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Research Note

Functional Properties of Traditional Rice Varieties of Karnataka

OVER half of the world's population uses rice as a staple food. The introduction of modern high yielding varieties, along with new management practices and green revolution has led to a considerable increase in rice production in India as well as in other Asian countries. This development has led to a gradual erosion of the rice genetic diversity, since thousands of traditional rice varieties were replaced by relatively few high yielding rice varieties (Rahman and Sahal *et al.,* 2006). Rice has many unique functional properties, such as ease of digestion, white color, hypoallergenic properties etc. Functional properties are the fundamental physico-chemical properties that reflect the complex interaction between the composition, structure, molecular conformation and physico-chemical properties of food components together with the nature of environment in which these are associated and measured (Kaur and Singh, 2006; Siddiq *et al.,* 2009). The change in nutritional quality, chemical composition and activities of various enzymes and biochemical processes would affect functional properties of rice flour, which directly influence the quality of rice based products. Therefore, this study was conducted to evaluate the functional properties of flours of traditional rice varieties.

The research work was carried out at the Department of Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bengaluru. Functional properties of rice flours from traditional rice varieties were determined for bulk density, water and oil absorption capacity, water solubility index, swelling capacity, emulsion activity and emulsion stability. The techniques and procedure adopted for determining the functional properties are presented below.

Ten grams of the rice flour was placed in a 25 ml graduated cylinder and packed by gentle tapping of the cylinder on a bench top, ten times until no visible decrease in volume was noticed, from a height of 5 to 8 cm. The final volume of the rice flour was measured and expressed as gram per cubic centimetre (cm^3).

Water and oil absorption capacity was determined according to the method reported by Elmoneim *et al.* (2010). One gram of flour was weighed into a pre-weighed centrifuge tube and 10 ml of distilled water were added. Samples were vortexed for one min and allowed to stand for 30 min at 25 °C before being centrifuged at 4000 × g for 25 min. Excess water was decanted by inverting the tubes over absorbent paper and samples were allowed to drain. For oil absorption, 10 ml refined sunflower oil were used. The weights of water and bound oil samples were calculated by difference. The results were expressed as per cent water or oil bound per gram of flour.

Water Solubility Index (WSI) of the rice flour was measured by the method of Kadan *et al.* (2008). Two and half grams of flour was suspended in 30 ml of distilled water (30 °C) in a 50 ml pre-weighed centrifuge tube by vortexing. The tubes were placed in a water bath at 30 °C and stirred intermittently for 30 min. The suspension was centrifuged for 10 min at 3000 × g. The supernatant was decanted into a pre-weighed 50 ml beaker. The supernatant was dried at 95 °C and the weight of dried solids was used to calculate the WSI.

The method of Chandra *et al.* (2015) with some modifications was used for determining the swelling capacity. The flour filled up to 10 ml mark in a 100 ml graduated cylinder was added with water to adjust total volume to 50 ml. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 min and allowed to stand for further 30 min. The volume occupied by the sample was taken after 30 min.

The emulsion activity and stability described by Chandra *et al.* (2015) was followed and the emulsion (1 g flour, 10 ml distilled water and 10 ml sunflower oil) was prepared in calibrated centrifuged tube. The emulsion was centrifuged at 2000 × g for 5 min. The ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion activity in percentage.

The emulsion stability was estimated after heating the emulsion contained in calibrated centrifuged tube at 80 °C for 30 min in a water-bath, cooling for 15 min under running tap water and centrifuging at 2000 × g for 15 min. The emulsion stability expressed as percentage was calculated as the ratio of the height of emulsified layer to the total height of the mixture.

All data were analyzed by the one way Analysis of Variance (ANOVA) procedure using Microsoft Excel 2007. Differences were declared statistically significant when $P<0.05$. Where significant differences were detected, the means were separated by Duncan's multiple range test (DMRT) at 5 per cent probability level using the MSTAT-C statistical package.

The results in table illustrates the functional properties of traditional rice varieties. The properties such as bulk density, water absorption capacity (WAC), oil absorption capacity (OAC), water solubility index (WSI), swelling capacity (SC), emulsion activity (EA) and emulsion stability (ES) were studied in rice flours of different varieties. Significant differences were observed between rice varieties with regard to functional properties.

The high bulk density suggests their suitability for use in food preparations. On contrast, low bulk density would be an advantage in the formulation of complementary foods. Bulk density of rice flours of long grain rice varieties ranged from 0.670 to 0.843 g/cm^3. Medium and short grain rice varieties showed bulk density in the range of 0.723 to 0.826 g/cm^3 and 0.690 to 0.810 g/cm^3, respectively. Overall, bulk density found significantly highest in long grain variety Gamnad batta (0.843 g/cm^3) followed by Murakan sanna (0.830 g/cm^3) and least was observed in Anandi and Nagabatta (0.670 g/cm^3). The results of this study are in accordance with those reported earlier by Moongngarm *et al.* (2014) in ungerminated brown rice flour ranged between 0.53 to 0.64 g/ml. Difference in the bulk density depends on particle size and initial moisture content of flours (Chandra and Samsher, 2013).

WAC of rice flours of long grain varieties ranged from 1.020 to 1.350 per cent being highest for variety Gamnad batta and least for Gajagunda. Rice flours of medium and short grain rice varieties recorded WAC in the range of 1.033 (Rajamudi) to 1.303 (Malgudi sanna) per cent and 1.043 (Kalajeera) to 1.250 (Rajakaime) per cent, respectively. Irrespective of grain type, WAC found significantly highest in Gamnad batta (1.350%) and lowest in Gajagunda (1.020%).The results are comparable with the values reported by Kadan *et al.* (2008) in commercial long grain rice flour and flours made by using a pin mill and the Udy mill from the same batch of broken second head white long grain rice.

The oil absorption capacity (OAC) of rice flour is equally important as it improves the mouth feel and retains the flavor (Islam *et al.,* 2012). OAC of long grains ranged from 0.720 to 1.050 per cent maximum values were recorded for variety Gamnad batta and minimum for Gajagunda. Medium and short grain rice varieties recorded OAC in the range of 0.733 to 1.003 per cent (Rajamudi & Malgudi Sanna) and 0.743 to 0.950 per cent (Kalajeera & Rajakaime), respectively. Overall, significantly highest oil absorption capacity recorded by long grain variety Gamnad batta (1.050%) and lowest recorded by Gajagunda (0.720%) followed by Rajmudi (0.733%). Results are comparable with the reported value of 0.83 to 1.01 per cent by Moongngarm *et al.* (2014).

The water and oil absorption capacity of flour depend upon the intrinsic factors like amino acid composition, protein conformation and surface polarity or hydrophobicity (Chandra and Samsher, 2013).

Similar trends were observed for WSI as in WAC and OAC among all the varieties studied. It ranged from 1.459 to 1.931 per cent in rice flours of long grains, 1.478 to 1.864 per cent in medium grains and 1.492 to 1.788 per cent in short grains. Similar findings were reported by Kadan *et al.* (2008). The difference in varieties for WSI might be due to particle size of the flour.

Swelling capacity of flours of long grain rice varieties has been reported to range from 11.83 to 17.10 ml with Gamnad batta having highest capacity. Swelling capacity range of 11.90 to 16.40 ml and 12.67 to 15.10 ml was observed in medium and short grain rice varieties, respectively. Overall, highest swelling capacity recorded by Gamnad batta (17.10 ml) and lowest by Gajagunda (11.83 ml). The values are in accordance with Islam *et al.* (2012), the researcher reported swelling capacity of 16.04 ml in brown rice flour.

The ability of the proteins of these rice flours to bind with oil makes it useful in food system where optimum emulsion capacity is desired. Highest

TABLE

Functional properties of flours of traditional rice varieties

Category	No.	Varieties	Bulk density (g / ml)	Water absorption capacity (%)	Oil absorption capacity (%)	Water solubility index (%)	Swelling capacity (ml)	Emulsion activity (%)	Emulsion stability (%)
Long grain	1	Gamnad batta	0.843 ^{a}	1.350 ^{a}	1.050 ^{a}	1.931 ^{a}	17.10 ^{a}	34.61 ^{g}	30.47 ^{g}
	2	Anandi	0.670 ^{j}	1.233 ^{cd}	0.933 ^{cd}	1.764 ^{cd}	14.23 ^{e}	38.54 ^{d}	34.39 ^{d}
	3	Krishnaleela	0.770 ^{e}	1.063 ^{h}	0.763 ^{h}	1.521 ^{h}	12.10 ^{n}	31.64 ^{n}	27.50 ^{n}
	4	Kagisaale	0.786 ^{d}	1.070 ^{h}	0.770 ^{h}	1.530 ^{h}	12.27 ^{m}	32.18 ^{k}	28.04 ^{k}
	5	Murakan sanna	0.830 ^{ab}	1.297 ^{b}	0.996 ^{b}	1.854 ^{b}	15.23 ^{c}	31.77 ^{lm}	27.63 ^{lm}
	6	Mysore mallige	0.790 ^{d}	1.163 ^{e}	0.863 ^{e}	1.664 ^{e}	12.83 ^{hi}	32.42 ^{j}	28.28 ^{j}
	7	Nagabatta	0.670 ^{j}	1.207 ^{d}	0.906 ^{d}	1.726 ^{d}	12.90 ^{h}	35.15 ^{e}	31.01 ^{e}
	8	Gajagunda	0.770 ^{e}	1.020 ^{i}	0.720 ^{i}	1.459 ^{i}	11.83 ^{o}	30.05 ^{o}	25.90 ^{o}
Medium grain	9	Doddabyranellu	0.750 ^{fg}	1.127 ^{fg}	0.826 ^{fg}	1.611 ^{fg}	12.60 ^{jk}	32.18 ^{k}	28.04 ^{k}
	10	Ratnachoodi	0.766 ^{e}	1.150 ^{ef}	0.850 ^{ef}	1.645 ^{ef}	13.17 ^{g}	32.22 ^{k}	28.08 ^{k}
	11	Malgudi sanna	0.826 ^{b}	1.303 ^{b}	1.003 ^{b}	1.864 ^{b}	16.40 ^{b}	42.27 ^{a}	38.13 ^{a}
	12	Gowrisanna	0.770 ^{e}	1.160 ^{e}	0.860 ^{e}	1.659 ^{e}	13.43 ^{f}	32.56 ^{i}	28.42 ^{i}
	13	Chinna ponni	0.723 ^{h}	1.167 ^{e}	0.866 ^{e}	1.668 ^{e}	13.27 ^{g}	34.77 ^{f}	30.63 ^{f}
	14	Salem sanna	0.790 ^{d}	1.110 ^{g}	0.810 ^{g}	1.587 ^{g}	12.50 ^{kl}	31.74 ^{m}	27.60 ^{m}
	15	Karimundaga	0.820 ^{bc}	1.153 ^{ef}	0.853 ^{ef}	1.649 ^{ef}	12.40 ^{lm}	33.58 ^{h}	29.44 ^{h}
	16	Rajmudi	0.823 ^{bc}	1.033 ^{i}	0.733 ^{i}	1.478 ^{i}	11.90 ^{o}	30.04 ^{o}	25.90 ^{o}
Short grain	17	Rajakaime	0.690 ^{i}	1.250 ^{c}	0.950 ^{c}	1.788 ^{c}	15.10 ^{c}	39.29 ^{c}	35.15 ^{c}
	18	Jeerige sanna	0.810 ^{c}	1.167 ^{e}	0.866 ^{e}	1.668 ^{e}	12.73 ^{ij}	32.48 ^{j}	28.33 ^{j}
	19	Gandhasaale	0.743 ^{g}	1.233 ^{cd}	0.933 ^{cd}	1.764 ^{cd}	14.60 ^{d}	40.08 ^{b}	35.93 ^{b}
	20	Kalajeera	0.760 ^{ef}	1.043 ^{hi}	0.743 ^{hi}	1.492 ^{hi}	12.67 ^{j}	31.83 ^{l}	27.69 ^{l}
		F test	*	*	*	*	*	*	*
		SEm±	0.006	0.010	0.010	0.014	0.047	0.026	0.080
		CD at 5 %	0.017	0.026	0.026	0.038	0.131	0.073	0.222

* Significant at 5 % level

Note: Means in the same column followed by different superscript letters differ significantly emulsion activity was observed in medium grain rice variety Malgudi sanna (42.27 %) and the least activity was observed in Rajmudi (30.04 %). Similar values were recorded by Chandra and Samsher (2013) for rice flour. Hydrophobicity of protein has been attributed to influence their emulsifying properties (Kaushal *et al.,* 2012).

The capacity of protein to enhance the formation and stabilization of emulsions is important for many applications in food products like cake, coffee whiteners and frozen desserts. In these products, varying emulsifying and stabilizing capacity are required because of their various compositions and processes (Adebowale *et al.,* 2005). In the present study, similar trend was observed between flours of different rice varieties for emulsion stability as in emulsion activity. Irrespective of flours of grain type, highest emulsion stability was recorded for the variety Malgudi sanna (38.13%) and least for Gajagunda and Rajmudi (25.90%) varieties. The reported value by Chandra and Samsher (2013) for emulsion stability in rice flour is comparable with the results obtained in this study.

The results of this study demonstrated a wide range of functional properties among traditional rice varieties, which provided the basic information for future development of food applications using these varieties.

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