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A Comprehensive Assessment was Conducted to Ascertain the Physical, Functional, and Nutritional Characteristics of Kodo Millet Flour Sold in the Local Market of Ayodhya, Uttar Pradesh, India

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Abstract: Development and exploitation of products based on millet are aided by the evaluation of the quality attributes of millet. Bulk density, rehydration ratio, water activity, water holding capacity, water absorption index, and water solubility index were found to be, respectively, 0.68 ± 0.00 g/ml, 2.14 ± 0.07%, 0.48 ± 0.00, 0.53 ± 0.00, 8.00 ± 0.00 g/100g, and 8.06 ± 0.02 g/100g, following an evaluation of the physical and functional properties. Good storage stability and freshness were indicated by water activity and rehydration ratio falling within the permissible range. Kodo millet flour's nutritional composition included moisture, protein, fat, ash and crude fiber, carbohydrate, energy, vitamin C, dietary fiber, and percentage of radical scavenging activity. These were 9.34 ± 0.23%, 7.60 ± 0.30%, 1.44 ± 0.15%, 1.39 ± 0.05%, and 4.06 ± 0.03%, 77.05 ± 0.42%, 345.77 ± 0.9%, and 0.67 ± 0.32%, 14.78 ± 0.21%, 77.28 ± 0.35%, and 55.22 ± 1.60%, corresponding to the respective nutritional composition.

Keywords: Millets, food security, nutritional security, climate smart, antioxidants, malnutrition

Introduction

for the increasing population. However, as time passed, the negative impacts of these practices on the environment and human health became more apparent.Some of the biggest challenges faced by modern agriculture include unsustainable use of water resources, soil degradation, loss of biodiversity, and high levels of greenhouse gas emissions. Additionally, the reliance on chemical inputs has led to the development of pesticide resistance, water contamination, and detrimental effects on beneficial insects.

As a result, there is a growing movement towards adopting sustainable agricultural practices such as organic farming, agroecology, and regenerative agriculture. These methods focus on improving soil health, promoting biodiversity, conserving water resources, and reducing the use of synthetic inputs.

By shifting towards more sustainable practices, farmers can not only improve the health of their land and environment but also produce healthier and more nutritious food. These methods also have the potential to combat the challenges posed by climate change and ensure food security for future generations. It is important for policymakers, researchers, farmers, and consumers to work together to promote and support these sustainable agriculture practices for a healthier and more resilient food system. (Kumar et al., 2018) [1] . Drastic climatic changes and reduced irrigation facilities are heading to increase the percent of dry lands and posing threat to food production and subsequently food and nutritional security. 40% of the global land surface is dry land and 78% dry land Expansion is expected to occur in developing countries by 2100 (Huang et al., 2016) [2] .

Hence, focus should be shifted to find sustainable solution that quench's world hunger and

Improve the quality of life. Role millets cannot be overlooked in achieving sustainable food

and nutritional security. International crops research institute for the semi-arid tropics

(ICRISAT) is focusing on increasing the productivity of millets and has included finger millet (Eleucine corcana) as sixth mandatory crop (ICRISAT, 2017) [3] .

Materials and methods

The word millet is derived from the French word "mille" which means thousand, implying that a handful of millet contains thousands of grains (Taylor et al., 2008) [4] . Millets are group of small seeded grasses popularly grown as cereal crops for food or fodder. Millets are often known as coarse grains or poor people's crops. Millets have been in the cultivation in the East Asia for about 10,000 years. Sorghum, pearl millet, finger millet, foxtail millet, kodo millet, proso millet, barnyard millet and little millet are commonly cultivated millets in India (Rao et al., 2017) [5] .

Millets are important nutritional bio sources due to its richness in starch, protein, fiber, niacin, magnesium, phosphorus, manganese, iron, potassium, essential amino acids and vitamin E. In addition to being as a good source of nutrients, millets have various therapeutic benefits such as prevention of heart diseases, diabetes, migraine, cancer and gastro intestinal diseases (Das et al., 2016) [6] .

In the recent years minor millets have gained the attention due to their ability to grow in poor

soil and adverse climatic conditions. They provide nutritious grain and fodder in a short span of time (Michaelraj et al., 2013) [7] . Hence, Minor millets play food based approach for achieving food, nutritional security and also address life style disorders.

Kodo millet (Paspalum scrobiculatum) is one among the minor millets also known as avaragu, haraka and arakalu, is widely grown in damp habitats of tropic and sub tropics of the world. In India it is widely grown in Uttar Pradesh, Tamilnadu and Kerala (Rao et al., 2017) [5] . Kodo millet has around 11% protein and is found to superior to other cereals in terms of dietary fiber and antioxidant potential (Patil et al., 2014) [8] . Hence evaluation of quality of millets would help understanding, diversifying the usage the millets in ensuring food, nutrition security in the ever changing modern world.

Materials and methods:

The Kodo millet grains that were procured from the local market in Ayodhya, Uttar Pradesh, India, underwent a rigorous cleaning process before being milled into fine flour. This flour was carefully examined to assess its quality, ensuring that only the best and most nutritious product was being produced. The dedication and attention to detail in this process reflect our commitment to delivering high-quality, healthy grains.

Physical and functional properties of kodo millet flour:

The bulk density of samples was determined by procedure given by Stojceska et al. (2008) [9] and calculated using below formula.

$$\text{Bulk Density} = \frac{(W2 - W1)}{\text{Volume (ml)}}$$

Rehydration ratio of the samples was estimated by procedure given by Haleem et al. (2014) [10] . Water activity of samples was determined according to the procedure given by Abramovic et al. (2008) [11] . Water holding capacity of samples was determined by the procedure given by Traynham et al. (2007) [12] and Ettoumi et al. (2015) [13] using below formula.

$$\text{WHC} = \frac{(\text{Wt of the bottel after decanting} - \text{Wt of dry bottel}) - \text{Sample Weight (g)}}{\text{Sample weight (g)}}$$

Water absorption index of the samples was analyzed by the procedure given by Thilagavathi et al. (2015) [14] using below formula.

$$\text{WAI(g/100g)} = \frac{\text{Weight of Sediment}}{\text{Weight of Sample}}$$

Water solubility index of the samples was assessed by following the procedure given by Thilagavathi et al. (2015) [14] using below formula

$$\text{WSI(\%)} = \frac{\text{weight of dissolved solid in superntant}}{\text{sample weight (g)}} 100$$

Results and Discussion

Physical and functional properties of kodo millet flour Physical and functional properties such as, bulk density, rehydration ratio, water activity, water holding capacity, water absorption index, water solubility index were discussed in figure:1.The bulk density of kodo millet flour was 0.68 ± 0.00 g/ml. Gull et al. [24] reported similar results with respect to bulk density in finger millet flour. Rehydration characteristics are usually used as the index for quality of the dried foods. The rehydration ratio of kodo millet flour was 2.14 ± 0.07%. Water activity of kodo millet flour was 0.48 ± 0.00, indicating high microbial stability as Haleem et al. (2014) [10] reported that the activity of all microorganisms would be inhibited at a water activity level less than 0.6. Traynham et al. (2007) [12] stated that, water holding capacity is the ability of a protein matrix to absorb and retain bound, hydrodynamic, capillary, and physically entrapped water against gravity. A water holding capacity of 0.53 ± 0.00 was seen kodo millet flour. Water absorption index and water solubility index of kodo millet flour was 8.00 ± 0.00 g/100g and 8.06 ± 0.02 (g/100g).The water absorption and water solubility indices of the present investigation were similar with the results reported by Thilagavathi et al. (2015) [14]

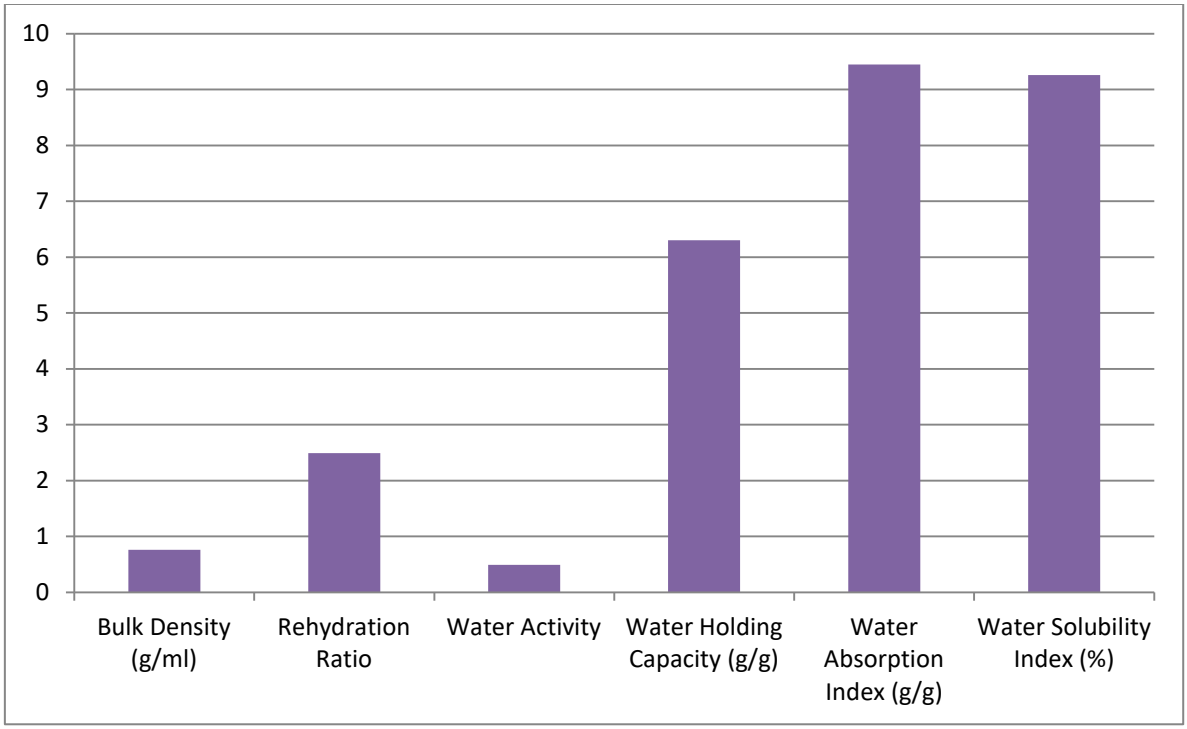

Fig 1: Physical and functional properties of kodo millet flour

Nutritional properties kodo millet flour

Nutritional properties of kodo millet flour were presented in the table 1. The moisture content of kodo millet flour was 9.34 ± 0.23%, protein was 7.60 ± 0.1%, fat was 1.24 ± 0.15%, ash was 1.39 ± 0.05% and crude fiber content was 4.06 ± 0.03%. Moisture, protein, fat, ash and crude fiber content of kodo millet flour of present investigation were found to be similar to results of kodo millet flour reported by Thilagavathi et al. (2015) [14] . 77.05 ± 0.32 g/100g and 345.77 ± 0.9 K. Cal/100g respectively and were found to be in similar with the results reported by Devi (2012) [25] Wakeel. (2007) [26] declared that dried products containing moisture content less than 10% indicate a good keeping quality. Hence it was clear that moisture content of the flour was within the acceptable range and indicates a good keeping quality.

Vitamin C content of kodo millet flour was 0.67 ± 0.12 mg/100g. The dietary fiber content of kodo millet flour was 14.78 ± 0.11 g/100g indicating that kodo millet is superior to many cereals and plays important role in managing life style disorders.

The in vitro protein digestibility of kodo millet flour was 74.58 ± 0.35%. It was found that in vitro protein digestibility of kodo millet flour was found to be similar to yellow and white varieties of foxtail millet (Mohamed et al., 2009) [27] Per cent radical scavenging activity of kodo millet flour was found to be 55.22 ± 1.60

Table 1: Nutritional properties of kodo millet flour

Nutritional parameter	kodo millet flour
Moisture (%)	9.34 ± 0.23
Protein (%)	7.60 ± 0.30
Fat (%)	1.44 ± 0.15
Ash (%)	1.39 ± 0.05
Crude fiber (%)	4.06 ± 0.03
Carbohydrates (%)	77.05 ± 0.42
Energy (K. Cal/100g)	345.77 ± 0.9
Vitamin C (mg/ 100g)	0.67 ± 0.32
Dietary fiber (g/100g)	14.78 ± 0.21
In vitro protein digestibility (%)	77.28 ± 0.35
Antioxidant capacity %	55.22 ± 1.60

Values are mean ± standard deviations

Conclusion

Kodo millet's superior nutrient composition makes it a promising food-based approach for achieving food and nutritional security. By diversifying consumption and promoting its consumption, it can be a climate-smart strategy for enhancing community health and nutrition. Incorporating Kodo millet into the diet provides essential nutrients and phyto-chemicals, supporting sustainable food production and addressing malnutrition and diet deficiencies. Promoting the consumption of Kodo millet is crucial for improving health and nutrition quality within communities.

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