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Evaluation of Kodo millet varieties for standardization of cookies

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Abstract
Kodo millet varieties (T_1V_1 - CO3, T_1V_2- Market variety), were procured from different places and study their physical and nutritional characteristics to found that best kodo millet variety for the standardization of cookies. The physical characteristics of kodo millet varieties *viz*., thousand grain weight, thousand grain volume and bulk density were studied and the values are higher than the market variety. The nutritional characteristics of kodo millet varieties *viz*., carbohydrate, protein, crude fibre, calcium and iron content was 65.15g, 8.25g, 8.90g, 26.00mg and 0.47mg in CO3 respectively. Cookies were prepared from kodo millet variety by incorporating flour each at 25, 50 and 75 per cent levels. The developed cookies were subjected to sensory evaluation for their organoleptic properties *viz*., colour and appearance, flavour, texture, taste and overall acceptability by a panel of 25 members using a nine point hedonic scale. The scores for T_1V_1 and T_1V_2 at 25, 50 and 75 per cent incorporation levels were 8.5, 8.6, 8.1 and 8.2, 8.4 and 8.0 for colour and appearance respectively. The overall results revealed that T_1V_1 sample were comparatively higher in physical and nutrient content and sensory scored 8.5 and was highly acceptable at 50 per cent incorporation level when compared to the market variety. Based on the results of physical and nutritional, formulation and sensory characteristics of the kodo millet composite flour used for the optimization of cookies, the varieties T_1V_1 were identified to be best suited for the product development.

Keywords: Kodo millet, physical, nutritional, formulation and sensory evaluation

Introduction
Millets are one of the oldest and first cereal grains to be used for domestic purposes. Millets are underutilized in many developed countries. There is an immense potential to process millet grains into value added foods. Millet grain is highly nutritious with good quality protein, vitamins, dietary fibre, Phyto-chemicals and rich in minerals. The nutritional composition of the millets is compared with that of rice and wheat. Millet grains account for about one sixth of the total food grain production hold an important place in the food grain economy of India (Pradhan *et al*., 2010) [6].

Kodo millet was domesticated in India almost 3000 years ago. The origin of kodo millet was India. It is found across the world in humid habitats of tropics and subtropics. It is a minor grain crop in India and an important crop in the Deccan plateau. Its cultivation in India is generally confined to Gujarat, Karnataka and parts of Tamil Nadu. It is classified in to the group Haria, Chaudharia, Kodra and Haria-chaudharia depending on panicle characters. Kodo is an annual tufted grass that grows to 90 cm high. The grain is enclosed in hard, corneous, persistent husks that are difficult to remove. The grain may vary in colour from light red to dark grey. The fibre content of the whole grain is very high and has around 11 per cent protein and nutritional value of the protein has been found to be slightly better than that of other small millets.

Materials and Methods
One variety of kodo millet (CO-3) from peraiyur, Madurai District and one variety from the local market (Market variety) were procured and utilized for the study. The commercial refined wheat flour was purchased from flour mill. The remaining ingredients namely sugar, yeast, shortening and baking powder were purchased from the local market. Baking oven and other accessories are used for the preparation of cookies.

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The procured kodo millet grains were cleaned to remove dust and other foreign materials and ground in a commercial roller mill. The flour was sieved using a BS 40-mesh sieve to obtain fine flour and was stored in stainless steel container.

A. Physical characteristics of kodo millet varieties

The characteristics like thousand grain weight, thousand grain volume and bulk density of kodo millet were studied by following the procedures as described below. All the estimations were done in triplicates. The size of the seed was measured using Calipers to the nearest of 0.01 mm. Thousand grain weight of randomly selected thousand grains was recorded in grams using electronic balance with a sensitivity of 0.01 mg. Thousand grain volume of randomly selected

thousand grains were dropped in a measuring cylinder containing known volume of distilled water. The difference in volume was recorded in ml. The bulk density was calculated as weight of grain (g) divided by grain volume (ml) and the bulk density was expressed as g per ml.

A 30g (14 per cent weight moisture content) of the sample was put into a 100ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained.

B. Nutritional characteristics of the kodo millet varieties

The chemical composition of the kodo millet varieties was analyzed. The nutrients like moisture, carbohydrate, crude protein, crude fibre, calcium, iron was analyzed and presented in Table 1.

Table 1: Methods of Analysis

Parameters	Methods	References
Moisture	Hot air oven method	Ranganna (1995) [4, 7].
Carbohydrate	Phenol sulphuric acid method	Dubois *et al,* (1956) [2].
Crude Protein	Micro Kjelplus method	Ma and Zuazaga, (1942) [4].
Crude fibre	Acid and alkali digestion	Sadasivam & Manickam (1996) [8].
Calcium	Titration	Clark and Collip, (1925) [1].
Iron	Colorimetric method	Wong, (1928) [11].

T_1V_1 - CO3 (TNAU) T_1V_2 - Market variety

C. Formulation and preparation of cookies

Cookies were prepared by incorporating kodo millet flour each at 25, 50 and 75 per cent levels. The ingredients used in the preparation of control/standard cookies were refined wheat flour (100g), powdered sugar (30g), shortening (50g), baking powder (2g) and corn flour (1g). The functional ingredient refined wheat flour was replaced by kodo millet flour and all other basic ingredients remained the same as given in Table 4.

The flour was sieved in a BS 60 mesh sieve. The powdered sugar and vanaspathi were mixed thoroughly and other ingredients were added. The dough was rolled into uniform sheet of desired size (thickness of 0.6cm and 4cm diameter) and was cut into circular shapes using cookies cutter and baked in an oven at 180ºC for 15 min. After 24hrs, the cookies were packed in different packaging materials.

D. Sensory evaluation of kodo millet incorporated cookies

The developed cookies were subjected to sensory evaluation for their organoleptic properties *viz*., colour and appearance, flavour, texture, taste and overall acceptability by a panel of 25 members using a nine-point hedonic scale. Ratings of 9-1 are rated as 9- Like extremely, 8-Like very much, 7-Like moderately, 6-Like slightly, 5-Neither like nor dislike, 4-Dislike slightly, 3-Dislike moderately, 2-Dislike very much,

1-Dislike extremely (Watts *et al*., 1989) [10]. The mean score was obtained for all the characters.

Results and Discussion
A. Physical characteristics of the kodo millet varieties

The whole millet grains and the dehulled grains were assessed for their physical properties. The physical characteristics of millet varieties *viz*., thousand grain weight, thousand grain volume and bulk density were studied and presented in Table 2. The mean thousand grain weight for the whole and dehulled grains of T_1V_1 was 5.93g and 3.87g and T_1V_2 was 5.87g and 3.82g respectively. The thousand grain volume of the whole and dehulled grains was8.23 ml and 4.98 ml for T_1V_1, Which was higher than $T_1V_2$with values 8.20 ml and 4.95 ml respectively. The bulk density of T_1V_1 and T_1V_2 was 0.60 and 0.59g per ml for whole grains and 0.86 and 0.84g per ml for dehulled grains respectively.

Vidhyavathi (2001) analyzed the physical characteristics of brown and white varieties of finger millet and found that in brown varieties 1000 grain weight ranged from 2.2 to 3.1g, 1000 seed volume ranged from 2.0 to 2.5 ml. Hydration capacities and hydration index of the varieties were in the range of 0.82 to 1.45 and 0.36 to 0.62, respectively. Specific gravity ranged from 1.12 to 1.30, gravity ranged from 1.12 to 1.30 and bulk density ranged from 0.67 to 0.75 g/cc.

Table 2: Mean value of Physical characteristics of the kodo millet varieties of grains

Treatment and Varieties	Thousand Grain weight (g)		Thousand Grain volume (ml)		Bulk density (g/ml)	
	Whole grain	Dehulled grain	Whole Grain	Dehulled grain	Whole Grain	Dehulled grain
T_1V_1	5.93	3.87	8.23	4.98	0.60	0.86
T_1V_2	5.87	3.82	8.20	4.95	0.59	0.84

T_1V_1 - CO3 (TNAU) T_1V_2 - Market variety

B. Nutritional characteristics of the kodo millet varieties

The mean proximate composition of the kodo millet grain varieties are presented in Table 3. The moisture content of T_1V_1 and T_1V_2 was 12.45g and 12.10g respectively. The Carbohydrate, protein and crude fibre content was 65.15g, 8.25g and 8.90g in T_1V_1 and 64.00g, 8.00g, 8.50 in T_1V_2 respectively. The calcium and iron content of $T_1V_1$was

26.00mg and 0.47mg and T_1V_2 was 25.00mg and 0.42mg per 100g of the grains respectively. The overall results revealed that T_1V_1 was comparatively higher in nutrient content than the market variety.

Kumari *et al*. (2000) [3] studied the nutritive value of malted finger millet varieties and their use in the preparation of burfi. Five finger millet varieties such as PES-400, PES-176, PES-

110, PES-4 and PES-5 were malted. Malting of finger millet resulted in significant changes in nutrient composition such as calcium, iron, zinc and vitamin-C which ranged from 516-596, 8.26-15.10, 1.66-2.22 and 5.08-8.74mg per 100g, respectively in all the varieties.

The minor millets are good store houses of nutrients with varietal differences evident within the species. Foxtail millet of 21 varieties recorded a fat content ranging from 2.3 to 5.9 per cent, followed by proso (2.1 to 5.2 per cent), little (3.10 to 3.7 per cent) and kodo millet (1.10 to 3.30 per cent) as reported by several investigators (Malleshi *et al.*, 1985) [5].

Table 3: Mean Value of Nutritional characteristics of the kodo millet varieties of grains (per 100g)

Varieties	Moisture (g)	Carbohydrate (g)	Protein (g)	Crude Fibre(g)	Calcium (mg)	Iron (mg)
T_1V_1	12.45	65.15	8.25	8.90	26.00	0.47
T_1V_2	12.10	64.00	8.00	8.50	25.00	0.42

T_1V_1 - CO3 (TNAU) T_1V_2 - Market variety

C. Formulation of kodo millet incorporated cookies
The formulation of kodo millet composite flour for cookies by the standard procedure incorporating kodo millet varieties at 25, 50 and 75 per cent levels.

Table 4: Formulation of kodo millet incorporated cookies

Ingredient	T_0	Kodo Millet					
		T_1V_1			T_1V_2		
	100	25	50	75	25	50	75
Refined wheat flour (g)	100	75	50	25	75	50	25
Kodo millet flour (g)	-	25	50	75	25	50	75
Powdered sugar (g)	30	30	30	30	30	30	30
Vanaspathy (g)	50	50	50	50	50	50	50
Baking powder (g)	2	2	2	2	2	2	2
Corn flour (g)	1	1	1	1	1	1	1

*Mean score T_1V_1 - CO3 (TNAU) T_1V_2 - Market variety

Sensory evaluation of the kodo millet incorporated cookies
Subjective sensory characteristics of varieties of kodo millet cookies are summarized in Table 5. The scores for T_1V_1 and T_1V_2 at 25, 50 and 75 per cent incorporation levels were 8.5, 8.6, 8.1 and 8.2, 8.4 and 8.0 for colour and appearance respectively. The texture and taste of T_1V_1 ranged from 8.5 to 7.9 and 8.4 to 7.5 respectively which showed that the increase in incorporation levels of the millet decreased the scores. The flavour of the cookies showed gradual decrease in the mean score value at increased levels of small millet incorporation. The overall acceptability showed that T_1V_1 scored 8.5 and was highly acceptable at 50 per cent incorporation level when compared to the market variety.

Based on the results of formulation of the kodo millet varieties and sensory characteristics of the kodo millet composite flour used for the optimization of cookies the varieties T_1V_1 were identified to be best suited for the product development.

Table 5: Mean Value of Sensory characteristics of kodo millet incorporated cookies

Varieties	Incorporation levels (%)	Sensory Attributes*				
		Color and Appearance	Flavor	Texture	Taste	Overall Acceptability
T_1V_1	25	8.5	8.6	8.5	8.4	8.4
	50	8.6	8.7	8.6	8.5	8.5
	75	8.1	8.0	7.9	7.5	7.6
T_1V_2	25	8.2	8.1	8.1	8.0	7.9
	50	8.4	8.5	8.3	8.2	8.1
	75	8.0	7.9	7.8	7.4	7.5

T_1V_1 - CO3 (TNAU) T_1V_2 - Market variety

Conclusions
The mean thousand grain weight for the whole and dehulled grains of T_1V_1 was 5.93g and 3.87g respectively which was higher than the market sample. The thousand grain volume of the whole and dehulled grain for T_1V_1 was 8.23 ml and 4.98 ml respectively. The bulk density of T_1V_1 and T_1V_2 was 0.60 and 0.59g per ml for whole grains and 0.86 and 0.84g per ml for dehulled grains respectively. The moisture content of T_1V_1 and T_1V_2 was 12.45g and 12.10g respectively. The Carbohydrate, protein, crude fibre, calcium and iron content was 65.15g, 8.25g, 8.90g, 26.00mg and 0.47mg in T_1V_1 respectively. The overall results revealed that T_1V_1 sample were comparatively higher in nutrient content than the market variety. From the results of physical and nutritional characteristics of the kodo millet varieties, C03 (T_1V_1) was best suited for the product development. The functional ingredient, kodo millet flour were used in the preparation of cookies replacing refined wheat flour at 25, 50 and 75 per cent levels while the other basic ingredients remained same. From the sensory evaluation, it was concluded that T_1V_1 incorporated cookies was highly acceptable up to 50 per cent incorporation levels with the mean values being 8.5.

From the results of formulation of the kodo millet varieties and sensory characteristics of the kodo millet composite flour used for the optimization of cookies, it was concluded that the varieties T_1V_1 were best suited for the product development.

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