200ml of 1.25 per cent H_2SO_4 by gentle boiling for half an hour. The contents filter and the residue washed several times with hot distilled water till it became free from acid. Acid free residue then transferred to the same flask to which 200 ml of 1.25 per cent NaOH is added. The contents digested again for half an hour, filtered it and residue was again washed with hot distilled till it became alkali free. The residue dried in an oven overnight at 100ºC and weighed and then placed in muffle furnace at 600ºC (±50ºC) for 4 hours. The loss in weight after ignition the sample represents the fibre in the sample.

$$\% \text{ fibre content} = \frac{\text{Initial weight - Loss in weight of sample}}{\text{Initial weight of sample}} \times 100$$

Carbohydrate content :

Carbohydrate was calculated by difference by using following formula.

% Carbohydrate content = 100 - (% Moisture + % Ash + % Fat + % Protein)

Storage studies :

The prepared product *Kharodi* were packed in High density polyethylene (HDPE) and microbial analysis were carried out.

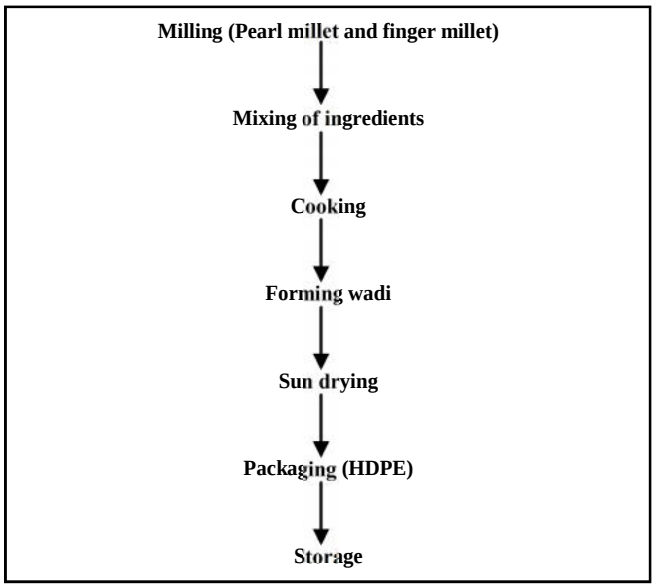
Composite flour formulation for preparation of *Kharodi* :

In order to formulate the recipe of composite flour for preparation of *Kharodi* with enhanced nutritional quality, different preliminary trials were carried out followed by information sensorial evaluation of product. Hence, on the basis on preliminary trials, following recipes were finalized for experimentation.

Table A : Different formulation of composite flour used for the standardization of *Kharodi*

Flour	Composition of composite flour			
	T_0	T_1	T_2	T_3
Pearl millet	100	70	60	50
Finger millet	0	30	40	50

Flow chart for development of *Kharodi* :



RESULTS AND DISCUSSION

The proximate analysis of Pearl millet flour were found to contain moisture content (11.21%), fat (5.14%), protein (10.97%), crude fibre (2.07%), carbohydrate (68.85%) and ash (2.05%) as depicted in Table 1. The results were in close agreement to the results obtained by Kulthe *et al.* (2016). The proximate analysis of Finger millet flour were found to contain moisture content (11.6%), fat (1.07%), protein (7.30%), crude fibre (3.21%), carbohydrate (74.47%) and ash (1.48%) as depicted in Table 1. The results were in close agreement to the results obtained by Karnika *et al.* (2016).

Effect of pearl and finger millet flour on physico-chemical characteristics of *Kharodi* :

The physico-chemical characteristics of pearl and finger millet added *Kharodi* were found to contain pH, acidity, moisture content (%), fat (%), protein (%), carbohydrates (%) and ash (%) Table 1. The graphical representation of the above table is presented in Fig 1.

Table 1 : Proximate analysis of pearl and finger millets flour

Parameter (%)	Pearl flour	Finger flour
Moisture	10.9	13.0
Fat	5.12	1.9
Protein	11.4	8.6
Crude fibre	2.2	3.6
Ash	2.5	2.4
Carbohydtres	67.88	70.50

*Each value represents the average of five determination

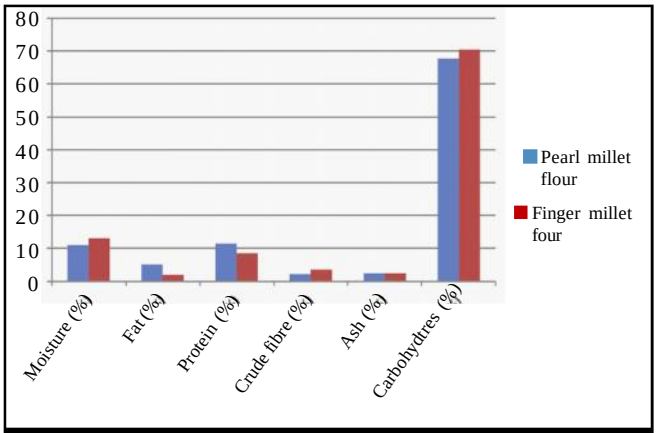


Fig. 1 : Proximate analysis of pearl and finger millets flour

Table 2 : Physical parameter of pearl and finger millet

Parameter	Pearl millet	Finger millet
Thousand kernal weight (g)	10.30	2.48
True density (kg/m^3)	1.315	1.12
Bulk density (kg/m^3)	0.842	2.75
Porosity (%)	48.30	49.6
Angle of repose	$28^0 8'$	18^0

*Each value represents the average of five determination

Table 3 : Minerals content of pearl and finger millet

Minerals (mg/100g)	Pearl millets	Finger millets
Calcium	45	3.1
Iron	8.2	342
Phosphorus	273	281
Zinc	4.1	2.4

*Each value represents the average of five determination

Sensory evaluation of *Kharodi* :

The sensorial quality characteristics of pearl and finger millet based *Kharodi* play a vital role in attracting consumers to purchase the product. Consumer judges pearl and finger millet based *Kharodi* quality on the basis of its sensory parameters such as color, flavour, texture,

Table 4 : Effect of pearl and finger millet flour on physico-chemical characteristics of *Kharodi*

Sample	Chemical parameters								
	Moisture (%)	Protein (%)	Fat (%)	Carbohydrates (%)	Ash (%)	Ca (mg)	Fe (mg)	Zinc (mg)	Phosphorus (%)
Control	6.0	12.00	13.30	64.62	1.78	166.30	9.02	4.57	319.43
T_1	6.1	13.47	12.80	63.07	1.76	288.47	7.8	4.82	327.52
T_2	6.3	13.85	12.60	62.65	1.73	291.4	8.61	4.98	332.60
T_3	6.4	14.05	12.35	62.53	1.72	298.5	8.3	5.02	339.40

*Each value represents the average of five determination
where,

Control= Pearl millet based *Kharodi* prepared from 0 per cent addition
T_1 = Pearl millet based *Kharodi* prepared from 30 per cent addition of Finger millet flour.
T_2 = Pearl millet based *Kharodi* prepared from 40 per cent addition of Finger millet flour.
T_3 = Pearl millet based *Kharodi* prepared from 50 per cent addition of Finger millet flour

Overall acceptability etc. Sensorial evaluation was done using 9 point Hedonic scale. Pearl and finger millet based *Kharodi* prepared was evaluated for acceptability based on characteristics such as colour, flavour and texture. The sensorial characteristics of pearl and finger millet based *Kharodi* are summarized in Table 5. The graphical representation is presented in Fig. 2.

Colour :

Colour serves as a preliminary parameter for the acceptance of food and indicates the fitness of Pearl millet and finger millet based *Kharodi* for consumption. Colour is an important sensory parameter concerning the consumer's acceptability of product. The results presented in Table 6 showed that the colour of Pearl millet and finger millet based *Kharodi* was but variation only in addition of Finger millet and acceptable color was observed in sample T_1 containing 70-30 per cent Pearl and Finger millet. The maximum score for color of Pearl millet and finger millet based *Kharodi* was obtained by

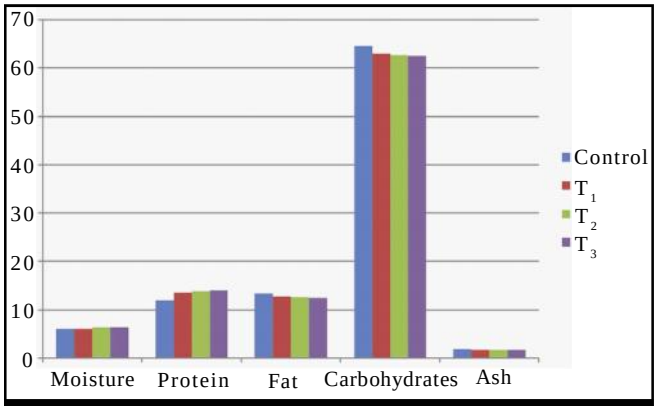


Fig. 2 : Effect of pearl and finger millet flour on physico-chemical characteristics of *Kharodi*

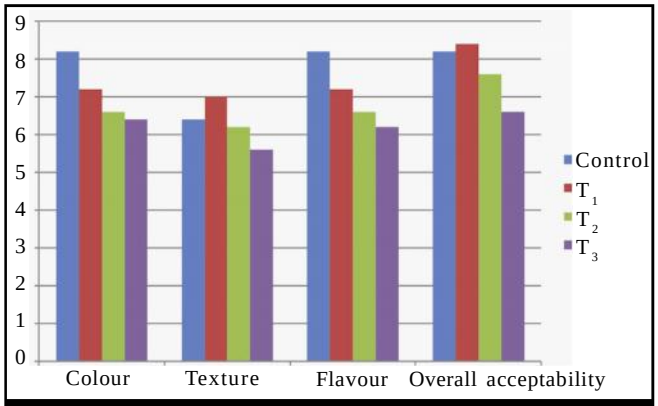


Fig. 3 : Sensory evaluation of composite flour based rusk

Table 5 : Sensory evaluation of *Kharodi*

Sample	Colour	Texture	Flavour	Overall acceptability
Control	8.2	6.4	8.2	8.2
T_1	7.2	7.0	7.2	8.4
T_2	6.6	6.2	6.6	7.6
T_3	6.4	5.6	6.2	6.6

*Each value represents the average of five determination
where,

Control= Pearl millet based *Kharodi* prepared from 0 per cent addition
T_1 = Pearl millet based *Kharodi* prepared from 30 per cent addition of Finger millet flour.
T_2 = Pearl millet based *Kharodi* prepared from 40 per cent addition of Finger millet flour.
T_3 = Pearl millet based *Kharodi* prepared from 50 per cent addition of Finger millet flour.

sample T_1.

Texture :

The textural parameters of sample T_1 were found to be increased in addition of pearl millet and finger millet flour. The pearl millet and finger millet based *Kharodi* samples blended with 70-30 per cent pearl and finger millet flour addition scored higher than control. The maximum textural score was scored for sample T_1, followed by sample T_2, while the minimum score was observed in T_3 sample. Because the more addition of pearl and finger millet flour to *Kharodi* induced the crispy, hard texture.

Flavour :

The score for flavour of composite flour based rusk ranged from 7-8 among the composite flour based rusk samples prepared from different level of soybean and oat flour addition. The composite flour based rusk sample T_2 scored significantly higher score after control. However, the sample T_4 scored lower for the flavour.

Overall acceptability :

Overall acceptability is based on multiple organoleptic quality parameters *i.e.* colour, flavour, texture etc. and shows the accumulative perception and acceptance by the panelists. The maximum score for overall acceptability was observed in sample T_1 and 70-30 per cent addition of pearl millet flour and finger millet flour, while the minimum score was observed in sample T_2, T_3. The 70-30 per cent addition of pearl millet and finger millet flour provides aromatic and pleasing flavour, and improves overall acceptability and shelf-life of pearl millet and finger millet based *Kharodi*, The control sample which is without addition of finger millet flour has scored lower as compared to sample T_1 with 70-30 per cent addition of finger millet flour which means the sample T_1 is nutritionally better as compared to control sample.

Microbial quality of selected sample of *Kharodi* :

The accepted composite flour based rusk sample was subjected to microbial studies for total plate count, yeast and mold count during the storage period as per method adopted by Laminu *et al*. (2016).The results recorded are presented in table . Photographs of TPC, yeast and mould count and coliform counts are shown in plate 13,14 and 15, respectively.

Sr. No.	Storage (in day)	Microbial quality (CFU/ml×10^3)	
		TPC	Yeast and mold
1.	0	Nil	Nil
2.	20	Nil	Nil
3.	40	Nil	Nil
4.	60	Nil	Nil

*Each value represents the average of five determination

Conclusion :

The existing homemade methods for preparation of *Kharodi* were studied. Also the textural profile of fortified and cooked pearl millet ingredients was determined and the quality parameters of dehydrated *Kharodi* prepared by varying process parameters were determined. Then process parameter of *Kharodi* was optimized and the cost economics of developed snack was estimated. Initially cooking and drying process parameters were optimized using response surface methodology to prepare optimally dried product. The optimum product characteristics were obtained at optimized, drying temperature of 600°C and drying time of 6 hr. A panel of 05 judges evaluated the *Kharodi* with and without sesame application along with *Kharodi* sample. These Four samples were evaluated in terms of colour, flavour, taste and mouthfeel (texture) and sensory scores were obtained. Thus, sesame application improved the overall acceptability of the product. The order of preference of quality attributes for *Kharodi* in general were also found out and it was found as mouthfeel > taste > flavour > colour. In the light of the results summarized above, it is concluded that.

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