



Diversified Millet-Based Products: A Way Forward to Climate Resilient and Sustainable Nutritional Security

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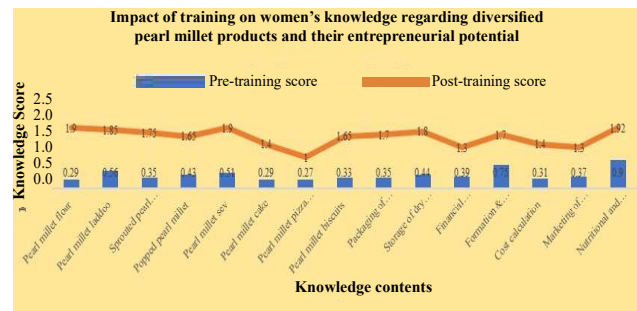
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HIGHLIGHTS

- Popularization of diversified pearl millet products increased the post knowledge score of women trainees significantly
- Addressing the key contents and essential steps for the establishment of entrepreneurial set up on diversified pearl millet products
- Tested perceived feasibility and utility of deliverables of trainings and identified products

GRAPHICAL ABSTRACT



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ABSTRACT

Context: Replacing rice crop with millets is a climate resilient approach since millets are less input crops especially in conserving water, resistant to climatic stress, pests and diseases. Millets are rich in nutrients and if compare with rice may provide double nutrition. There is an urgent need to increase the consumption of pearl millet among rural and urban population by introducing pearl millet based diversified value-added products.

Objective: This study was aimed to train rural women for developing diversified value-added products of pearl millet.

Methods: Sixty women were divided in two groups of 30 women in each for imparting training on diversified value-added products of pearl millet such as self- stable pearl millet flour, pearl millet laddoo, cutlet, sev, sprouted and popped pearl millet, pearl millet based idli, dhokla, cake, biscuits and cookies. Five days training was organized for both the groups separately at KVK, Faridabad, CCS HAU, Hisar during 2022-2023. Sensory preference, perceived feasibility of developed products and pre and post training knowledge score of women were calculated. Utility and coverage of delivered contents were also calculated.

Results & Discussion: Results indicated that knowledge score at pre-training were ranged from 0.27±0.18 to 0.90±0.41 which increased significantly ($p \leq 0.05$) after exposure of five days training programme on demonstration of preparation of diversified pearl millet-based products and ranged from 1.00±0.32 to 1.92±0.57. As a result, there was a significant gain in awareness and knowledge regarding processing, products development, cost calculation, packaging and marketing of developed products, nutritional and health benefits and entrepreneurial potential of pearl millet-based products.

Significance: Skilled and trained women will improve their own nutritional status while incorporating various diversified pearl millet products in their diets; they will earn money by selling these products and overall, it will increase the demand of climate resilient pearl millet.

In Haryana, pearl millet is the fourth most important cereal crop after wheat, rice and maize. Pearl millet is graded as a “Nutri smart crop” and it is rich in carbohydrates, protein, fat, fiber and mineral content (Sah *et al.*, 2021). In Haryana, during 2021–2022, pearl millet was grown in an area of 0.48 million ha with production and average productivity of 1.12 MT per year and 2318 kg/ha, respectively (DAFW, 2023). Pearl millet is the best alternative of climate resilient crop system and imperative to reduce the negative effects of climate change. It has the super potential to increase income and nutrition security of farming communities in arid regions and other parts of India through FPO (Chandegara *et al.*, 2023).. Pearl millet has a deep root system and can survive in a wide range of ecological conditions under water scarcity (Satyavathi *et al.*, 2021). Pearl millet has great agripreneurial potential in processing and value addition and has blossoming future in food industry. Without shifting from agriculture further expanding wings to agribusiness is an essential pathway to revitalize Indian agriculture and to make more attractive and profitable venture (Elakkiya and Asokhan, 2023). Cleaning, dehusking, hand pounding, blanching and milling of pearl millet and developing diversified pearl millet products are such entrepreneurial activities where women can execute better and have wide scope to earn securely.

The Agribusiness and innovation Platform of International Crops Research Institute for the Semi-Arid Tropics has proposed a model to enhance demand of pearl millet and therefore to enhance income of small holder farmers. Training and capacity building, production, entrepreneurship development, and marketing and business development on processed pearl millet and diversified pearl millet products, the major intervention suggested in the model served a window of opportunity for women (Satyavathi *et al.*, 2017). Training, skill development and capacity building of women who are directly engaged in pearl millet production or women part of farming community is necessary to step in the suggested model. In this modern era of early exposure of social media no one wants to limit their tongue to taste monotonous food items such as roti, dalia or khichdi rather novel food products with local taste and nutrition are in great demand. Diversified novel food products with local taste and nutrition such as pearl millet biscuits, pearl millet buns or *pav*, pearl millet cake, pearl millet

muffins, pearl millet pizza, pearl millet *idli*, pearl millet *dosa*, pearl millet macaroni and pasta may be developed locally even by farm women if they are equipped and skilled. Women are engaged in each of the household level income generating activities such as milk and animal husbandry tasks, aquaculture (Raja *et al.*, 2023) and weeding and harvesting of crops however least involved in decision making that hinder their entrepreneurial potential (Krishna *et al.*, 2022; Jumi *et al.*, 2023).

Women are laborious, fast learner, keen observer and best team workers; they should be encouraged to enter in the gainful profession of entrepreneurship to develop socially, economically and technologically and to stand in society on their own with confidence (Saikia, 2022; Singh *et al.*, 2023). Trainings and capacity building of women can improve their work flow, work efficiency and product quality and income (Singh *et al.*, 2020a; Marbaniang *et al.*, 2021), but their training part is on the willingness of the household head (Gupta *et al.*, 2016). Lack of economic motivation and poor economic empowerment are the factors that only fourteen percent of women comprised of the total entrepreneurs in India (Ministry of Statistics and Programme Implementation, 2020). Economic motivation had a positive and significant relationship with education, enterprise income, sources of information, mass media contact, infrastructural facilities, and entrepreneurial experience (Spandana *et al.*, 2023). Keeping in view the agripreneurial potential of diversifies pearl millet-based products and entrepreneurial potential of women this study was designed to impart vocational trainings to farm women to develop diversified pearl millet-based products and to develop entrepreneurial skills to link their product with supply chain.

METHODOLOGY

This study was conducted in Faridabad district (Longitude: 77°18'28" E | Latitude: 28°25'16" N) of Haryana purposively. Four villages namely Atali, Naryala, Piala and Tigaon were selected randomly for the selection of women. Sixty women (SC/ST; 15 from each village) between the age of 20 to 50 years, interested in pearl millet processing and product development based entrepreneurial activities were selected and divided in two groups of 30 women in each. Five days training was organized for both the groups separately at KVK, Faridabad, CCS HAU,

Hisar during 2022-2023. Demonstration on self-stable pearl millet flour, storage of dry ingredients, pearl millet *laddoo*, sprouted and popped pearl millet, *sev*, pearl millet cake, muffins, pizza base, biscuits and cookies were given. Different sessions were given on packaging of developed products. Lectures were delivered on formation and registration of self-help groups, financial assistance related schemes of NABARD for employment and income generation, cost calculation and marketing of developed products, nutritional and health benefits and entrepreneurial potential of pearl millet-based products. To observe the effect of training knowledge score of women was collected before and after training exposure and gain in knowledge was calculated. Women were also assessed for perceived feasibility of developed products and technology. Sensory preference was measured as liked extremely, liked very much and not liked by giving score 3, 2 and 1 respectively. Likewise ease of making of products was measured as very easy, easy and cannot make by giving score as 3, 2 and 1, respectively. Training utility was measured by getting the response of trainees for 15 items related to training on four-point continuum i.e., very useful, useful, undecided and not useful with scores assigned 4, 3, 2 and 1 respectively. Likewise, training coverage was measured and response of trainees were taken on four-point continuum i.e., well covered, moderately covered, poorly covered, not covered with scores 4, 3,



Figure 1. Locate of the study

2, and 1 respectively. Statistically data was analysed using SPSS software to get the results in meaningful manner.

RESULTS

Impact of training : The pre and post average knowledge scores of women trainees obtained before and after imparting training have been presented in Table 1. The average knowledge score of trainees regarding self-stable pearl millet flour before imparting training was 0.29 which improved significantly to 1.90 after having training exposure (Table 1). Likewise, the average knowledge score regarding diversified pearl millet products before imparting training ranged between 0.27 to 0.56 which

Table 1. Impact of training on women’s knowledge regarding diversified pearl millet products and their entrepreneurial potential

Knowledge contents	Pre-training score (N=60)	Post-training score (N=60)	Gain in knowledge	t value
Self- stable pearl millet flour	0.29 ± 0.12	1.90 ± 0.48	1.61	23.5**
Pearl millet laddoo	0.56 ± 0.18	1.85 ± 0.51	1.29	18.1**
Sprouted pearl millet salad	0.35 ± 0.14	1.75 ± 0.43	1.40	11.6**
Popped pearl millet	0.43 ± 0.15	1.65 ± 0.38	1.22	8.90**
Pearl millet sev	0.51 ± 0.23	1.90 ± 0.57	1.39	7.20**
Pearl millet cake/muffins	0.29 ± 0.11	1.40 ± 0.36	1.11	6.40**
Pearl millet pizza base	0.27 ± 0.18	1.00 ± 0.32	0.73	5.80**
Pearl millet biscuits/cookies	0.33 ± 0.15	1.65 ± 0.56	1.32	7.20**
Packaging of products	0.35 ± 0.15	1.70 ± 0.47	1.35	4.80**
Storage of dry ingredients	0.44 ± 0.21	1.80 ± 0.39	1.36	11.9**
Financial assistance related schemes of NABARD	0.39 ± 0.17	1.30 ± 0.51	0.91	5.62**
Formation & registration of SHG	0.75 ± 0.35	1.70 ± 0.48	0.95	7.35**
Cost calculation of products	0.31 ± 0.12	1.40 ± 0.35	1.09	6.52**
Marketing of products	0.37 ± 0.19	1.30 ± 0.39	0.93	8.60**
Nutritional and health benefits of pearl millet products	0.90 ± 0.41	1.92 ± 0.57	1.02	2.54*

Values are mean ± SD; ** Significant at 1% level; * Significant at 5% level

Table 2. Feasibility of diversified pearl millet products perceived by trainees (N=60)

Diversified Pearl millet products	Sensory preference				Ease of making			
	Liked Extremely	Liked very much	Don't like	W.M.S.	V. Easy	Easy	Can't make	W.M.S.
Self- stable pearl millet flour	13	47	-	2.21	48	12	-	2.40
pearl millet <i>laddoo</i>	15	45	-	2.25	07	53	-	2.12
Sprouted pearl millet	04	52	04	2.00	19	41	-	2.32
Popped pearl millet	05	52	03	2.03	05	54	01	2.06
pearl millet <i>sev</i>	18	42	-	2.25	35	25	-	2.58
pearl millet cake	25	45	-	2.75	08	50	02	2.10
pearl millet muffins	23	47	-	2.71	12	48	-	2.20
pearl millet pizza base	28	32	-	2.46	16	44	-	2.27
pearl millet biscuits	27	33	-	2.45	09	51	-	2.15
pearl millet cookies	16	44	-	2.26	17	43	-	2.28

Table 3. Utility of contents delivered on diversified pearl millet products under training program reported by women trainees (N=60)

Knowledge contents	V. Useful	Useful	Don't know	Not useful	Overall utility (W.M.S.)	Rank
Self- stable pearl millet flour	36	22	02	-	3.56	IV
Pearl millet <i>laddoo</i>	23	47	-	01	3.90	II
Sprouted pearl millet salad	13	38	04	05	2.98	X
Popped pearl millet	16	41	02	01	3.22	VIII
Pearl millet <i>sev</i>	36	24	-	-	3.60	III
Pearl millet cake/muffins	19	37	03	01	3.25	VII
Pearl millet pizza base	21	36	01	02	3.26	VI
Pearl millet biscuits/cookies	36	24	-	-	3.60	III
Packaging of products	22	36	01	01	3.32	V
Storage of dry ingredients	14	42	02	02	3.13	IX
Financial assistance related schemes of NABARD	08	32	06	04	2.40	XIII
Formation & registration of SHG	10	32	07	11	2.68	XI
Cost calculation of products	32	28	-	-	3.98	I
Marketing of products	08	33	03	06	2.58	XII

was improved significantly, and ranged between 1.00 to 1.90 after imparting training. Similarly, the post knowledge score of trainees regarding packaging of products, storage of dry ingredients, financial assistance related schemes of NABARD, formation & registration of SHG, cost calculation of products, marketing of products, and nutritional and health benefits of pearl millet products were increased significantly and found to be 1.35, 1.36, 0.91, 0.95, 1.09, 0.93 and 1.02, respectively.

Further, results indicated that all ten types of diversified pearl millet products were highly appreciated by trainees (Table 2). Pearl millet cake got the highest sensory preference (2.75) by the

trainees followed by pearl millet muffins (2.71), pizza base (2.46), biscuits (2.45), cookies (2.26), *sev* (2.25), *laddoo* (2.25), self-stable pearl millet flour (2.21), popped pearl millet (2.03), and sprouted pearl millet salad (2.00).

Likewise, as per the weighted mean score in ease of making highest preference was given to *sev* (2.58) followed by the self-stable pearl millet flour (2.40), sprouted pearl millet salad (2.32), pearl millet cookies (2.28), pearl millet pizza base (2.27), pearl millet muffins (2.20), pearl millet biscuits (2.15), pearl millet *laddoo* (2.12), pearl millet cake (2.10) and popped pearl millet (2.06) (Table 2).

Results presented in Table 3 and Table 4

Table 4. Coverage of contents delivered on diversified Pearl Millet products under trainings reported by women trainees (N=60)

Knowledge contents	W. covered	M.covered	P. covered	Overall coverage (W.M.S.)	Rank
Self- stable pearl millet flour	52	06	02	3.83	I
Pearl millet laddoo	51	04	05	3.76	II
Sprouted pearl millet salad	47	09	04	3.71	III
Popped pearl millet	41	13	06	3.58	IV
Pearl millet sev	42	11	07	3.58	IV
Pearl millet cake/muffins	33	21	06	3.50	V
Pearl millet pizza base	33	22	05	3.47	VII
Pearl millet biscuits/cookies	31	24	05	3.43	VIII
Packaging of products	18	32	10	3.13	XII
Storage of dry ingredients	32	17	08	3.25	X
Financial assistance-related schemes of NABARD	31	19	07	3.25	X
Formation & registration of SHG	27	16	13	3.03	XIII
Cost calculation of products	34	21	05	3.48	VI
Marketing of products	18	34	08	3.17	XI
Nutritional and health benefits of millet products	20	38	02	3.30	IX

indicated the effectiveness of the training program conducted by KVK in terms of utility and coverage of delivered contents. However, all the demonstrated products were found useful by the trainees, yet as per the weighted mean scores cost calculation of developed products was found most useful content with a weighted mean score of 3.98. Pearl millet *laddoo* and pearl millet *sev* were found next useful products to learn with weighted mean scores of 3.90 and 3.60, respectively.

Results presented in Table 4 indicated that all the contents of the training program delivered through demonstrations and lecture methods were covered thoroughly however trainees perceived that the demonstration related to self-stable pearl millet flour was covered best followed by the demonstration on preparation of *laddoo*, sprouted salad, *sev* cake and so on.

DISCUSSION

Diversified millet-based products: A way forward to climate resilient and sustainable nutritional security:

This study was undertaken to train and empower rural women to develop diversified millet-based products. Millets cover a wide variety of tiny grains that are nutrient-dense, easy to process, need comparatively lesser inputs to grow, and are climate resilient. Imparting training under close supervision has a positive impact on knowledge gain and confidence building among respondents (Bala *et al.*, 2020; Bora

and Deka, 2021). In the present study, imparting training among respondents has increased their post-knowledge scores significantly and they developed a very good understanding of self-stable pearl millet flour, diversified pearl millet products, packaging of products, storage of dry ingredients, financial assistance-related schemes of NABARD, formation & registration of SHG, cost calculation of products, marketing of products, and nutritional and health benefits of pearl millet products (Table 1). Similar improvement after training exposure in performance and knowledge of kitchen gardening among women trainees was observed by Ojha and Singh (2020) in Banda district. Our results on improved knowledge scores of trainees have been found in agreement with earlier findings of Buraka and Sreenivasarao (2020) and Bora and Deka (2021).

Though all the demonstrated products were highly appreciated by the women yet pearl millet cake followed by pearl millet muffins were liked the most and scored highest in terms of sensory acceptability (Table 2). It might be because they observed a novel taste and catchy appearance due to the appealing garnishing of these products. Further, the results presented in Table 2 indicated that based on ease of preparation women gave the highest scores to pearl millet *sev* and self-stable pearl millet flour and that might be because women found *sev*-making very easy and quick with the help of the *sev*-making machine and they found blanching of pearl millet enough

worth to improve the shelf-life of flour with enhanced colour and taste. When women were asked to rate the different demonstrated products and delivered topics based on their utility in daily life, cost calculation of developed products and self-stable pearl millet products were found to be reported as most useful. It might be because women generally are unable to decide fair price to sell their products and sometimes, they skip to add their labor and profit. The technology of self-stable pearl millet flour was found useful to women as it saved labor in frequent milling of pearl millet flour due to its bitter taste over the storage of 15 days.

Further, results presented in Table 4 indicated that all the contents delivered through demonstrations and lecture methods were covered thoroughly. Capacity building of women through training programs is an effective approach to skill them and make them ready to face market challenges confidently. Similar results were observed by Bala *et al.* (2020) who observed the similar effectiveness of cutting and tailoring training organized for scheduled caste women in Hisar district. Our results of the usefulness of vocational trainings for women trainees are in close agreement with the earlier findings of Singh *et al.* (2020a) and Singh *et al.* (2020b). 'Vocational training provided by Krishi Vigyan Kendra helps the majority of the farming community especially marginal and small farm women to become empowered with the acquaintance of new skills, knowledge, and attitudes' (Singh *et al.*, 2022).

CONCLUSION

This study was planned to train rural SC/ST women to develop diversified pearl millet products and to inculcate entrepreneurial skills in them. It was observed that the post-knowledge score of women regarding diversified pearl millet products, packaging, marketing and cost calculation, formation and registration of self-help groups, and the financial assistance scheme of NABARD increased significantly. All the developed products were adjudged as liked extremely to liked very much by the trainees and were found easy to prepare at home. Women trainees found the delivered contents very useful to start their work or otherwise to prepare at home to add variety. Pearl millet is a very nutritious crop and women should be encouraged after such training programs to start their small-scale level

production by forming self-help groups. Consumer demand for such nutritious and diversified products is very high in the market and women should learn to step in within the food supply chain. The demand and supply of these products will increase the demand for pearl millet and that will serve as a golden opportunity to small-scale farmers. In this way, efforts should be made to achieve climate-resilient and sustainable nutritional security.

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Data availability : The data utilised in this paper is available in the public domain and if demanded will be made available.

Authorship contribution: The first author conceptualized and designed the research, organized pieces of training and wrote the original draft. The second author validated and analysed the results. The third and fourth authors acted as co-coordinators of the trainings and tabulated the results. The fifth author supervised, visualized, and edited the manuscript.

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