Int.J.Curr.Microbiol.App.Sci (2024) *13*(07): 100-105

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 13 Number 7 (2024)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2024.1307.012

Investigating the Physical and Functional Properties of Diverse Sorghum Varieties

M. P. Prathika*, Kashibai Khyadagi, Uma N Kulkarni and Gouramma Sajjanar

Departement of Food Science and Nutrition, College of Community Science, Univeristy of Agricultural Sciences, Dharwad – 580005, India

**Corresponding author*

Keywords

Sorghum, M-35-1, AKJ-1, Market sample, Visual observations, Physical properties, Functional properties

Article Info

Received:
22 May 2024
Accepted:
26 June 2024
Available Online:
10 July 2024

A B S T R A C T

The present investigation was focused on investigating the physical characteristics such as length, width, breadth, weight, volume, bulk density, and colour, as well as functional properties such as water absorption capacity, oil absorption capacity, swelling power, and percent solubility. The sorghum varieties are comprised of *rabi* seasons, viz. M-35-1 (Maldandi), AKJ-1 (Atarga kempu jola), and sorghum variety available at Dharwad local market (market sample). The market sample and M-35-1 variety had a cream colour with a lustrous appearance, whereas AKJ-1 variety had a red colour with a non-lustrous appearance. All sorghum varieties were circular in shape. Significant variation was observed in physical parameters such as grain length (4.50 to 4.92 mm), grain width (3.53 to 3.83 mm), grain breadth (2.34 to 2.89 mm), hundred kernel weight (2.56 to 3.92 g), hundred kernel volume (2.00 to 3.33 ml), and bulk density (1.17 to 1.30 g/ml). Similarly, functional properties of flour, viz., water absorption capacity (84.78 to 89.77%), oil absorption capacity (91.10 to 94.30%), swelling power (8.61 to 10.38 g/g), and percent solubility (16.96 to 25.26%) of selected sorghum varieties showed significant variation. Among the sorghum varieties, M-35-1 had the highest length, breadth, kernel weight, and bulk density, while AKJ-1 variety had significantly higher values for width. The AKJ-1 variety had higher values for water absorption capacity (89.77 %), oil absorption capacity (94.30 %), and swelling power (10.38 g/g), whereas M-35-1 variety had a higher percent solubility (25.26 %).

Introduction

Sorghum (*Sorghum bicolor* L.) is an important cereal crop for food and fodder in India next to rice, wheat and maize. It is cultivated worldwide in warmer climates and is an important food crop in semi-arid areas of Africa, Asia and Central America. Sorghum has the potential for grain production even under low rainfall and it sustains adverse agro-climatic conditions. The common names of *Sorghum bicolor* L. Moench include; sorghum, brown corn, grain sorghum, milo, durra (English); sorgho, sorghofourager, gros mil (French), Mohrenhirse, Durralcous, Guinea korn (Germany); sorgho, milo-zaburo (Portuguese); sorgo, zahina (Spanish); jowar,

jowari (Hindi), amongst other names from other localities. The largest share of India's sorghum production is contributed by Maharashtra and Karnataka states. Due to its ability to grow in the dry lands of tropical Africa, India and China, it has also become the staple diet of these countries. Sorghum is the main staple food of Maharashtra and Karnataka and is also an important food in Madhya Pradesh, Tamil Nadu and Andhra Pradesh (Chavan *et al.,* 2017). Among the cereals without gluten used in food, sorghum has been characterised as a staple food for more than half a billion people in at least thirty countries (FAO, 2012).

However, despite the fact that its consumption is expanding worldwide, sorghum crop has not yet reached its productive potential. As it is devoid of gluten, sorghum is important in human nutrition. Though over the years, consumption of sorghum has decreased due to the easy availability of rice and wheat, there is growing awareness among the urban population that sorghum is a health food because of its nutritional superiority, especially its higher dietary fibre and antioxidant capacity due to the presence of phytochemicals that were earlier known to be antinutritional (Hariprasanna *et al.,* 2015). The investigation was carried out on *rabi* sorghum varieties with the objective of screening sorghum varieties for grain physical and functional properties.

Materials and Methods

The experiment was conducted during the year 2022–2023 at the Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad. Two sorghum varieties, *i.e.,* M-35-1 and AKJ-1 were procured from the Regional Agricultural Research Station, Vijayapur, University of Agricultural Sciences, Dharwad and the sorghum variety available at Dharwad local market was procured.

The physical characteristics of grains of sorghum varieties, such as size (length, width and breadth) were recorded using a digital calliper by measuring the dimensions at maximum points in 10 randomly selected grains (mm), weight, volume, bulk density (Amal *et al.,* 2007) and colour of sorghum grains was assessed in the spectrophotometer model Konica Minolta, CM-2600/2500d and measured in chromatic components of 'L' (black - 0 to white - 100), 'a' represents redness (+a values) to greenness (-a values) and 'b' represents yellowness (+b values) to blueness (-b values) and size of grains.

Seeds of each sorghum varieties were cleaned, washed, dried (overnight), powdered and analysed for flour functional properties. Functional properties such as water absorption capacity (Quinn and Paton, 1983), oil absorption capacity (Sosulski *et al.,* 1976), swelling power and per cent solubility (Schoch, 1964).

Results and Discussion

Visual observation of grains revealed that M-35-1 and the market sample were lustrous and creamy in appearance, while AKJ-1 was non-lustrous and red in colour (Table 1). Colour analysis also found higher L^*, a^* and b^* values in AKJ-1 variety, indicating red in colour. The red colour of sorghum may be due to anthocyanidin pigment, polyphenol and tannin content of the grains (Sedghi *et al.,* 2012).

A significant variation was found for grain length, width, breadth, hundred kernel weight, hundred kernel volume and colour ($p \leq 0.01$) among the varieties, while a non-significant difference was noticed for bulk density (Table 2). The grain length of sorghum varieties ranged from 4.50 to 4.92 mm, grain width from 3.53 to 3.83 mm and grain breadth from 2.34 to 2.89 mm. The highest grain length and breadth were found in M-35-1 variety, whereas AKJ-1 variety had highest grain width.

The 100 kernel weights of sorghum varieties ranged from 2.56 to 3.92 g, 100 kernel volume was from 2.00 to 3.33 ml and bulk density was between 1.17 and 1.30 g/ml. The highest hundred kernel volume was found in the market sample, whereas highest hundred kernel weight and bulk density were found in M-35-1 variety. The variations in physical properties of sorghum varieties might be due to the influence of genetic and environmental factors (Chaitanya and Hemalatha, 2017).

A high significant variation ($p \leq 0.01$) was found for water absorption capacity, oil absorption capacity, swelling power and per cent solubility among all the sorghum varieties (Fig. 1 and Fig. 2). The water absorption capacity, oil absorption capacity, swelling power and per cent solubility of sorghum varieties ranged from 84.78 to 89.77 per cent, 91.10 to 94.30 per cent, 8.61 to 10.38 g/g and 16.96 to 25.26 per cent respectively.

Higher water absorption capacity may be due to high protein content in the flour, which is both hydrophilic and hydrophobic in nature and therefore it can interact with water (Iwe, 2000).

Table.1 Visual observation of sorghum varieties

Characteristics	Market sample	M-35-1	AKJ-1
Appearance	Lustrous	Lustrous	Non-lustrous
Colour	Cream	Cream	Red
Shape	Circular	Circular	Circular

Table.2 Physical properties of sorghum varieties

Sorghum varieties	Length (mm)	Width (mm)	Breadth (mm)	100 kernel weight (g)	100 kernel volume (ml)	Bulk Density for grains (g/ml)	Colour		
							*L**	*a**	*b**
Market sample	4.50±0.11^{c}	3.73±0.05^{b}	2.80±0.18^{b}	3.84±0.81^{b}	3.33±0.05^{a}	1.17±0.19^{a}	82.22±0.14^{c}	1.95±0.30^{c}	9.83±0.02^{c}
M-35-1	4.92±0.26^{b}	3.53±0.8^{c}	2.89±0.14^{b}	3.92±0.18^{b}	3.00±0.00^{a}	1.30±0.06^{a}	83.36±0.15^{b}	1.52±0.02^{d}	8.75±0.04^{d}
AKJ-1	4.63±0.20^{c}	3.83±0.04^{a}	2.34±0.15^{c}	2.56±0.14^{c}	2.00±0.00^{b}	1.28±0.06^{a}	84.34.4±0.04^{a}	2.87±0.02^{a}	14.12±0.02^{b}
F-value	669.24	490.47	39.54	145.73	15.67	1.19	227.67	1738.10	79836.65
S.E.m	0.05	0.01	0.04	0.08	0.16	0.06	0.06	0.01	0.01
C.D	0.16**	0.06**	0.13**	0.28**	0.54**	NS	0.31**	0.08**	0.08**

Note: Values indicated mean±SD. S.E.m- standard error of mean; C.D- Critical difference, ** significant at 1% level, NS- Non-significant

Figure.1 Water absorption capacity (%) and Oil absorption capacity (%) of sorghum varieties

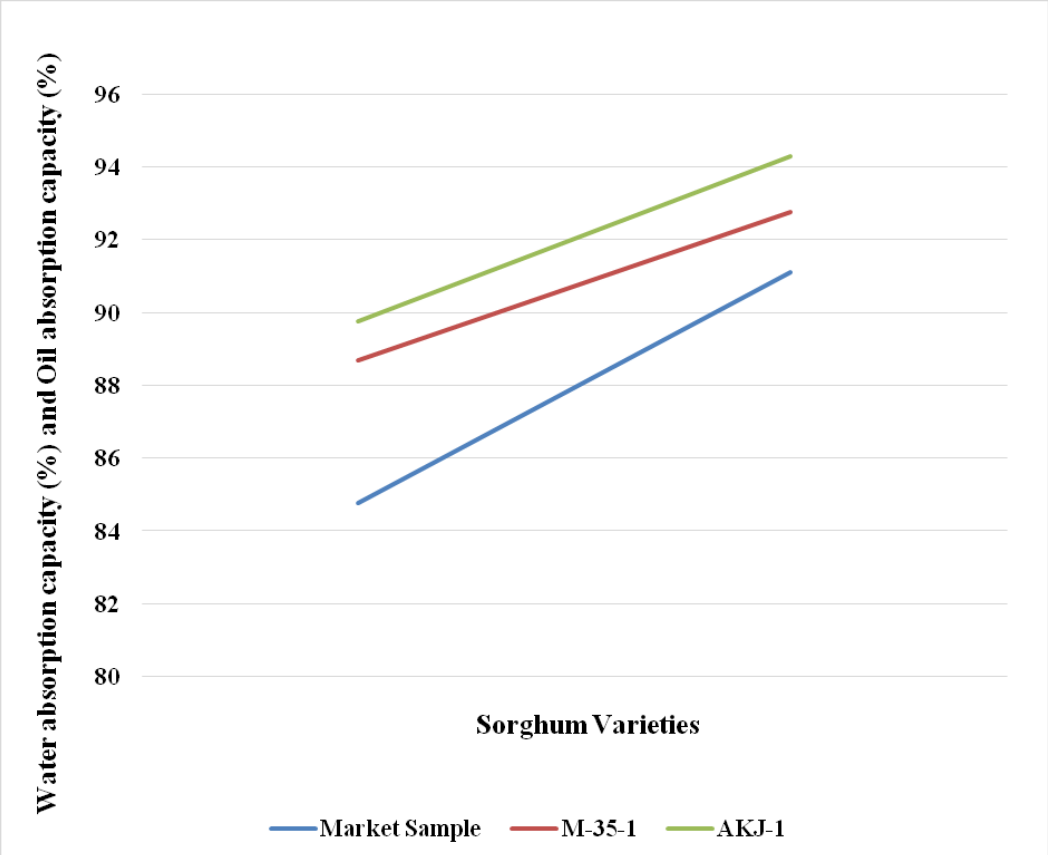
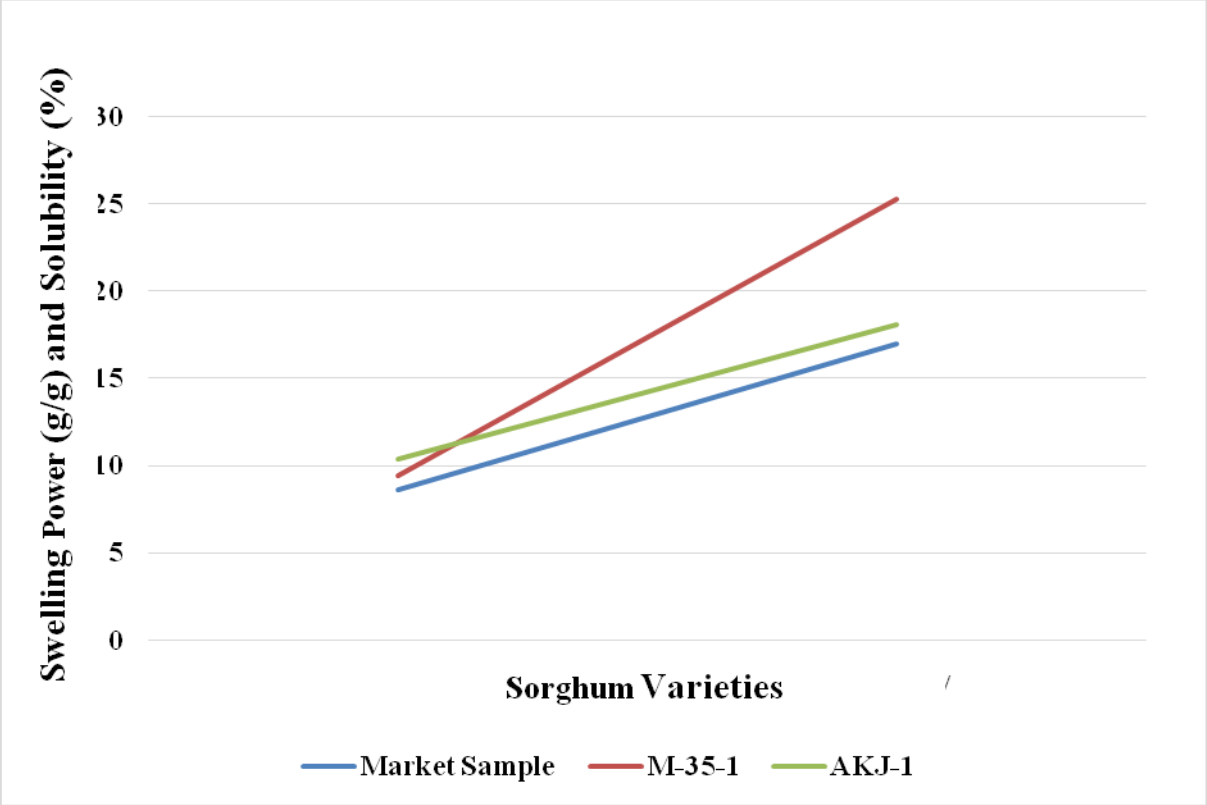


Figure.2 Swelling Power (g/g) and Solubility (%) of sorghum varieties



The higher oil absorption capacity is due to lipophilic nature of the constituents of flour (Ubbor and Akobundu, 2009). A similar range of water and oil absorption capacity in different sorghum varieties were reported by Thilagavathi *et al.,* (2015).

High water absorption capacity and high fibre content will give rise to high swelling power (Chinaza *et al.,* 2019). The higher per cent solubility in M-35-1 (25.26 %) may be due to the high per cent of starch and amylose content, which leaches out during the swelling process and increases solubility (Chinaza *et al.,* 2019).

Similar results were observed for swelling power and solubility of sorghum varieties by Harinder *et al.,* (2009). Among all the sorghum varieties, AKJ-1 variety had higher water absorption capacity, oil absorption capacity and swelling power whereas M-5-1 variety had a higher per cent solubility.

Visual observation of grains revealed that M-35-1 and the market sample were lustrous and creamy in appearance, while AKJ-1 was non-lustrous and red in colour. Colour analysis also found higher L^*, a^* and b^* values in AKJ-1 variety. The length, grain width, grain breadth, 100 kernel weight and 100 kernel volume showed significant differences among the sorghum varieties ($p<0.01$), whereas bulk density showed a non-significant difference ($p>0.01$). Among the sorghum varieties, M-35-1 had highest length (3.73 mm), breadth (2.89 mm), hundred kernel weight (3.92 g) and bulk density (1.30 g/ml), while AKJ-1 variety had a significantly higher width (3.83 mm).

Similarly, functional properties of sorghum varieties, viz., water absorption capacity, oil absorption capacity, swelling power and per cent solubility showed significant variation ($p<0.001$). Among the sorghum varieties, AKJ-1 had higher values for water absorption capacity, oil absorption capacity, swelling power and per cent solubility, whereas M-35-1 had higher values for per cent solubility.

Author Contributions

M. P. Prathika: Investigation, formal analysis, writing—original draft.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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How to cite this article:

Prathika, M. P., Kashibai Khyadagi, Uma N Kulkarni and Gouramma Sajjanar. 2024. Investigating the Physical and Functional Properties of Diverse Sorghum Varieties. *Int.J.Curr.Microbiol.App.Sci.* 13(7): 100-105.
doi: https://doi.org/10.20546/ijcmas.2024.1307.012