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A study on the sensory quality, nutrient content and shelf life of kavuni rice flour

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Abstract
The present study aimed to determine the acceptability of Kavuni rice as a breakfast item idly and to assess the nutrient content, antioxidant activity and shelf life of the Kavuni rice flour. The results of the experimental study revealed that the Kavuni rice idly had acceptable sensory quality in taste, texture and flavor is due to its distinctive odor. Kavuni rice is dense in macronutrients when compared to white rice. The Kavuni rice flour has an excellent antioxidant property and it could be used in scavenging free radicals. Microbial analysis showed that the Kavuni rice flour has better keeping quality. Developing products using Kavuni rice that are nutrient rich with better acceptability and keeping quality can help improve the overall health of the population.

Keywords: Kavuni rice, sensory evaluation, nutrient content, shelf life

1. Introduction
Rice is an important staple food crop for human health because it provides the bulk of calories for more than half the world's population. Colored rice has been consumed for a long time in many Asian countries. Among these varieties, black glutinous rice is the most famous one, generally used as an ingredient in snacks and desserts (Tananuwong and Tewaruth, 2010) [12]. In Karaikudi village, Tamil Nadu where the black rice is grown, the farmers and natives use this rice to prepare sweet Pongal recipe (Sridevi *et al*., 2015) [10]. Black rice is overall praised world-wide for its health benefit which makes it the perfect rice selection for the best health return (Kushwaha, 2016) [4].

Food is being rated for its quality either consciously or sub-consciously by the people. Food chosen by the consumers are based on its quality and their individual likes and dislikes (Roday, 2012) [8]. Quality has been defined as the degree of excellence (Potter and Hotchkiss, 1995) [7]. It includes factors such as taste, appearance, and nutrient content as well as its bacteriological or keeping quality (Vaclavik and Christian, 2003) [13]. This includes external factors such as appearance (size, shape, color, gloss and transparency), texture, and flavor; factors such as federal grade standards (e.g. of eggs) and internal (chemical, physical and microbial) (Souza and Pradhan, 2010) [9].

2. Objectives of the study
1. To assess the acceptability of the Kavuni rice idly for the sensory attributes-color, taste, texture, flavor and overall acceptability using 5-point scorecard.
2. To assess the nutrient content and antioxidant activity.
3. To assess the shelf life of the Kavuni rice flour.

3. Design of the study
This study is an experimental research. The breakfast item Kavuni rice idly was developed and was tested for its acceptability using a five-point score card. The nutrient content, antioxidant activity and shelf life of the Kavuni rice flour was assessed using laboratory techniques.

3.1 Sample Size
- Thirty adolescent girls between the age of 19-25 years were selected as taste panel members from Women's Christian College, Chennai.

3.2 Criteria for selection of sample
- Subjects willing to participate in the study.
- Subjects with no other complications and food allergies.

3.3 Duration of the Study
The duration of the study was six months. It was carried out between December 2017- March 2018.

3.4 Assessment of Sensory Quality and Acceptability
The breakfast item idly was developed by replacing refined rice flour with Kavuni rice flour. The recipe was tried for several times, the methods were standardized and the product was evaluated for their sensory attributes. A five-point scale was used to determine the sensory quality and acceptability of the Kavuni rice idly by the taste panel. The product to be tested was served to the judges in a single plate and were asked to taste and fill the 5-point score card for the product. Qualities describing the product were attributed to each score. The newly developed product was assessed for the sensory attributes in terms of appearance, color, flavor, taste, texture, overall acceptability. A maximum score of 5.0 was given for excellent quality and 1.0 for poor quality.

3.5 Assessment of Nutrient Content, Antioxidant Activity and Shelf Life
Kavuni rice flour was analyzed for its nutrient content, antioxidant content, fiber and moisture content. The antioxidant activity was also assessed using DPPH method. The shelf life of the Kavuni rice flour was assessed using microbial techniques like standard plate count using pour plate technique and to detect the presence of pathogenic microbes like salmonella, and coliforms. The tests were conducted on 1st, 15th, and 28th day.

3.6 Statistical Analysis
The data collected were subjected to suitable statistical analysis.

4. Results and Discussion
The present study was designed to assess the acceptability of the newly developed breakfast item Kavuni rice idly and also to determine the nutrient content, antioxidant activity and shelf life of the Kavuni rice flour.

4.1 Sensory Evaluation
The Kavuni rice idly was prepared and standardized. The idly was assessed for sensory quality with five-point score card for the attributes-appearance, color, taste, texture, flavor and overall acceptability.

From table 1 and figure 1, it can be seen that the attribute color has received the highest score with the mean value of 3.96 for a maximum score of 5.0 followed by the attribute appearance (3.83) The overall acceptability score was 3.26. With regard to other attributes, the mean score of taste was 2.6, texture was 2.56 and flavor was 2.73. The lower scores in taste, texture and flavor is due to the dark color of the Kavuni rice and because of its distinctive odor. A study by Sridevi *et al*. (2015) [10] states that generally the recipes prepared by black rice were moderately accepted. Also the findings of the study showed that more number of breakfast and lunch recipes prepared using White rice scored higher significant level. On the other hand, the snack item prepared both from black rice and White rice were equally acceptable (Sridevi *et al*., 2015) [10].

4.2 Nutrient Content
The nutrient content of Kavuni rice flour was analyzed for macronutrients. Antioxidant activity was also assessed. The results of the nutrient analysis is given in table 2.

From the table 2, we could see that the energy value of Kavuni rice (375kcal) found to be slightly more than the raw rice (356kcal). The macronutrients, such as protein (15g) and fat (0.63g) is higher in Kavuni rice when compared to White rice; while the carbohydrate content (78.24g) of White rice is marginally greater than Kavuni rice. The black rice has a number of nutritional advantages over common rice as it contains higher content of protein, dietary fiber, vitamins, minerals and natural anthocyanin compounds, such as cyanidin 3-glucoside and peonidin 3-glucoside, which possess anti-oxidative and anti-inflammatory activities (Chun Hu *et al*., 2003) [2]. Protein is high in Kavuni rice. Dietary protein is crucial for development of bone and muscle, and recent evidence suggests that increasing dietary protein above the current Recommended Dietary Allowance (RDA) may help maintain bone and muscle mass in older individuals (Stomberg *et al*., 2009) [11].

4.3 Antioxidant Activity
The antioxidant activity of the Kavuni rice flour was studied using DPPH method. Ascorbic acid was used as standard control. The percentage inhibition of the sample is given in table 3.

The table 3 and figure 2 shows that, as the concentration of the sample increased the annihilation activity of free radicals decreased. This is evident by the increase in the percentage of inhibition after addition of different concentration of sample extracts. In the control, at 200µg the percentage inhibition was 79.5. From 400 to 1000µg concentration the percentage inhibition was 93.45 to 94.29. This shows that, percentage of inhibition remained somewhat stable even though there was an increase in the concentration of the extract in the control. In the sample, the percentage inhibition increased as the concentration increased. The Kavuni rice flour has an excellent antioxidant property and it could be used in scavenging free radicals. Kavuni rice is rich in anthocyanins. Anthocyanins, belong to a group of reddish purple water soluble flavonoids (Yafang, Gan and Jinsong, 2011) [14]. Anthocyanins also have the ability to prevent the formation or to decrease the concentrations of reactive cell damaging free radicals (Chun Hu, *et al*., 2003; Adom and Liu, 2002) [2, 1]. Studies have also shown that Black rice extracts could more effectively scavenge superoxide anions than hydroxyl radicals (Nam *et al*., 2006) [6].

4.4 Shelf Life of Kavuni Rice Flour
Kavuni rice was subjected to microbial analysis for assessing the shelf life on the 1st day, 15th day and 28th day. The results of the microbial analysis are presented in table 4. From figure 3, Plate 1(a), Plate 1(b), Plate 1(c), Plate 2(a), Plate 2(b), Plate 2(c) and Plate 3(a), Plate 3(b), Plate 3(c), it is very clear that the Kavuni rice flour stored in an airtight packet had no growth of colonies on the 1stday, 15th day and 28th day. Also no growth of pathogenic organisms like salmonella and *E. coli* was observed on the plates during the 1st, 15th and 28th days of observation. This indicates the absence of pathogenic organisms in the sample and is safer for human consumption even after 28 days of storage.

Salmonella spp., *V. cholerae*, and *E. coli* are classified as zoonotic agents. These bacteria are found almost everywhere. Humans, animals, and sewage can be sources of these bacteria. The presence of *E. coli*, *Salmonella* spp., or *V. cholerae* in drinking water is a threat to human health. These bacteria can cause haemorrhagic colitis, diarrhea, nausea, abdominal cramps, fever, and vomiting, and cholera, respectively (Momtaz *et al*., 2013) [5]. The table shows that the Kavuni rice is free from pathogenic organisms and therefore safer for human consumption.

5. Tables and Figures

Table 1: Mean scores for the sensory attributes

Attributes	Appearance	Color	Taste	Flavor	Texture	Overall Acceptability
Mean score	3.83	3.96	2.6	2.73	2.56	3.26

Table 2: Nutrient Content of Kavuni Rice Flour

Nutrients	Quantity	
	Kavuni rice/ 100g	White rice /100g
Energy (kcal)	375	356
Protein (g)	15	7.94±0.58
Fat (g)	0.63	0.52±0.05
Carbohydrates (g)	78	78.24±1.07

Table 3: Percentage Inhibition of sample

Concentration (µg)	Percentage inhibition	
	Sample	Control
200	21.40	79.5
400	36.54	93.45
600	50.29	93.73
800	62.31	94.12
1000	64.20	94.29

Table 4: Microbial Analysis of Kavuni Rice Flour

Microbial Test	10^{-3}			10^{-4}			10^{-5}		
	1th Day (CFU)	15th Day (CFU)	28th Day (CFU)	1th Day (CFU)	15th Day (CFU)	28th Day (CFU)	1th Day (CFU)	15th Day (CFU)	28th Day (CFU)
Total Plate Count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Salmonella	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E.coli	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

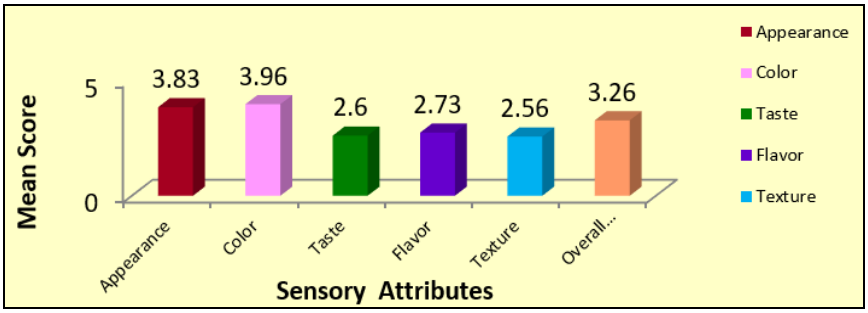

Fig 1: Mean Sensory Scores for Kavuni Rice Idly

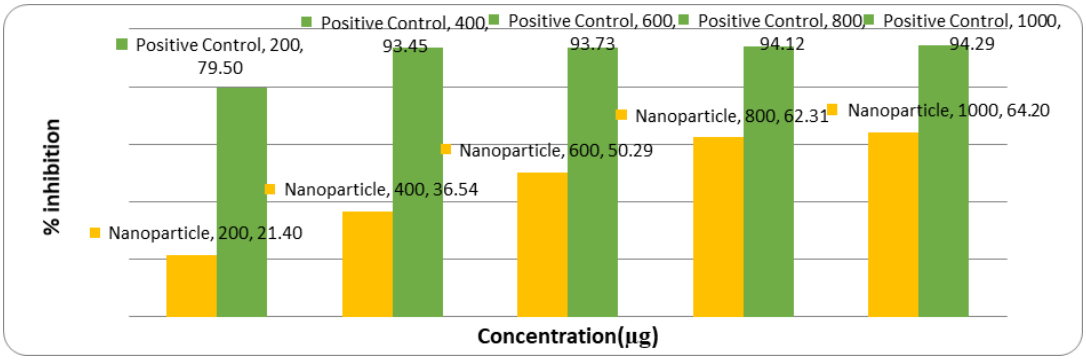

Fig 2: DPPH Scavenging Activity

Plate 1(a): 1st Day Plate Count -No Colonies

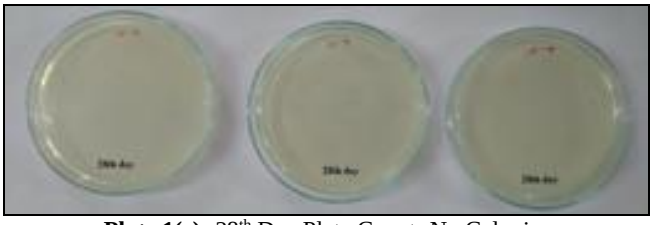

Plate 1(c): 28th Day Plate Count -No Colonies

Plate 1(b): 15th Day Plate Count -No Colonies

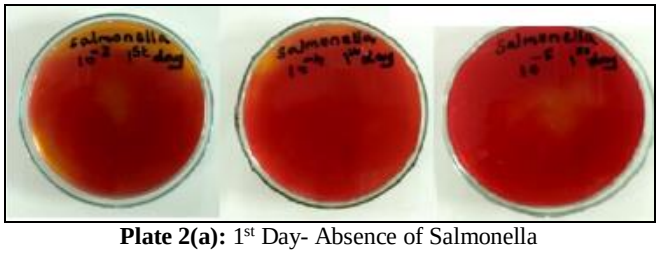

Plate 2(a): 1st Day- Absence of Salmonella

Plate 2(b): 15th Day- Absence of Salmonella

Plate 2(c): 28th Day- Absence of Salmonella

Plate 3(a): 1st Day- Absence of *E. coli*

Plate 3(b): 15th Day- Absence of *E. coli*

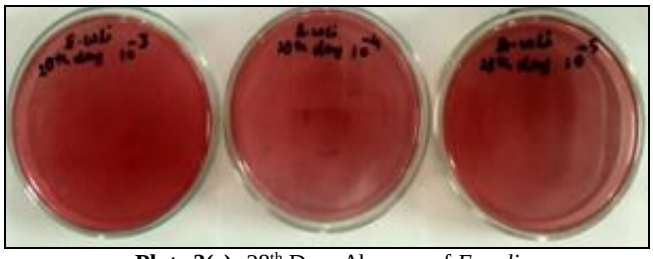

Plate 3(c): 28th Day- Absence of *E. coli*

Fig 3: Qualitative determination of pathogenic organism in the samples

6. Conclusion

Black rice is one of the healthiest food types of today. It is packed with a wide array of nutrients (Guo, *et al*., 2007). The sensory attributes of the Kavuni rice idly showed better acceptability when compared to white rice except for its taste, texture and flavor attributes because of its distinctive odor. Kavuni rice is nutrient dense when compared to white rice and showed better keeping quality when stored in an airtight packet.

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