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Development, standardization and evaluation of millet based food product rich in total phenols and flavonoids

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Abstract
Millets are unique among the cereals because of their richness in calcium, dietary fibre, polyphenols and protein. They are nutrients rich and recommended for the health and well-being of infants, lactating mothers, elderly and convalescents. Four millets such as bajra, sawan, Jowar and kodo which are rich in flavonoids and total phenols were selected and subjected to biochemical analysis. The research revealed that among the four millets, total phenols were highest in bajra (1mg) followed by sawan (0.9mg) Jowar (0.8mg) kodo (0.7mg). It was also found that the flavonoids content was also highest in the millet of bajra (0.5mg) compared to sawan (0.31mg) kodo (0.5mg) and jowar (0.5mg).So bajra was selected for food product development and further analysis. Bajra, is referred as the "magical pearl" It is a gluten free grain and it is noted for its high iron content. It has immense health benefits and uses. Three traditional food products such as Bajra laddoo, Bajra kolukattai, Bajra malt were formulated. The malted bajra powder contains 10mg of iron,1g of fibre,40mg of calcium, 300mg of phosphorous, 5g of moisture, 12g of protein and 130 µg of ß carotene. The bacterial content was enumerated by using standard plate count method in the malted bajra powder.

Keywords: Millets, total phenols, flavonoids, traditional foods

1. Introduction
Millets are the oldest foods known to human beings. They are highly nutritious and easily digestible grains available in the world. They have been in food use since time immemorial and an array of traditional healthy foods are prepared across rural India. However, food use of millets is fast decreasing due to several reasons. Apart from health benefits, millets are also good source of energy, protein, vitamins and minerals (Ravindran, 1991) [3]. Beside this, these crops also contain biologically active compounds including tannins, phenols, anthocyanins, flavonoids which has been linked with potential antioxidant activities. Millet foods are also known for their low glycemic index (Itagi, 2003) [4]. Therefore there is a need to revive these important groups of health promoting foods to enhance the nutritional quality of diets of the consumers.

The millets are the sources of antioxidants such as phenolic acids and glycosylated flavonoids. Polyphenols are considered the most important phytochemicals in millets, because of their nutraceutical potential such as antioxidant activity, anti-inflammatory, anti-carcinogenic, antimicrobial, anti-diarrheal, anti-ulcer and anti-cardiovascular properties. The flavonoids are known to have a positive role in strengthening the capillary walls, thinning blood by reducing the agglutination of RBCs and even preventing cancer. Therefore, realizing the health benefits of millets, industries are now exploring millets for product development in promoting the millet consumption and thereby, nutritional intake of the consumers significantly increases (Verma and Patel, 2013) [2]. Millets can be the source of value-added healthy food-products with different varieties for traditional and non-traditional millet users (Mal *et al*, 2010) [1]. Rapid urbanization, industrialization and consequent changes in eating habits of people have lead to development of instant dry mixes and ready-to-eat convenience food. The nutritional significance of millets demand for development of new millet based food products**.** Therefore, the present study comprised of collection of seeds of four different millets i.e bajra, jowar, kodo and sawan millet from different localities of Virudhunagar and compared the phytochemical activity of the above millets.

We also developed the traditional foods such as laddu, kolukkattai and malt from the millet which contain more phytochemical activity.

2. Objectives

1. To find out the millet rich in total phenols and flavonoids among bajra, jowar, kodo and sawan.
2. To prepare the malted bajra powder.
3. To develop and find out the acceptability of malted bajra products by sensory evaluation.
4. To analyze the microbial load of the malted bajra powder

3. Materials and Methods

3.1 Plant Materials: The materials for the present study comprised of seeds of four different millets i.e. bajra, jowar, kodo and sawan millets were collected. The present investigation was carried out at Food Processing Lab in Department of Food Processing and Quality Control, V.V. Vanniaperumal College for Women, Virudhunagar, Virudhunagar district, Tamilnadu. The millet samples were then crushed to coarse powder using grinder. The dried millet seeds materials were stored in paper bags.

Total phenols and flavonoids were determined among the millets of Bajra, sawan, kodo and jowar by adopting the following methods.

3.2 Determination of Total Phenol Content (Gutfinger, 1981) [5]

The amount of total phenol content was determined by Folin-Ciocalteau reagent method 1 ml of 50% Folin-Ciocalteau reagent was mixed with 1ml of millets sample extract and the mixture was incubated at room temperature for 15 mins. Then 2.5 ml of sodium carbonate solution was added and further incubated for 30 mins at room temperature and the absorbance was measured at 760 nm. Total phenol values are expressed in terms of catechin equivalent (mg/g of extracted compound).

3.3 Flavonoid determination (Bohan *et al,* 1974) [6]

Two grams of the sample was extracted repeatedly with 20ml of 80% aqueous methanol at room temperature .The whole solution was filtered through what man filter paper no 42(125mm). The filtrate was later transferred in to a crucible and evaporated into dryness over a water bath and weighted to a constant weight. Percentage of crude flavonoids was calculated by,

$$\text{Percentage of total flavonoid} = \frac{\text{Weight of residue}}{\text{Weight of sample taken}} \times 100$$

3.4 Preparation of malted bajra flour

The malted bajra flour was prepared by soaking the grain in water for 12 hours and germinated by tying it in muslin cloth for 12hours and dried in a cabinet drier. Then powdered it after roasting. Then the products such as Bajra laddoo, Bajra kolukattai and Bajra malt were prepared.

3.5 Preparation of bajra laddoo

Ingredients used for laddoos were accurately weighed. Malted Bajra, Green gram, Roasted Bengal Gram and Jaggery were taken in the varied ratio of 15:5:5:75 (Sample A), 30:10:10:50 (Sample B) and 45:15:15:25 (Sample C) respectively. All the above mentioned ingredients in varied ratios were mixed to jaggery syrup of two threads consistency and small round balls (laddoo) were made.

3.6 Preparation of bajra kolukattai

For the kollukattai, the dough was prepared by mixing of various ratio (10%, 30%, 50%) of malted bajra flour and roasted rice. Then made the small round balls stuffed with roasted bengal gram flour and coconut poorna. The ingredients used for bajra kolukattai is given in Table 1.

Table 1: Ingredients used for the preparation of Bajra Kolukattai

Ingredients	Sample-A (g)	Sample-B (g)	Sample-C (g)
Bajra	10	30	50
Rice flour	5	5	5
Roasted Bengal gram	5	10	15
Coconut	5	5	5
Palm jaggery	75	50	25

3.7 Preparation of bajra malt

The bajra malt mix was prepared by incorporating the prepared malted bajra powder in the ratio of 10%, 20% and 35% level into the milk and palm jaggery. Table 2 shows the ingredients used for bajra malt

Table 2: Ingredients used for the preparation of bajra malt

Ingredients	Sample-A (g)	Sample-B (g)	Sample-C (g)
Bajra	10	20	35
Milk	15	30	40
Palm jaggery	75	50	25

The acceptability for three variations of bajra laddoo, bajra kolukattai and bajra malt were carried out by nine panel members using Hedonic Scale.

3.9 Analysis of biochemical composition of malted bajra

The nutrient composition of malted bajra powder was analysed by AOAC, 1995 [8] method.

4. Results and Discussion

4.1 Estimation of total phenols and flavonoids among bajra, jowar, kodo and sawan millets

Table 3: Total phenol (TP) and flavonoids of millets

Millets extracts	Total phenol	Flavonoid content
Bajra	1mg	0.5mg
Sawan	0.9mg	0.31mg
Jowar	0.8mg	0.5mg
Kodo	0.7mg	0.5mg

Table 3 shows the total phenols and flavonoids of millets such as bajra, sawan, jowar and kodo. It was found that among the four millets total phenols was highest in bajra (1mg) followed by sawan (0.9mg) Jowar (0.8mg) Kodo (0.7mg). This result coincides with the research done by Upadhyayay *et al.* (2013) [7]. They found that the analysis of total phenols of millets by Folin-ciocalteu method resulted in contents of 0.8-2.6mg gallic acid equivalents (GAE)/g Millets dry matter(DM) in acetone extract and highest for bajra. Among the millets extracts, highest Total phenols followed by Sawan, Jowar, kodo in decreasing order. It was also found that the flavonoids content was highest in the millets of bajra (0.5mg) compared to sawan (0.31mg) kodo (0.5mg) and jowar (0.5mg). This result goes in line with the study of Upadhyayay *et al.* (2013) [7]. They found that the flavonoids was highest for bajra (0.5mg) .The flavonoids content in millet extracts followed similar trends as observed for TPC except for sawan and kodo extracts where sawan showed slightly higher flavonoids content than kodo.

4.2 Sensory evaluation of Malted bajra powder products

The developed bajra powder products were subjected to sensory evaluation by nine panel members and the mean score obtained for Sample-A, Sample-B and Sample-C bajra products were found out and statistically analyzed.

4.3 Sensory evaluation of bajra laddoo

Table 4 shows the sensory evaluation mean score of bajra laddoo.

Table 4: Sensory Evaluation of Bajra Laddoo

Proportions of Bajra powder	Appearance	Colour	Texture	Flavour	Taste	Over all acceptability
Sample-A	4.41±0.49	4.66±0.51	3.66±1.03	4.33±0.51	4.08±0.16	4.22±0.78
Sample-B	4.13±0.71	4.33±0.81	3.41±0.91	4.00±0.63	3.80±0.69	3.93±1.07
Sample-C	4.75±0.41	4.91±0.20	4.55±0.78	4.75±0.41	4.91±0.20	4.77±0.23

Evaluation of organoleptic attributes of the bajra laddoo for colour, flavor, texture, appearance, taste and over all acceptability was done by panel members. It was found that the overall acceptability of Sample-C bajra laddoo was excellent and the mean score was 4.77. But in the Sample-A and Sample-B bajra laddoo mean scores were 4.22, 3.93 respectively.

4.4 Sensory evaluation of bajra kolukattai

Table 5 shows the sensory evaluation mean score of Bajra kolukattai.

Table 5: Sensory evaluation of Bajra kolukattai

Proportions of Bajra powder	Appearance	Colour	Texture	Flavour	Taste	Over all acceptability
Sample-A	4.33±0.40	4.58±0.49	4.38±0.37	4.41±0.49	4.41±0.49	4.42±0.58
Sample-B	4.66±0.40	4.75±0.41	4.50±0.44	4.66±0.40	4.71±0.40	4.65±0.40
Sample-C	4.33±0.40	4.58±0.37	4.13±0.21	4.46±0.32	4.16±0.51	4.33±0.67

Evaluation of organoleptic attributes of the bajra Kolukattai for colour, flavour, texture, appearance, taste and over all acceptability was done by panel members. It was found that the overall acceptability of Sample-B bajra kolukattai was excellent and the mean score was 4.65.But in the Sample-A and Sample-C bajra kolukattai mean scores were 4.42 and 4.33 respectively.

4.5 Sensory evaluation of bajra malt

Table 6 shows the sensory evaluation mean score of bajra malt.

Table 6: Sensory evaluation of the bajra malt

Proportions of Bajra powder	Appearance	Colour	Texture	Flavour	Taste	Over all acceptability
Sample-A	3.90±0.89	3.40±0.54	3.80±0.83	3.80±0.83	3.40±0.54	3.66±1.34
Sample-B	4.96±0.08	4.96±0.89	4.90±0.22	4.90±0.22	4.96±0.08	4.93±0.07
Sample-C	4.70±0.44	4.70±0.44	4.60±0.54	4.70±0.44	4.30±0.44	4.60±0.40

Evaluation of organoleptic attributes of the bajra malt for colour, flavour, texture, appearance, taste and over all acceptability was done by panel members. It was found that the overall acceptability of Sample-B bajra malt was excellent and the mean score was 4.93. But in the Sample-C and Sample-A Bajra malt mean scores were 4.60 and 3.66 respectively.

4.6 Nutrient analysis of malted Bajra powder

The nutrient content of malted bajra powder was analyzed and the results showed that the nutrient content of 100gm of malted bajra powder contains 10mg of iron, 1g of fibre, 40mg of Calcium, 300mg of phosphorous, 5g of moisture, 12g of protein and 130ɥg of β carotene.

4.7 Microbial analysis of Malted Bajra powder

The bacterial count was enumerated by using standard plate count method in the malted bajra powder. The result showed that there was no contamination for the period of 30 days. Thus it can be concluded that the bajra powder can be stored upto 30 days without undergoing any deteriorative changes.

5. Conclusion

It was found that among the four millets, total phenols and flavonoids were high in bajra compared to other three millets. So Bajra was selected to develop the traditional products such as Laddoo, Kolukattai and Malt. The products were prepared in three variations namely Sample A, Sample B and Sample C which contained various proportions of malted Bajra for achieving the nutrients enhancement in the products. The sensory evaluation result found that among the prepared variations, sample B of Malted bajra kolukkattai (4.65), Sample C of Malted Bajra laddoo (4.77) and malt (4.93) were selected as the best variations of each developed malted bajra incorporated products.

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