Evaluation of foxtail millet varieties for standardization of bread

P KARUPPASAMY, SUSHEELA THIRUMARAN and R VEENA

Department of Food Science and Nutrition, Tamil Nadu Agricultural University
Coimbatore 641003 Tamil Nadu, India
Email for correspondence: samysks@gmail.com

 Received: 12.5.2019/Accepted: 28.5.2019

ABSTRACT

Foxtail millet varieties T_3V_1: CO5, T_3V_2: CO6 and T_3V_3: CO (Te) 7 were procured from Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu and one variety of foxtail millet (T_3V_4) was procured from local market and their physical, nutritional and sensory characteristics were studied to find out the best variety for the standardization of bread. The 1000-grain weight of T_3 samples ranged from 2.69 to 2.75 g for whole grain and 2.24 to 2.29 g for dehulled grains. Among these T_3V_3 was found to have higher values of 2.75 and 2.29 g for whole and dehulled grains respectively than the other samples. The 1000-grain volume of the T_3V_3 sample was found to be higher with values 3.80 ml for whole and 2.95 ml for dehulled grains. The bulk density of T_3V_3 sample was 0.75 and 0.87 g per ml for whole and dehulled grains respectively which was higher than the other T_3 samples. Among the four samples T_3V_3 was found to be higher in nutrient content than the other samples. These varieties were used for the preparation of bread at 10, 20, 30, 40, 50, 60 and 70 per cent incorporation levels. The sensory attributes of the bread were evaluated using 100-point score card. The sample T_3V_3 was found to be more acceptable than the other varieties at 20 per cent incorporation level. Based on the results of physical and nutritional formulation and sensory characteristics of the foxtail millet flour used for the optimization of bread, T_3V_3 was found to be best suited for the product development.

Keywords: Foxtail millet; varieties; bread; characteristics; whole grain; dehulled grain

INTRODUCTION

Millet grain is highly nutritious with good quality protein, vitamins, dietary fibre and phyto-chemicals and rich in minerals. Foxtail millet is also called as Italian, German, Hungarian or Sibarian millet. It is regarded as a native of China and is one of the world's oldest cultivated crops known from the Yang-Shao culture period dating back about 5,000 years. It ranks second in the total world production of millets and continues to have an important place in the world agriculture providing approximately six million tonnes of food to millions of people mainly on poor or marginal soils in southern Europe and in temperate, subtropical and tropical Asia. Its grain is used for human consumption and as feed for poultry and cage birds (Pandey 2004). Grains have been included in human diet ever since early man discovered that these were edible. Health-conscious consumers are now looking for products with particular ingredients and nutrients.

Practically devoid of grain storage pests foxtail millet has a long storage life. It has higher proportions of non-starchy polysaccharides and dietary fibre. Millets release sugars slowly and thus have a low glycemic index. Millets have great potential for being utilized in different food systems by virtue of their nutritional quality and economic importance. There is a wide scope of their exploitation in different food products including baked goods like breads, biscuits, cakes, cookies, breakfast cereals, muffins, pies, pancakes, snacks and extruded food stuffs.

The present study was undertaken to evaluate different foxtail millet varieties for standardization of bread.

MATERIAL and METHODS

Three varieties of foxtail millet from the Centre for Plant Breeding and Genetics, Tamil Nadu

Agricultural University, Coimbatore and one variety from the local market (Market variety) were procured and utilized for the study.

Physical characteristics of foxtail millet varieties

The characteristics like 1000-grain weight, 1000-grain volume and bulk density of foxtail millet were studied. All the estimations were done in triplicate. 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. To calculate 1000-grain volume, 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/ml. A 30 g (14% weight moisture content) of the sample was put into a 100 ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained.

Nutritional characteristics of the foxtail millet varieties

The chemical composition of the foxtail millet varieties was analyzed. The nutrients like moisture, carbohydrates, crude protein, crude fibre, calcium and iron were analyzed and the methods are given in Table 1.

Formulation and preparation of bread

Bread was prepared by incorporating foxtail millet flour each at 10, 20, 30, 40, 50, 60 and 70 per cent levels. The ingredients used in the preparation of control/standard bread were refined wheat flour (100 g), sugar (18 g), yeast (3 g), shortening (2.5 g), salt (1.5 g), water (54 ml), calcium propionate (0.3 g) and bread improver (0.2 g). The functional ingredient refined wheat flour used in the preparation of bread was replaced by foxtail millet flour and all other basic ingredients remained same except water content (60 ml for foxtail millet) required for preparing the dough. The proportions of refined wheat flour and foxtail millet were in the ratio of 90:10, 80:20, 70:30, 60:40, 50:50, 40:60 and 30:70.

The flour was sieved in a BS 60 mesh sieve. The sugar and yeast were dissolved in required amount of water and kept for 10 minutes. All dry ingredients were mixed by using yeast suspension, fat was added, mixed well and kneaded for 15 minutes. The dough was covered with a wet cloth and kept for one hour. It was knocked back and transferred into the greased bread moulder for final proving for one hour. The dough was then baked at 220°C for 30 minutes and the bread was cooled and packed.

Sensory evaluation of foxtail millet-incorporated bread

Descriptive characteristics of any product are very important to assess the acceptability of the product. Breads developed from different varieties of foxtail millets were evaluated for their organoleptic characteristics by a panel of 25 members using a 100-point scale according to AACC method 10-70 (Anon 1983) using a slightly modified score card. Each product was evaluated for its external, internal and taste properties such as crust colour, symmetry and appearance, texture (finger feel), crumb colour, grain, aroma and taste (mouth feel) and overall acceptability. Scores between 91-100 were rated as excellent, 81-90 as good, 66-80 as satisfactory, 51-65 as fair and 50 or less as poor. The mean score was obtained for all the characteristics.

RESULTS and DISCUSSION

Physical characteristics of the foxtail millet varieties

The whole millet grains and the dehulled grains were assessed for their physical properties. The physical characteristics of millet varieties viz 1000-grain weight, 1000-grain volume and bulk density were studied (Table 2).

The 1000-grain weight of T_3 samples ranged from 2.69 to 2.75 g for whole grain and 2.24 to 2.29 g for dehulled grains among which T_3V_3 was found to have higher values of 2.75 and 2.29 g for whole and dehulled grains respectively than the other samples. Similarly the 1000-grain volume of the whole and dehulled grains was assessed. In sample T_3V_3 it was 3.80 ml for whole grains and 2.95 ml for dehulled grains. The bulk density of T_3V_3 sample was 0.75 and 0.87 g per ml for whole and dehulled grains respectively which was higher than the other T_3 samples.

Nutritional characteristics of the foxtail millet varieties

The mean proximate composition of the foxtail millet grain varieties are presented in Table 3 (Figs 1, 2). The moisture content of the varieties ranged from 11.10 to 11.18 g per 100 g. The carbohydrate and protein

Table 1. Methods used for analysis

Parameter	Method	Reference
Moisture	Hot air oven method	Ranganna (1995)
Carbohydrate	Phenol sulphuric acid method	Dubois et al (1956)
Crude protein	Micro-Kjelplus method	Ma and Zuazaga (1942)
Crude fibre	Acid and alkali digestion	Sadasivam and Manickam (1996)
Calcium	Titration	Clark and Collip (1925)
Iron	Colorimetric method	Wong (1928)
Sensory evaluation	100-point scale	Anon (1983)

Table 2. Physical characteristics of foxtail millet varieties of grains (mean values)

Treatment x variety	100-grain weight (g)		100-grain volume (ml)		Bulk density (g/ml)	
	Whole grain	Dehulled grain	Whole grain	Dehulled grain	Whole grain	Dehulled grain
T_3V_1	2.72	2.26	3.74	2.92	0.73	0.86
T_3V_2	2.69	2.24	3.72	2.88	0.72	0.84
T_3V_3	2.75	2.29	3.80	2.95	0.75	0.87
T_3V_4	2.71	2.25	3.75	2.90	0.73	0.85

T_3V_1: CO5 (TNAU), T_3V_2: CO6 (TNAU), T_3V_3: CO (Te) 7 (TNAU), T_3V_4: Market variety

Table 3. Nutritional characteristics of foxtail millet varieties per 100 g grains (mean values)

Variety	Moisture (g)	Carbohydrates (g)	Protein (g)	Crude fibre (g)	Calcium (mg)	Iron (mg)
T_3V_1	11.12	60.79	12.15	7.92	30.70	2.62
T_3V_2	11.15	60.81	12.19	7.95	30.72	2.68
T_3V_3	11.18	60.85	12.26	7.98	30.79	2.75
T_3V_4	11.10	60.80	12.20	7.93	30.65	2.71

T_3V_1: CO5 (TNAU), T_3V_2: CO6 (TNAU), T_3V_3: CO (Te) 7 (TNAU), T_3V_4: Market variety

contents ranged from 60.79 to 60.85 g and 12.15 to 12.26 g per 100 g respectively. The T_3 samples were found to be highly rich in calcium content ranging from 30.65 to 30.79 mg per 100 g. Among the four samples T_3V_3 was found to be high in nutrient content than the other samples. The overall results revealed that T_3V_3 samples procured from Tamil Nadu Agricultural University were comparatively higher in nutrient content than the other varieties.

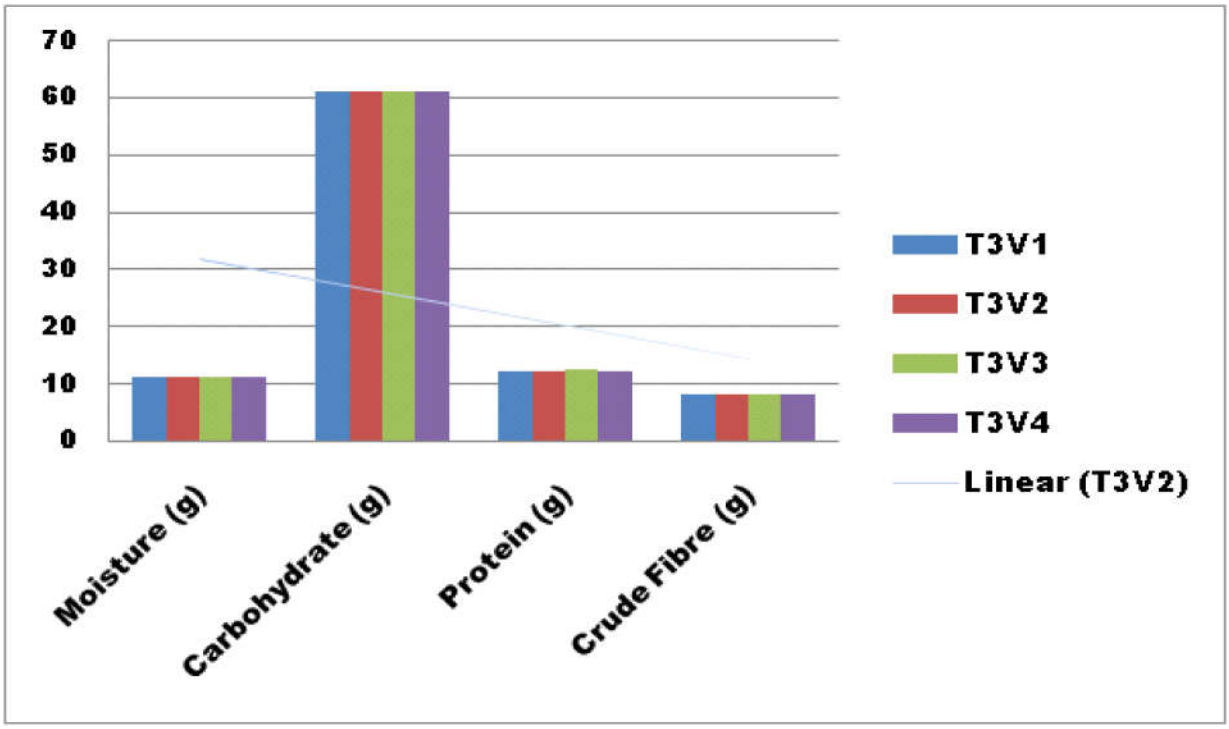
Formulation of foxtail millet-incorporated bread

The formulation of millet composite flour for bread was done by the standard procedure incorporating foxtail millet varieties at 10, 20, 30, 40, 50, 60 and 70 per cent levels. A total of 28 different composite flour blends were formulated by incorporating millet for the optimization of bread (Table 4).

Sensory evaluation of the foxtail millet-incorporated cookies

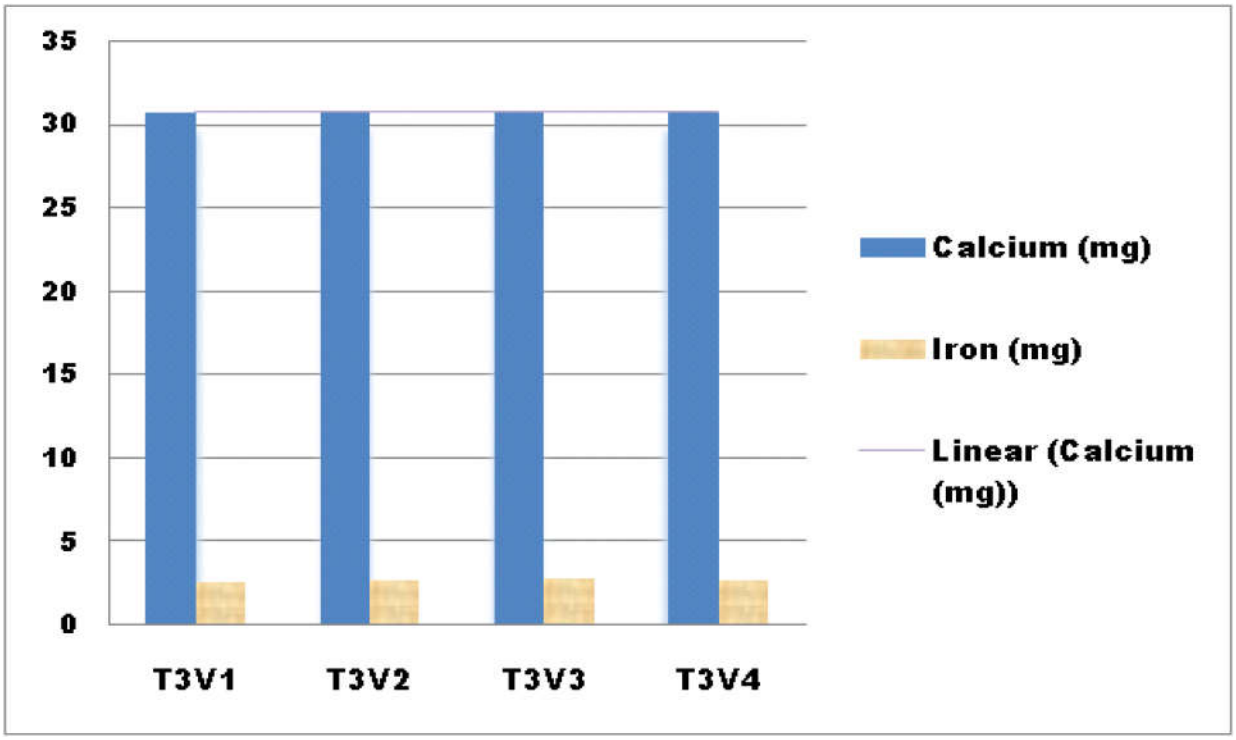
The sensory attributes of the foxtail millet-incorporated bread were evaluated using 100-point score card. The external properties including volume, crust colour, symmetry and appearance; the internal properties including texture, crumb colour and grain colour; the taste properties including aroma and taste were evaluated and judged for their quality.

The results of the descriptive organoleptic characteristics of the bread developed at different incorporation levels from 10 to 70 per cent are presented in Table 5. A slight difference was observed in the mean values of the external properties of the bread. The total points for the external properties including volume, crust colour, symmetry and appearance for T_3V_1, T_3V_2, T_3V_3 and T_3V_4 ranged from 26.6 to 19.7,



T_3V_1: CO5 (TNAU), T_3V_2: CO6 (TNAU), T_3V_3: CO (Te) 7 (TNAU), T_3V_4: Market variety

Fig 1. Proximate composition of foxtail millet varieties (per 100 g)



T_3V_1: CO5 (TNAU), T_3V_2: CO6 (TNAU), T_3V_3: CO (Te) 7 (TNAU), T_3V_4: Market variety

Fig 2. Mineral content of foxtail millet varieties (per 100 g)

Table 4. Formulation of foxtail millet composite flour for bread-I and bread-II

Ingredient	Variety													
	T_3V_1							T_3V_2						
	10	20	30	40	50	60	70	10	20	30	40	50	60	70
Refined wheat flour (g)	90	80	70	60	50	40	30	90	80	70	60	50	40	30
Foxtail millet flour (g)	10	20	30	40	50	60	70	10	20	30	40	50	60	70
Yeast (g)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Salt (g)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sugar (g)	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Calcium propionate (g)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Vanaspathy (g)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table 4. Contd…..

Ingredient	Variety													
	T_3V_3							T_3V_4						
	10	20	30	40	50	60	70	10	20	30	40	50	60	70
Refined wheat flour (g)	90	80	70	60	50	40	30	90	80	70	60	50	40	30
Foxtail millet flour (g)	10	20	30	40	50	60	70	10	20	30	40	50	60	70
Yeast (g)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Salt (g)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sugar (g)	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Calcium propionate (g)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Vanaspathy (g)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

T_3V_1: CO5 (TNAU), T_3V_2: CO6 (TNAU), T_3V_3: CO (Te) 7 (TNAU), T_3V_4: Market variety

26.2 to 14.7, 27.1 to 18.7 and 25.40 to 17.4 respectively. The scores for internal properties decreased with the increase in the incorporation levels of millet. The scores for the textural properties decreased gradually as the incorporation level of the millet increased with the maximum score of 11.6 for T_3V_3.

The textural properties of the developed millet-incorporated bread scored a maximum of 11.6 at 10 and 20 per cent incorporation level for T_3V_3 which decreased to 7.0 at 70 per cent incorporation level. The scores for T_3V_1, T_3V_2 and T_3V_4 were observed to decrease from 11.4 to 9.0, 11.4 to 6.3 and 11.2 to 8.6 respectively. The score values for colour of crumb varied between the incorporation levels. The maximum scores were observed at lower incorporation levels with lighte coloured bread crumbs. The values ranged from 9.0 to 6.0, 9.0 to 4.6, 9.1 to 4.6 and 8.8 to 5.1 for T_3V_1, T_3V_2, T_3V_3 and T_3V_4 respectively. The value for the colour of the grain was observed to be 9.00 at 20 per cent incorporation level for T_3V_1 and T_3V_3 being the maximum than the other varieties.

Iwuoha et al (1997) observed that the textural scores of foxtail millet-incorporated bread decreased significantly due to the increase in incorporation levels. The panel members agreed that the developed product did not reach appealing values because of their chewy crusts and gummy crumbs.

The taste and aroma of the foxtail millet bread scored well up to 30 per cent incorporation and significantly decreased as the level of incorporation of foxtail millet increased. The scores for aroma were found to decrease from 13.0 to 9.3, 13.0 to 8.0 and 13.0 to 7.8 for T_3V_1, T_3V_2 and T_3V_3 respectively and from 12.6 to 9.1 for T_3V_4. Higher score values were observed for taste of the foxtail millet bread with 18.2 being the maximum for T_3V_3 when compared with the other varieties at different incorporation levels. The overall acceptability scores ranged from 85.8 to 59.1 for T_3V_1, 85.9 to 45.5 for T_3V_2, 87.9 to 50.2 for T_3V_3 and 85.0 to 56.6 for T_3V_4. The sample T_3V_3 was found to be more acceptable than the other varieties at 20 per cent incorporation level.

Table 5. Sensory characteristics of foxtail millet-incorporated bread

Variety	Incorporation level (%)	External property				Internal property				Taste property			Total score (100)	Acceptability rating
		Volume (15)	Crust colour (5)	Symmetry & appearance (10)	Total points (30)	Texture (15)	Crumb colour (10)	Grain colour (10)	Total points (35)	Aroma (15)	Taste (20)	Total points (35)		
T_3V_1	10	14.1	4.0	8.5	26.6	10.8	8.9	8.9	28.6	13.0	16.8	29.8	85.0	G
	20	13.6	4.0	8.5	26.1	11.1	9.0	9.0	29.1	13.0	17.6	30.6	85.8	G
	30	13.9	3.9	8.1	25.9	11.4	8.3	8.2	27.9	12.4	16.1	28.5	82.3	G
	40	13.1	3.5	7.9	24.5	10.5	8.0	7.9	26.4	11.7	15.0	26.7	77.6	S
	50	13.0	3.1	7.6	23.7	11.0	7.4	7.3	25.7	11.1	14.8	25.9	75.3	S
	60	10.2	2.5	6.3	19.0	9.1	5.7	6.3	21.1	9.6	11.6	21.2	61.3	F
	70	11.0	2.5	6.2	19.7	9.0	6.0	5.6	20.6	9.3	9.5	18.8	59.1	F
T_3V_2	10	13.2	4.0	8.9	26.1	11.4	9.0	8.9	29.3	13.0	17.5	30.5	85.9	G
	20	13.4	3.9	8.9	26.2	11.3	8.9	8.9	29.1	12.9	18.0	30.9	86.2	G
	30	14.0	3.8	8.4	26.2	10.8	8.9	8.9	28.6	13.0	17.1	30.1	84.9	G
	40	13.0	3.5	8.0	24.5	11.0	8.0	7.9	26.9	11.8	15.0	26.8	78.2	S
	50	11.5	3.0	6.5	21.0	9.5	6.7	5.9	22.1	10.2	11.5	21.7	64.8	F
	60	9.5	2.1	5.8	17.4	8.6	5.1	5.2	18.9	9.1	11.2	20.3	56.6	F
	70	8.7	1.9	4.1	14.7	6.3	4.6	4.3	15.2	8.0	7.6	15.6	45.5	P
T_3V_3	10	13.7	4.0	9.0	26.7	11.6	9.1	9.0	29.7	13.0	18.1	31.1	87.5	G
	20	13.9	4.2	9.0	27.1	11.6	9.0	9.0	29.6	13.0	18.2	31.2	87.9	G
	30	13.6	3.7	8.1	25.4	11.0	8.6	8.7	28.3	12.6	17.1	29.7	83.4	G
	40	12.9	3.5	7.5	23.9	10.2	7.9	7.9	26.0	11.8	16.2	28.0	77.9	S
	50	12.0	3.1	7.0	22.1	10.0	7.0	6.4	23.4	10.5	11.3	21.8	67.3	S
	60	11.0	2.5	6.2	19.7	9.0	6.0	5.6	20.6	9.3	9.5	18.8	59.1	F
	70	10.6	2.6	5.5	18.7	7.0	4.6	4.0	15.6	7.8	8.1	15.9	50.2	P
T_3V_4	10	13.6	3.7	8.1	25.4	11.0	8.6	8.7	28.3	12.6	17.1	29.7	83.4	G
	20	13.3	3.7	8.8	25.8	11.2	8.8	8.7	28.7	12.7	17.8	30.5	85.0	G
	30	13.0	3.5	8.0	24.5	11.0	8.0	7.9	26.9	11.8	15.0	26.8	78.2	S
	40	12.0	3.1	7.0	22.1	10.0	7.0	6.4	23.4	10.5	11.3	21.8	67.3	S
	50	10.2	2.5	6.3	19.0	9.1	5.7	6.3	21.1	9.6	11.6	21.2	61.3	F
	60	11.0	2.5	6.2	19.7	9.0	6.0	5.6	20.6	9.3	9.5	18.8	59.1	F
	70	9.5	2.1	5.8	17.4	8.6	5.1	5.2	18.9	9.1	11.2	20.3	56.6	F

T_3V_1: CO5 (TNAU), T_3V_2: CO6 (TNAU), T_3V_3: CO (Te) 7 (TNAU), T_3V_4: Market variety

CONCLUSION

The 1000-grain weight, 1000-grain volume, bulk density, proximate composition and sensory characteristics of T_3V_3 sample were higher than the other T_3 samples. The sample T_3V_3 was found to be more acceptable than the other varieties at 20 per cent incorporation level. From the results of physical and nutritional characteristics of the foxtail millet varieties and sensory characteristics of the flour used for the optimization of bread it was concluded that the variety T_3V_3 was best suited for the product development.

REFERENCES

Anonymous 1983. Approved methods of the American Association of Cereal Chemists. 8th edn, Approved Methods Committee American Association of Cereal Chemists, Minnesota, USA.

Clark EP and Collip JB 1925. A study of the Tisdall method for the determination of blood serum calcium with a suggested modification. Journal of Biological Chemistry **63:** 461-464

Dubois M, Gilles KA, Hamilton JK, Rebers PA and Smith F 1956. Colorimetric method for determination of sugars and related substances. Analytical Chemistry **28(3):** 350-356.

Iwuoha CI, Anyadike AC and Eke OS 1997. The effect of flour blending on the physico-chemical and sensory qualities of bread. Journal of Food Science and Technology **34:** 311-315.

Ma TS and Zuazaga G 1942. Micro-Kjeldahl determination of nitrogen. A new indicator and an improved rapid method. Industrial and Engineering Chemistry (Analytical Edition) **14:** 280-282.

Pandey SK 2004. Functional properties of hydrothermally processed proso millet (*Panicum miliaceum*). Student Project Report, Central Food Technological Research Institute, Mysore, Karnataka, India.

Ranganna S 1995. Manual of analysis of fruits and vegetable products. Tata McGraw Hill Publishing Co Ltd, New Delhi, India.

Sadasivam S and Manickam A 1996. Biochemical methods. 2nd edn, New Age International Pvt Ltd Publisher, New Delhi, India, pp 179-186.

Wong SY 1928. Colorimetric determination of iron and hemoglobin in blood. II. Journal of Biological Chemistry **77:** 409-412.